



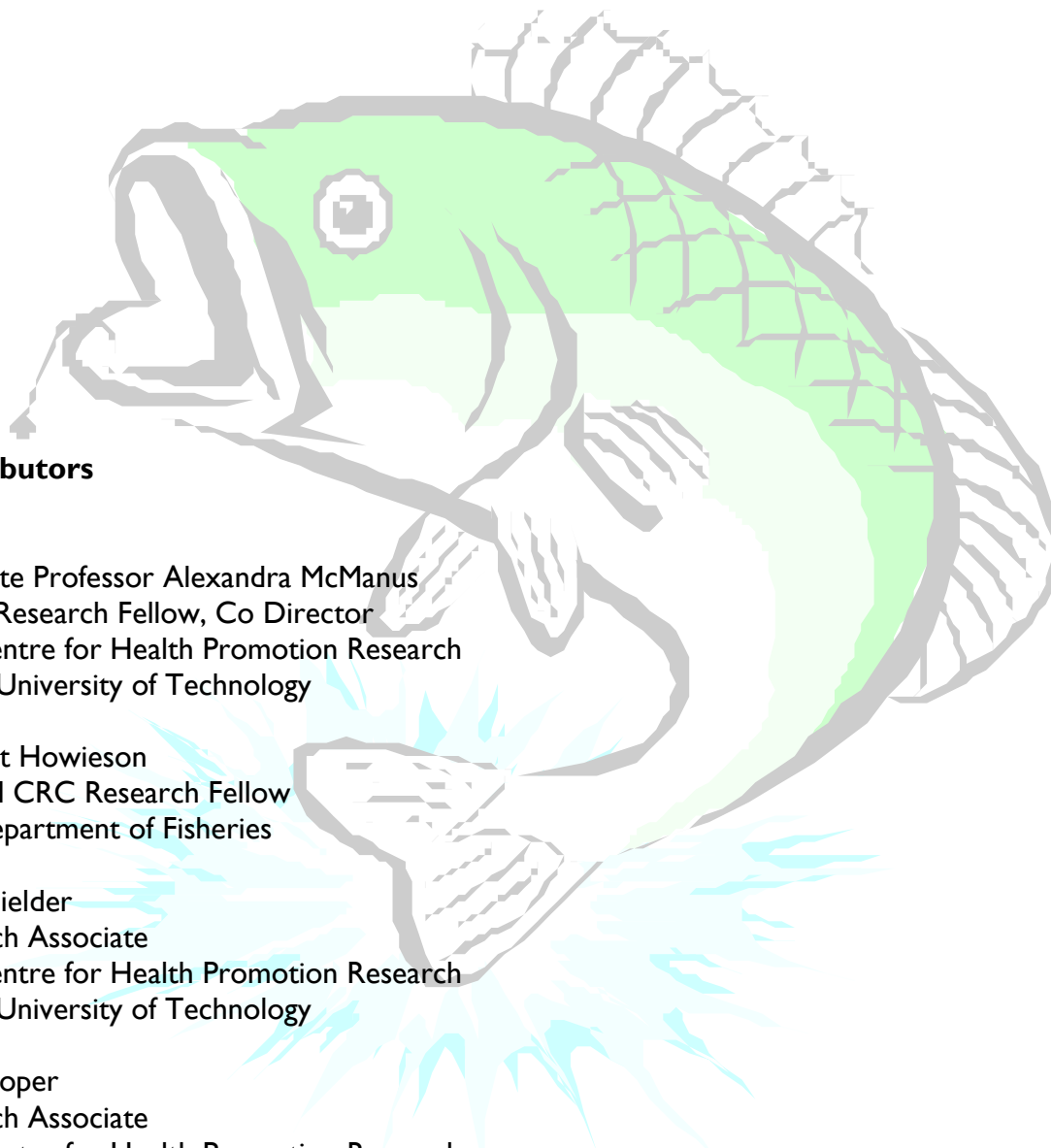
**Review of health benefit research and development relevant  
to the Australian seafood industry and members of the  
Australian Seafood CRC**

**Prepared by the**

**Western Australian Centre for Health Promotion Research  
Curtin University of Technology**

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## **Review of health benefit research and development relevant to the Australian seafood industry and members of the Australian Seafood CRC**



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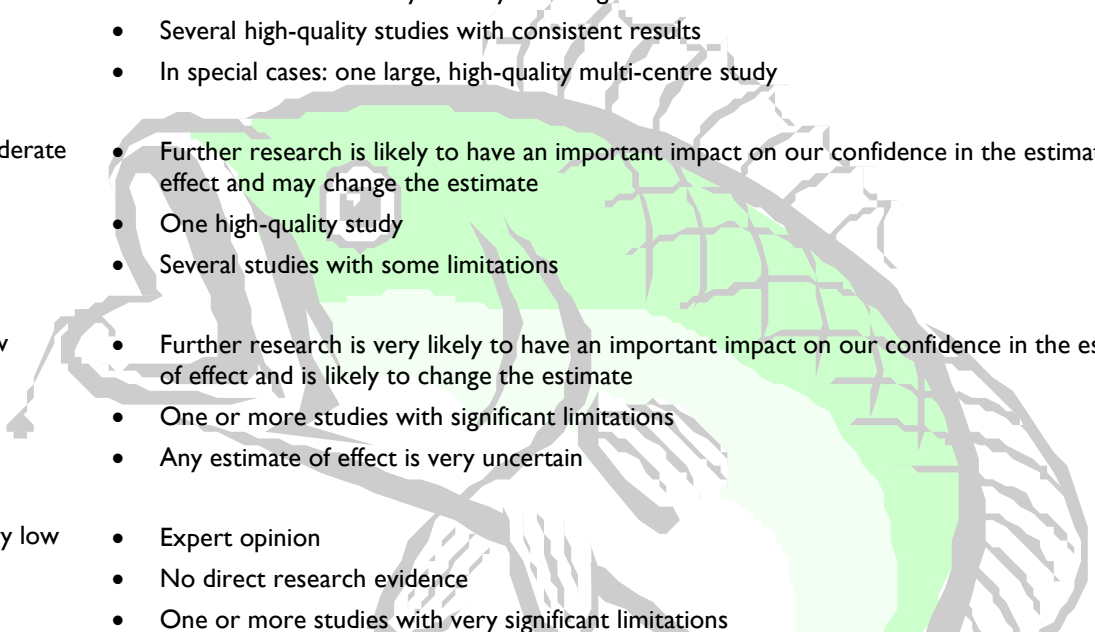
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## Executive Summary

### 1.0 Evidence relating to health conditions and seafood consumption

The following provides an overview of evidence from studies published in peer-reviewed journals associated with seafood consumption and health. The level of evidence around each health issue was estimated using the following criteria:

- 
- A High
- Further research is very unlikely to change our confidence in the estimate of effect
  - Several high-quality studies with consistent results
  - In special cases: one large, high-quality multi-centre study
- B Moderate
- Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate
  - One high-quality study
  - Several studies with some limitations
- C Low
- Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate
  - One or more studies with significant limitations
  - Any estimate of effect is very uncertain
- D Very low
- Expert opinion
  - No direct research evidence
  - One or more studies with very significant limitations

#### 1.1 All cause mortality

- Regular fish consumption is associated with a significantly reduced risk of total mortality. (A)
- There is strong evidence that increased consumption of n-3 polyunsaturated fatty acids (PUFA) reduces the risk of all cause mortality. (B).
- 1-2 serves fish/wk (esp. those  $\uparrow$  in n-3 PUFA's)  $\downarrow$  risk total mortality by 17% (A).

#### 1.2 Arthritis

- Evidence that fish consumption is protective against rheumatoid arthritis, and ulcerative colitis in males. (A)
- Ingestion of n-3 fatty acid supplements has consistently shown improvement in joint tenderness and the amount of morning stiffness in those with rheumatoid arthritis.(B)
- Evidence that regular fish intake is beneficial in the management of inflammatory diseases.(B)
- Moderate to high intake of fish appears to be protective against rheumatoid arthritis.(B)

### 1.3 Asthma and allergies

- Fish consumption in the first year of life ↓ risk asthma and allergic rhinitis in childhood. (B)
- Risk of allergic rhinitis substantially ↓ in children who had fish during the first year of life (Relative Risk (RR) 0.025) compared with children who had fish later in life (RR 0.060). (B)
- Early introduction to fish shows a consistent negative assoc. with the risk of allergic rhinitis. (B)
- Results suggest that early intake of fish protects against airway disease in early life. (B)
- For children born to mothers with a history of asthma, Odds Ratio (OR) for asthma was 0.20 when mothers ate oily fish at least once mth during pregnancy compared with no consumption. (B)
- In contrast, fish sticks (source of trans fats) consumption during pregnancy increased asthma risk in children (OR 2.04). (B)

### 1.4 Cardiovascular disease (CVD) - overall

- 2-3 fish meals/wk is protective against CVD. (A)
- Adequate intake of Omega-3 fatty acids ↓ incidence of CVD. (A)
- Fish is more beneficial than fish oil in combating CVD and all cause mortality. (C)
- Traditional fish-based diets appear to be protective against CVD. (B)

#### 1.4.1 CVD - Cardiac conditions

- Fish intake is beneficial to heart health. (A)
- 1 serve fish/wk (20gm/day) ↓ risk of coronary heart disease (CHD). (A)
- 1-2 serves/wk (esp species high in n-3 PUFA's) reduces the risk of:
  - coronary death by 36% (A)
  - coronary heart failure by 20% (A)
  - arterial fibrillation (28% ↓ risk 1-4 /wk, 31% ↓ risk ≥5 /wk (A) and
  - myocardial infarction. (A)
- The risk of CHD is ↓ by 31% if 3-4 fish meals/wk and by 32% ↓ risk if consumed ≥ 5 /wk (A).
- Fish oil acids may reduce potentially fatal arrhythmias in people at high risk. (C)

#### 1.4.2 CVD - Stroke

- 1 serve fish/wk (white or oily fish) ↓ risk of stroke. (A)
- 1-4 serves fish/wk ↓ risk ischemic stroke by 27% (A)
- ≥ 5 serves fish/wk ↓ risk ischemic stroke by 30% (A)
- 44% ↑ risk of ischemic stroke if > 1 serve/wk of fried or sandwich fish. (A)
- Oily fish intake significantly ↓ in women who subsequently had a stroke. (A)

## 1.5 Cancer

- 30yr follow-up, men who ate no fish had a 2-3 fold higher frequency of prostate cancer than those who ate moderate or high amounts of fish. (A)
- $\geq 4$  serves fish/wk associated with  $\downarrow$  risk of prostate cancer (strongest assoc with metastatic cancer (RR=0.56) (A).
- Daily intake of marine fatty acids associated with 24%  $\downarrow$  risk in metastatic cancer. (B)
- Slightly  $\downarrow$  risk of colorectal cancer in fish consumers, more pronounced in women (B)
- Fish consumption assoc with  $\downarrow$  risk of lung cancer mortality in males (independent of cigarettes, animal fat minus fish fat, vegetable and fruit consumption). (A)

## 1.6 Diabetes

- $\uparrow$  consumption of fish assoc with  $\downarrow$  risk of CHD in diabetic women. (A)
- $\uparrow$  consumption of fish assoc with  $\downarrow$  risk of islet autoimmunity precursor for Type I diabetes in children at increased risk of Type I diabetes. (A)

## 1.7 Gender

### 1.7.1 Men

- 20%  $\downarrow$  risk in total mortality assoc with  $\geq 1$  serve fish/wk in men. (A)
- Evidence fish consumption protective against CVD and chronic respiratory disease in males. (A)
- 30yr follow-up, men who ate no fish had a 2-3 fold higher frequency of prostate cancer than those who ate moderate or high amounts of fish. (A)
- Fish consumption assoc with  $\downarrow$  risk of lung cancer mortality in males (independent of cigarettes, animal fat minus fish fat, vegetable and fruit consumption). (A)
- Men who consumed  $\geq 1$  serve fish/wk RR of sudden death of 0.48. (B)
- The influence of dominant male within the family unit should be considered in any intervention to increase regular seafood consumption. (C)

### 1.7.2 Women

- $\uparrow$  consumption of fish assoc with  $\downarrow$  risk of CVD (A) and colorectal cancer. (B)
- Women of childbearing age should consume  $\geq 2$  serves of fish /wk. (A)

## 1.8 Maternal

- Pregnant and lactating mothers should consume up to 12oz of a variety of fish each week (incl. shellfish low in mercury). (A)
- Fish consumption does not adversely affect infant gestation and birth size at a population level. (A)
- $\geq 340$  g/wk maternal seafood intake beneficial to child cognitive development. (A)
- Low seafood intake during pregnancy could lead to adverse effects on neurodevelopment. (A)
- Occurrence of preterm delivery varied from 7.1% in group never consumed fish to 1.9% in those consuming fish at least once/wk. (A)
- Low consumption of fish was a strong risk factor for preterm delivery and low birth weight. (A)
- Small amounts of n-3 FA's (provided as fish or fish oil) protective against preterm delivery and low birth weight. (A)
- Fish sticks (source of trans fats) consumption during pregnancy  $\uparrow$  asthma risk in children (OR 2.04).(B)
- Nutritional education for pregnant women required. (C)
- Fish consumption assoc. with increased length of gestation in women with a low risk of adverse pregnancy outcomes. (C)
- High shellfish intake assoc. with  $\uparrow$  risk of small for gestational age births. (C)

## 1.9 Mental health (including cognitive development)

- $\geq 340$  g/wk maternal seafood intakes beneficial to child cognitive development. (A)
- Maternal intake of very-long-chain-fatty-acids during pregnancy and lactation may be favourable for mental development of children. (B)
- Compared with low intake (21mg/d), high intake (407mg/d) of n-3 fatty acids was assoc with fewer depressive symptoms in adults (OR 0.46). (B)
- An average intake of 400 mg/d of n-3 FA's may reduce depression. (C)
- Fish consumption may be associated with slower cognitive decline with age (C)
- Greater seafood consumption predicted lower lifetime rates of bipolar disorders. (C)
- $\uparrow$  intake maternal fish during pregnancy assoc with longer gestation, increased birth weight, reduced risk of intrauterine growth retardation and lower prevalence of pregnancy-induced hypertension. (C)
- There is limited evidence around seafood, fish oil or supplements in the management of attention disorders such as ADHD. However the evidence that is available is promising.(C]
- Brains of Alzheimer patients have lower DHA in gray matter. N-3 fatty acids retard the decline in cognition over time. (C)

## 1.10 Other issues

- Negative assoc between diet rich in fruit, veg and fish and the risk of Congestive Obstructive Pulmonary Disease (COPD) (A)
- Mercury levels in Alaskan women who had a  $\uparrow$  fish intake were well below World Health Organization effect levels. (C)
- National fish advisories overemphasis risks and undervalue the benefits of fish consumption. (C)

- Interventions seeking to promote seafood as an integral part of a healthy diet should address existing negative attitudes and beliefs around the storage and preparation of seafood. (C)
- The influence of dominant males within the family unit (whether child or adult) should be considered. (C)
- Strategies directed at parents and children should include experimental hands on components to encourage experimentation, particularly focussing on use of, preparation and the variety of lower cost seafood available. (C)
- Food involvement correlated positively with fish consumption intention and frequency. (C)
- Dietary fish and weight loss had significant independent and additive effects on 24 hour ambulatory blood pressure and heart rate in overweight persons. (C)

## **2.0 What are the health risks associated with eating fish and seafood?**

- The level of pollutants in seafood, in general, was very low. (B)
- The benefits of seafood consumption far outweigh the risks associated with possible pollutants. (B)
- Fish low in mercury and high in omega-3 fatty acids are recommended. (B)
- Consumption of omega-3 fatty acids during pregnancy is essential for optimum foetus neural development. (A)

## **3.0 Consumer behaviour in relation to fish and seafood consumption**

- Perceived cost, freshness, quality, availability, taste and easy preparation were considered to be the main influences in consumer choice of fish and seafood products. (B)
- The lowest income households had the lowest fish consumption frequency. (B)
- The highly processed product varieties (battered and crumbed fish and fish in sauce dishes) were often popular among the families and perceived as easy and convenient to cook. (B)
- Odours common to fish and seafood often a deterrent to consumption. (B)
- Fresh fish and seafood preferred to alternative products (processed, smoked, canned and frozen products). (C)
- Bones and price influence purchase type but not intention to purchase. (C)
- The presence of children in the households led to lower fish consumption. (C)

## **4.0 Marketing and advertising**

- Food advertising to children predominantly featured snack foods/fast foods and confectionary. (A)
- Modern marketing techniques had a strong influence on food choice. (B)
- Changing the food advertising environment within children's television viewing time to an environment where nutritious foods are promoted and less healthful foods unrepresented would lead to the normalisation and reinforcement of healthy eating. (C)

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## 1.0 Introduction

### 1.1 Objectives for the review of evidence

The following outcomes (objectives) were proposed for the review of published literature related to seafood consumption and human health:

#### *Capacity needs*

1. Identify which organisations, institutions and spokespeople are currently providing information on seafood health benefits and the level of credibility that those organisations and institutions have. Undertake an initial assessment of their capacities and relevance to the seafood industry
2. Assess the availability of trained people to develop the resources and to deliver health benefits information to the target audiences.

#### *Health benefits research and development issues*

3. Detail the work that has been done to document the health benefits of seafood.
4. Identify the work that has been done on how communication of health benefits can and does change consumer behaviour, particularly those in the target groups (young, older people, pregnant women and specific condition sectors).
5. Identify the barriers to and drivers for the use of seafood benefits information.
6. Identify current communication material used to disseminate health benefits information to target groups. Consider the strengths and weaknesses of these
7. Identify the appropriate delivery frameworks for health benefits information and detail any specific requirements for these.

#### *Opportunities for collaboration and co funding*

8. Identify potential opportunities for collaboration nationally and internationally with industry, governments, NGOs and Research and Development organisations.
9. Identify potential alternative and collaborative funding partners.

## 2.0 Methodology

### 2.1 Criteria for considering studies

The following describes the methodology used to source literature relating to the relationship between seafood and human health.

## 2.2 Databases and sites searched

A comprehensive search was conducted of evidence utilising the following databases:

- Archive of Life Sciences;
- Proquest;
- PubMed;
- Science Direct;
- Taylor and Francis;
- The Cochran Collaboration;
- Web of Knowledge;
- Web of Science; and
- Wiley Interscience.

## 2.3 Other sources:

Other sources of information were:

- National and international seafood-based databases;
- Seafood industry websites or databases;
- Major national and international academic libraries;
- Electronic sources of information (e.g. Google, Google Scholar, international websites);
- Departments of Health within Australia; and
- Educational institutions.

## 2.4 Presentation of data

Data from published studies were summarised and presented in table form. The evidence from each study was then classified as: high, moderate, low or very low (see Table 2.1).

Table 2.1 Classification of the level of evidence

Code	Strength of evidence	Definition
A	High	Further research is very unlikely to change our confidence in the estimate of effect Several high-quality studies with consistent results In special cases: one large, high-quality multi-centre study
B	Moderate	Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate One high-quality study Several studies with some limitations
C	Low	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate One or more studies with significant limitations Any estimate of effect is very uncertain
D	Very low	Expert opinion No direct research evidence One or more studies with very significant limitations

### 3.0 Literature Review Results

Key findings from published studies are presented herein in dot point form.

Table 3.1 follows the key findings and includes a summary of relevant peer-reviewed journal articles that provide evidence in relation to the health benefits of seafood consumption. Each has been assigned a level of evidence based on the 'Classification of Evidence' as outlined in Table 2.1.

#### 3.1 Asthma and Allergies

##### *What we know:*

- Epidemiological studies of Australian schoolchildren have shown that children who eat fish more than once a week have one third the risk of airway hyper-responsiveness of children who do not eat fish regularly [1, 2].
- Regular consumption of fresh, oily fish was associated with a reduced risk of asthma and airway diseases.[3]
- Recent research suggests that eating fish and seafood during pregnancy may protect some children from asthma.[3, 4]
- Fish consumption in the first year of life was associated with a reduced risk of asthma and allergic rhinitis in childhood. [5]
- Early introduction to fish showed a consistent negative association with the risk of allergic rhinitis.[5]
- Fish sticks (trans fats) consumption during pregnancy significantly increased asthma risk in children (OR 2.04).[4].

##### *What we need to know:*

- Further evidence is needed to support the association between eating fish and seafood and reduced asthma risk among asthma sufferers.
- Investigation of the physiological function of the major nutrients found in various types of seafood and components that impact of the risk of asthma is warranted. [6] [7]
- Future research is needed to investigate the protective mechanisms associated with eating fish and seafood during pregnancy.
- The protective link between common childhood allergies and seafood consumption (both and maternal and child) should be investigated further.
- The relationship between the increased risk of asthma and trans fats (fish sticks) should be investigated further.

### 3.2 Behavioural problems

#### *What we know:*

- There is limited evidence around seafood, fish oil or supplements in the management of attention disorders such as Attention Deficit Hyperactivity Disorder (ADHD). However the evidence that is available is promising.[8-13]

#### *What we need to know:*

- Treatment of attention disorders (including ADHD) in children and adults with fatty acids via fish intake and/or supplements warrants further attention.

### 3.3 Cardiovascular disease - overall

#### *What we know:*

- Fish intake is beneficial to heart health.[14-17]
- 1 serve fish/wk reduces the risk of coronary heart disease and stroke. 2 or > serves fish/wk provides increased protection against all cardiovascular diseases.[18-20]
- Omega 3, also known as n-3 fatty acids, was associated with a reduced risk of cardiovascular disease, cardiac events (heart attack) and mortality (death).[21, 22]
- Omega 3 fatty acids from fish and fish oils can protect against coronary heart disease.[23-27]
- Increasing fish consumption or fish-oil supplementation was associated with reduced coronary mortality for people with pre-existing coronary disease.[26]
- Regular consumption of fish and omega-3 fatty acids found in fish and seafood can lower blood pressure levels.[28]
- Fish consumption was associated with a reduced risk of death from stroke and all-cause ischemic heart disease (blockage of the arteries) in both men and women. Even consumption of fish as little as 1 to 3 times per month may reduce the risk of ischemic stroke.[17, 27, 29]
- The benefits of eating fish depended on the type of fish meal prepared. Broiled or baked fish was better than fried fish (which was not associated with lower risk of ischemic heart disease).[27]
- Strong evidence suggests that fish oil consumption is associated with a reduced heart rate (a major risk factor for sudden death).[30]
- Fish consumption was associated with lower inflammatory markers indicating lower risk of coronary heart disease.[31]
- For women, higher consumption of fish and omega 3 fatty acid (twice weekly), was associated with a reduced risk of coronary heart disease including, coronary artery atherosclerosis (the build up of fatty deposits in the arteries that carry blood to the heart).[21] [26]
- Fish and seafood are preferred sources of essential fatty acids (such as DHA (docosahexaenoic acid) and EPA eicosapentaenoic acid) as the body processes them more efficiently (compared with supplements).[32]

- Regular fish consumption was associated with suppressed inflammation proving beneficial in the prevention of coronary heart disease. These benefits were particularly pronounced when 0.6g of omega 3 fatty acids per day were consumed in the form of fish rather than supplement form.[31]
- Despite knowledge of the benefits of fish oil and favourable attitudes toward nutritional therapy, family physicians infrequently recommend fish oils to CVD patients. [33]
- Although evidence clearly shows that fish intake provides greater benefits than supplements such as fish oil, they may be beneficial to those who cannot or do not eat seafood. [34]
- Fish oil supplements and EPA/DHA enriched concentrates need to ensure accurate content claims, oxidative stability, negligible levels of environmental contaminants, the appropriate accompanying presence of physiological anti-oxidants, plus other factors.[34]

*What we need to know:*

- We know that regular fish intake is protective against all cardiovascular diseases (CVD) and is also beneficial to those who have various forms of CVD. We urgently need guidelines around what a healthy diet that is protective against CVD at a population level looks like.
- We also need population-based dietary guidelines for those who are at higher risk of developing CVD and other lifestyle conditions such as diabetes, hypertension, arthritis, overweight and obesity.
- Evidence is mounting regarding problems associated with the composition and variability of over-the-counter supplements. Further research is needed to assess the health impact of commonly available supplements in relation to: accuracy of health claims; variability of fillers used; possible contaminants; stability over time; properties of common components; shelf life and interactions with various medications and herbal preparations.

### **3.4 Cancer**

*What we know:*

- Epidemiological studies assessing the benefits of fish and seafood consumption associated with the risk of cancer (ie. lung, prostate, breast, colorectal, (non-Hodgkin), ovarian, pancreatic, skin (basal cell carcinoma), and stomach) show promising results. [17, 35-40]

*What we need to know:*

- More research is needed around the mechanisms by which fish consumption appears to protect against lung cancer.[17]
- Animal experiments have shown marine fatty acids, particularly the important omega-3 fatty acids EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid), slow the growth rate of breast and prostate cancer cells in vitro. However whether a high intake of marine fatty acids can reduce the risk of these cancers or other hormone dependent cancers in humans is unclear and needs further investigation.[39]
- More evidence is needed to link the health benefits of fish and marine fatty acids to particular types of cancer.[39]
- Guidelines around diets protective against various types of cancer are required.

### 3.5 Cystic Fibrosis

#### *What we know:*

- Regular intake of omega-3 fatty acids may provide some benefits for people with cystic fibrosis with relatively few adverse effects.[41]

#### *What we need to know:*

- More research is needed to determine whether or not there is a significant therapeutic effect to further assess the influence of disease severity, dosage and duration of treatment.
- Future research on omega-3s and cystic fibrosis is needed to be meaningful to people with, or making treatment decision about, cystic fibrosis.

### 3.6 Diabetes

#### *What we know:*

- Regular fish consumption should be considered as part of a healthy diet for diabetic management. [42].
- Regular fish consumption has a strong association with positive management of triglyceride levels in diabetic individuals and helps the kidneys to function more efficiently in Type I diabetic patients [43]

#### *What we need to know:*

- Evidence is needed of the levels of regular fish (seafood) consumption that provides the best protection against developing or managing the various forms of diabetes, across the lifespan.
- Further evidence around the benefit of regular fish consumption on the positive management of diabetes is needed. In particular the effect of omega-3 fatty acids on triglyceride levels and kidney function in type I diabetics.

### 3.7 Inflammatory conditions

#### *What we know:*

- Ingestion of n-3 fatty acid supplements has consistently shown improvement in joint tenderness and the amount of morning stiffness in those with rheumatoid arthritis.[44, 45]
- Evidence shows that fish intake is beneficial in the management of inflammatory diseases.[45, 46]
- Moderate to high intake of fish appears to be protective against rheumatoid arthritis.[47]

#### *What we need to know:*

- Further research is needed to confirm that fish intake is beneficial to the management of inflammatory diseases. How much/how often/for which condition/s?
- Further research is needed to investigate if fish intake is protective against the development of inflammatory conditions.

### 3.8 Maternal health

#### *What we know:*

- High levels of fish intake during pregnancy have been associated with longer gestation, increased birth weight and lower hypertension during pregnancy [48].
- Fish and seafood are potential sources of exposure to pollutants such as methylmercury that may adversely affect pregnancy outcomes. Thus, advising pregnant women about fish consumption requires consideration of potential risks as well as benefits. [48] [49]
- Seafood is an excellent source of omega-3 fatty acids, which are essential for optimum foetus neural development [50].
- The beneficial effects on child development with maternal seafood intake of more than 340 g per week were found in a United States study. This suggests that advice to limit seafood consumption could actually be detrimental. These results show that risks from the loss of nutrients were greater than the risks of harm from exposure to trace contaminants in 340 g seafood eaten weekly.[50, 51]
- Fish and seafood contain large amounts of essential fatty acids, as does breast milk. The fatty acid content of mothers' breast milk is determined mostly by diet. Maternal nutrition is important to foetal brain development. [52].

#### *What we need to know:*

- We need to understand the real risk of potential exposure to pollutants such as methylmercury through fish and seafood. More research is needed to determine safe levels of exposure and the source/s of exposure eg. local fish/seafood; imported fish/seafood.[53]
- Further investigation into exposure levels of imported seafood and regulatory food standards relating to exposure of seafood to pollutants is required.

### 3.9 Mental health

#### *What we know:*

- A growing body of evidence suggests a protective effect of omega-3 fatty acids against dementia.[54]
- Results of two clinical trials are due in 2008, until then there is no strong evidence to support the intake of omega-3s for the prevention of cognitive impairment or dementia.[54]
- Intake of at least 1 fish serve/wk reduces the risk of Alzheimer Disease.[55-57]
- There is a significant negative correlations btwn worldwide fish consumption and rates of depression (including post-partum), bipolar disorder and suicidal ideation.[58-61]
- Evidence suggests a link between the consumption of fish and seafood and lower rates of mood and depressive disorders.[61]
- Fish consumption is significantly associated with higher self-reported mental health status.[58]

*What we need to know:*

- Further research is needed to establish a significant association between fish consumption and its effect on mental health and cognitive impairment.
- Further research is needed to establish a strong positive association between fish and seafood consumption and mood disorders.
- Evidence of a therapeutic effect on general mental wellbeing would contribute to a population level campaign promoting the benefits of fish and seafood consumption.

### **3.10 What are the health risks associated with eating fish and seafood?**

*What we know:*

- Levels of dioxins and other pollutants in fish are low, and potential carcinogenic and other effects are outweighed by potential benefits of fish intake and should have little impact on choices or consumption of seafood.[62]
- Fish that are likely to contain higher levels of mercury are shark, swordfish and king mackerel. Fish low in mercury and high in omega-3 fatty acids are recommended.[63]
- Women of childbearing age should consult regional advisories for locally caught freshwater fish. The benefits of modest fish intake, excepting a few selected species, also outweigh risks.[62]
- Women who are pregnant, may become pregnant or are breastfeeding plus very young infants should avoid fish with higher mercury content. However, consumption of fish and seafood should not be avoided altogether as it is the predominant source of omega-3 fatty acids, which are essential for optimum foetal neural development [50].
- Light tuna has relatively low levels of mercury, and other fish, such as wild and farmed salmon and shrimp, contain very low levels of mercury.
- A balance of risk-benefit in relation to the consumption of fish and seafood is recommended in the literature, as well as taking into consideration meal size and frequency of consumption.[64]
- Advances have made biomonitoring a cost-effective public health tool for helping federal, state and local health agencies develop optimal dietary guidance.[65]
- Guidelines are available to assist people to make informed choices about the types and amount of seafood they ingest based on higher Omega-3 content and low mercury concentrations.[53]

*What we need to know:*

- There is very little information available about actual dangers of mercury levels in seafood from Australian waters.
- More research is required on the nutritional security of fish and seafood in Australian waters. This should include guidelines for consumption of seafood.
- Evidence based guidelines on the amount of fish that Australian pregnant women and infants can safely eat are required.



### 3.11 Consumer behaviour in relation to fish and seafood consumption.

#### *What we know:*

- Perceived cost, freshness, quality, availability, ease of use, and (confidence in) preparation were considered to be the main influences in consumer choice of fish and seafood products. Quality was perceived by appearance and odour.[66, 67]
- Fresh fish and seafood was preferred to alternative products including processed, smoked, canned and frozen products.[66]
- Taste was the most important driver for eating fish, followed closely by health.[68]
- Bones and price influenced purchase type but not intention to purchase.[68]
- Eating fish in compliance with health recommendations was higher among women and increases with increasing age.[68]
- The presence of children in the households led to lower fish consumption.[68]
- The influence family members (particularly the husband or partner) impacted upon the likelihood of the serving fish and seafood, and the types of products served.[67]
- Lower income was positively associated with lower fish consumption. Higher education resulted in a higher intention to eat fish but has no effect on how often fish was eaten.[68]
- Fish was often perceived to be tasteless and preparation of sauces imposed extra cost. Consumers often fried fish in batter or butter which reduced the healthful effects on disease and conflicted with the health guidelines.[69]
- Packaged fresh fish was often perceived by heavy fish purchasers as inferior to fresh fish and by infrequent fish purchasers as having all the problems of fresh fish.[69]
- Plain fresh frozen fillets were sometimes rejected as they were perceived as grey, lifeless, anonymous and basic. They were associated with factories and processing.[69]
- The highly processed product varieties (battered and crumbed fish and fish in sauce dishes) were often popular among the families and perceived as easy and convenient to cook. However, they were negatively perceived to be made from poor quality fish, less healthy due to the cooking techniques associated with them (eg. deep fry) and they lacked variety.[69]
- Odours common to fish and seafood were often a deterrent to consumption. These were often related to bacteria.[70]
- Strategies directed at parents and children should include experimental 'hands-on' components to encourage experimentation, particularly focussing on ease of preparation and the variety of lower cost seafood available.[67]

#### *What we need to know:*

- The influence of the dominant male within the family unit should be considered and researched further.
- Interventions seeking to promote seafood (particularly fish) as an integral part of a healthy diet should be investigated further and should address existing negative attitudes and beliefs around the storage and preparation of seafood.

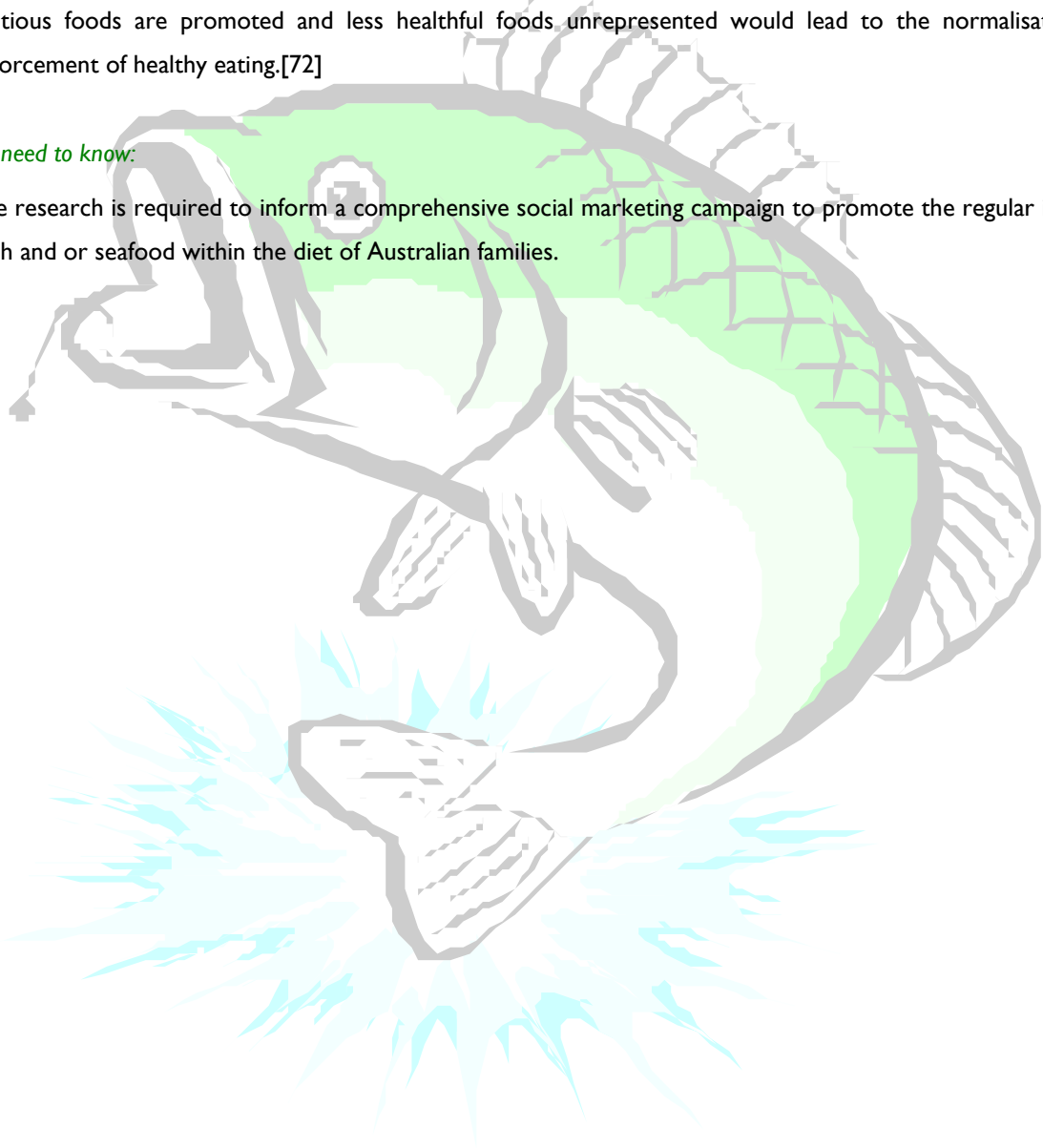
### 3.12 Marketing and advertising

#### *What we know:*

- Modern marketing techniques, in particular advertising, had a strong influence on food choice.[70]
- Food advertising to children predominantly featured snack foods/fast foods and confectionary. They often used themes that promoted grazing, the denigration of core foods and exaggerated health claims.[71]
- Changing the food advertising environment within children's television viewing time to an environment where nutritious foods are promoted and less healthful foods unrepresented would lead to the normalisation and reinforcement of healthy eating.[72]

#### *What we need to know:*

- More research is required to inform a comprehensive social marketing campaign to promote the regular inclusion of fish and or seafood within the diet of Australian families.



**Table 3.1 Systematic review of peer-reviewed publications around Seafood Consumption and Health, to 2007**

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Albert, Hennekens. et al., JAMA 1998; 279(1): 23-28 <sup>1</sup>	Dept Prev Med, Harvard School of Public Health, Boston, USA	20,551 adults USA	Fish consumption and risk of sudden <b>cardiac death</b> .	CVD – Cardiac	Cohort	Fish intake	<ul style="list-style-type: none"> <li>• 133 sudden deaths throughout study.</li> <li>• After controlling for age, randomised aspirin and beta carotene assignment, and coronary risk factors, <b>dietary fish intake was associated with a reduced risk of sudden death</b>.</li> <li>• Apparent threshold effect at consumption of one fish meal per week.</li> <li>• For men who consumed fish at least once per week, the multivariate RR of sudden death was 0.48 compared with men who consumed fish &lt; once/mth.</li> <li>• Fish consumption was associated with a significantly reduced risk of total mortality</li> </ul>	A
Almqvist, et al., J Allergy Clin Immunol 2007; 119:1438-1444 <sup>2</sup>	Woolcock Inst Med Research, Sydney, Australia	516 children from birth to 5 yrs Australia	Omega-3 and omega-6 fatty acid exposure from early life does not affect atopy and <b>asthma</b> at age 5 years.	Asthma	Cohort plus RCT	Fish oil	<ul style="list-style-type: none"> <li>• Included children with familial link to asthma</li> <li>• Plasma fatty acids measured at 18mths, 3 yrs &amp; 5yrs.</li> <li>• Plasma levels of omega-3 or omega-6 acids were not associated with wheeze, eczema or atopy at age 5 yrs.</li> <li>• Observation of cohort supported negative findings of RCT.</li> <li>• Modification of dietary polyunsaturated fatty acids in early childhood is not helpful in preventing atopy and asthma.</li> </ul>	B
Amiano, et al., European J of Clin Nutr 2001; 55:827-832 <sup>3</sup>	Dept of Health Basque Govt, Gipuzkoa, Spain	120 healthy adults aged 35-65 yr Spain	Relationship btwn habitual fish intake and fatty acid levels in serum	CVD	Cohort	Fish intake	<ul style="list-style-type: none"> <li>• Concentrations of very-long-chain <math>\omega</math>-3 fatty acids are useful biomarkers for dietary fish intake, mainly lean fish.</li> </ul>	D

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Arnold, Lynn et al. Am J Public Health 2005; 95(3): 393-397 <sup>4</sup>	Alaska Division of Public Health, Epidemiology, Anchorage, Alaska	150 pregnant women and 52 women of child bearing age (15-47 yrs) Alaska	Human biomonitoring to optimize fish <b>consumption</b> advice	Fish intake Environ	Cohort	Fish intake	<ul style="list-style-type: none"> <li>All healthcare providers in Alaska recd intro materials and encouraged to test pregnant women for mercury levels via hair samples.</li> <li>Mercury levels among pregnant women and women of child bearing age in Alaska were well below WHO no observed effect level.</li> <li>National fish advisories overemphasise risks and undervalue benefits of fish consumption.</li> <li>Highly respective generis fish consumption advisors can cause harm by unnecessarily warning people not to consume fish.</li> <li>Among cultural groups who rely heavily on these foods for their nutritional, spiritual and cultural health, the results can be disastrous.</li> <li>Advances have made biomonitoring a cost-effective public health tool for helping federal, state and local health agencies develop optimal dietary guidance.</li> </ul>	C
Ascherio, Rimm, et al. N Eng J Med 1995; 332(15): 977-982 <sup>5</sup>	Dept of Nutrition & Epidemiology, Harvard School of Public Health, Boston, USA	1,543 coronary events in men, USA	Dietary intake of marine fatty n-3 acids, fish intake, and the risk of <b>CHD</b> among men.	CVD – CHD	Cohort	Fish intake Fish oil	<ul style="list-style-type: none"> <li>After controlling for age and several coronary risk factors, there were no sign assoc betwn dietary intake of n-3 fatty acids or fish intake and the risk of coronary disease.</li> </ul>	B
Augustsson, Michaud et al. cancer Epidemiol, Biomarkers & Prev 2003; 12: 64-67 <sup>6</sup>	Dept of Nutrition & Epidemiology, Harvard School of Public Health, Boston, USA	47,882 males aged 40-75 yrs followed over 12 yrs USA	Intake of fish and marine FA's and <b>prostate cancer</b>	Cancer – prostate	Cohort Follow up 12 yrs	Fish intake Fish oil Suppl Other food	<ul style="list-style-type: none"> <li>Eating fish at least 4 x/wk assoc with reduced risk of prostate cancer, and the strongest assoc was for metastatic cancer (RR= 0.56).</li> <li>Similar but weaker assoc with marine FA's.</li> <li>Each additional daily intake of 0.5g of marine FA's from food was assoc with a 24% decreased risk of metastatic cancer.</li> </ul>	A

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Boa, et al., Hypertension 1998; 32:710-717	Dept of Medicine, Uni of Western Aust, Perth, Aust	63 o/weight hypertensive subjects over 16 wks Australia	Effects of dietary fish and weight reduction on ambulatory <b>blood pressure</b> in <b>overweight</b> hypertensives	Over weight  Blood pressure	Cohort  Follow up 16 wks	Fish intake	<ul style="list-style-type: none"> <li>Dietary fish and weight loss had sign independent and additive effects on 24 ambulatory BP.</li> <li>Dietary fish also sign reduced 24 hr and awake ambulatory heart rate.</li> <li>Combining a fish meal with a weight reducing regimen led to additive effects on ambulatory BP and decreased heart rate.</li> <li><b>The effects were large</b>, suggesting that CV risk and antihypertensive drug requirements are likely to be reduced substantially by <b>combining dietary fish meals rich in n-3 fatty acids with weight loss regimens in overweight medication treated hypertensives.</b></li> <li><b>The reduction in heart rate seen with dietary fish suggests a cardiac/autonomic component, as well as vascular effects, of increased consumption of n-3 fatty acid from fish.</b></li> </ul>	C
Broadfield, McKeever et al. Clin Exp Allergy 2004;34 (8):1232-1236 <sup>8</sup>	Division of Respiratory Medicine, Uni of Nottingham, UK	89 cases of asthma and 89 controls UK	A case-control study of dietary and erythrocyte membrane fatty acids in <b>asthma</b> .	Asthma	Cohort  Case- control	Fish intake Other food	<ul style="list-style-type: none"> <li>Results suggest that omega-3 FA's do not play a major role in protecting against asthma, and that higher levels of erythrocyte membrane linoleic acid are assoc with lower risk of asthma</li> </ul>	C
Buck, et al., BioMed Central 2003; 2 (7):1-9 <sup>9</sup>	National Institute of Child Health & Human Development, MD, USA	2,716 infants USA	<b>Maternal</b> fish consumption and infant size and gestation	Pregnancy	Cohort	Fish intake	<ul style="list-style-type: none"> <li>No sign mean diffs in gestation or any measure of birth size in relation to duration of maternal lifetime fish consumption.</li> <li>Gestational age, male sex, number of daily cigarettes, parity and placental infraction were significant determinants of birth size.</li> <li>This study adds to evidence that fish consumption does not adversely affect infant gestation and birth size at a popn level.</li> <li>This will help to demystify issues so public can be advised accordingly.</li> </ul>	A
Burgess, et al., Am J Clin Nutr 2000; 71 (suppl):327-330 <sup>10</sup>	Dept Foods and Nutr, Purdue Uni, West Lafayette, IN, USA	Review international	Long-chain polyunsaturated fatty acids in children with attention-deficit hyperactivity disorder.	ADHD  Attention disorders	Review	Fish intake Fish oil	<ul style="list-style-type: none"> <li>Children with ADHD have lower levels of long-chain polyunsaturated fatty acids.</li> <li>Further research is needed to assess the association between PUFA and management of attention disorders.</li> </ul>	C

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Chrysohoou, et al., Am J Clin Nutr 2007;85(5): 1385-1391 <sup>11</sup>	First Cardiology Clinic, Uni of Athens, Greece	1514 men, 1528 women 18-89 yrs Greece	Long-term fish consumption and <b>arrhythmia</b> in healthy people	CVD – Cardiac	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Long-term consumption of fish is assoc with lower QTc interval in free-eating people without evidence of CVD.</li> <li>Fish intake seems to provide antiarrhythmic protection at a popn level.</li> </ul>	C
Cohen, Bellinger et al. Amer J Prev Med 2005; 29(4):366-374 <sup>12</sup>	Harvard Center for Risk Analysis, Harvard School of Public health, USA	Meta-analysis international	Quantitative analysis of prenatal intake of n-3 polyunsaturated FA's and <b>cognitive development</b>	Cognition Brain dev	Cohort Meta-Analysis RCT	Fish intake Fish oil Suppl	<ul style="list-style-type: none"> <li>An increase in maternal intake of DHA during pregnancy of 1 g/day will increase child IQ by 0.8 to 1.8 pts.</li> <li>Study has provided a starting point to quantitatively evaluate the cognitive benefits of maternal fish consumption, so that these benefits can be compared to the attendant risks resulting from prenatal exposure to mercury.</li> </ul>	B
Cohen, et al. Amer J Prev Med 2005; 29(4):325-334 <sup>13</sup>	Harvard Center for Risk Analysis, Harvard School of Public health, USA	Review USA	A quantitative <b>risk-benefit</b> analysis of changes in population fish <b>consumption</b>	Intake	Cohort Review RCTs	Fish intake Fish oil Suppl	<ul style="list-style-type: none"> <li>Recommendations to women of child bearing age to eat fish with less MeHg may result in a reduction in consumption, thus may reduce net benefits.</li> <li>Other adults may also reduce their fish intake resulting in a negative net public health benefit.</li> <li><b>Risk managers should investigate and carefully consider how popns respond to interventions, how these responses influence nutrient intake and contaminant exposure, and how these changes affect aggregate public health.</b></li> </ul>	C
Connor & Conner Am J Clin Nutr 2007; 85: 929-930 <sup>14</sup>	Division of Endocrinology, Diabetes and Clinical Nutrition, Oregon Health & Science Uni, Portland, USA	Review USA	The importance of fish and docosahexaenoic acid in <b>Alzheimer Disease</b>	Alzheimer disease	Cohort Review	Fish intake Fish oil	<ul style="list-style-type: none"> <li>It is estimated that 20-40% of the popn over the age of 85 yrs may have Alzheimer Disease.</li> <li>Brains of Alzheimer disease patients have a lower content of DHA in the gray matter of the frontal lobe and hippocampus than do the brains of persons without Alzheimer disease.</li> <li>The major dietary sources of fatty acids (DHA &amp; EPA) are fish and shellfish, from both salt water and fresh water.</li> <li>N-3 fatty acids retarded the decline in cognition over time.</li> </ul>	C

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Daviglus, et al., N Eng J Med 1997; 336(15): 10-46 1053 <sup>15</sup>	Dept Prev Med, NthWstn Uni Med School, Chicago, USA	1,822 men aged 40-55 yrs	Fish consumption and the 30-year risk of <b>fatal myocardial infarction.</b>	CVD CHD MI	Cohort  Follow- up 47,153 person/y rs (30 yrs)	Fish intake	<ul style="list-style-type: none"> <li>Men who consumed 35 gm or more of fish/day (compared with those who had none) the RR of death from CHD and from sudden or non sudden MI were 0.62 and 0.56 respectively, with a graded relation btwn the RR and the strata of fish consumption.</li> <li>These data show an inverse assoc btwn fish consumption and death from CHD especially non sudden death from MI</li> </ul>	B
Denomme, J Nutr 2005, 135: 206-211 <sup>16</sup>	Dept Human Biology & Nutrition Science, Uni of Guelph, ON Canada	20 pregnant women Canada	Directly quantitated dietary (n-3) acid intakes of <b>pregnant</b> Canadian women are lower than current dietary recommendations	Pregnancy	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Maternal intake of (n-3) poly unsaturated fatty acids must be sufficient to maintain maternal tissues stores and meet fetal accrument.</li> <li>Recommendations for pregnant women include 0.6 to 1.2% of energy for (n-3) PUFA intake in the current dietary reference intakes, and <math>\geq 300</math> mg/d of DHA suggested by the International Society for the Study of Fatty Acids and Lipids.</li> <li>Nutritional education of pregnant women to ensure adequate intakes of (n-3) PUFA for optimal health of mother and child and the inclusion of DHA in prenatal vitamins may be pertinent.</li> <li>The (n-3) PUFA intakes of pregnant women reported herein raise concerns and implications for public health.</li> <li>There is a need to create greater awareness, educational programs and counselling regarding DHA intake targeted at women planning to become pregnant.</li> </ul>	C
Dewailly, et al., Am J Clin Nutr 2002; 76:85-92 <sup>17</sup>	Public Health Research Unit, Centre Hospitalier Uni Quebec, Canada	917 persons aged 18-74 yrs, Canada	<b>Cardiovascular disease risk</b> factors and n-3 fatty acid status in the adult population of James Bay Cree	CVD	Cohort	Fish intake	<ul style="list-style-type: none"> <li>N-3 fatty acids may favourably influence some CVD risk factors.</li> <li>The Cree popn must be encouraged to maintain their traditional fish-based diet, which may be one of the factors protecting then against mortality from CVD.</li> </ul>	B
Din, Newby et al. BMJ 2004; 328:30-35 <sup>18</sup>	Cardiovascular Research, Uni of Edinburgh, UK	Clinical review international	Omega-3 FA's and <b>CVD</b> – fishing for a natural treatment	CVD – Cardiac	Review	Fish intake Fish oil	<ul style="list-style-type: none"> <li>Omega-3 FA's from fish and fish oils can protect against CHD.</li> <li>There is evidence to support the use of fish and fish oil suppl after MI.</li> <li>Consumption of fish and higher blood concentrations of omega-3 FA's are assoc with a reduced risk of sudden death.</li> </ul>	A

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Domingo JL. Environmental International 2007; 33: 993-998 <sup>19</sup>	School of Medicine, Rovira I Virgili Uni, Catalonia, Spain	Review Spain	Omega-3 FA's and the <b>benefits of fish consumption.</b>	CVD – Cardiac Intake	Review	Fish intake	<ul style="list-style-type: none"> <li>Balancing adequately the risks and benefits of fish consumption is currently a nutritional/ environmental health key issue.</li> <li>Although evident that fish must be a part of a balanced diet, choosing suitable species in terms of levels of PUFA's and pollutants, the freq of consumption and the meal size are essential aspects to balance benefits and risks of regular consumption.</li> <li>For all – benefits of fish consumption outweighs potential risks.</li> <li>For women of childbearing age, benefits of modest fish intake, excepting a few selected species, also outweighs risks.</li> <li>Evidence supports 500 mg/d of EPA and DHA for CVD reduction, this equates to 2 fish meals/wk (preferably fatty fish).</li> </ul>	B
Donaldson. Nutrition 2004; 3(19): 1-21 <sup>20</sup>	Hallelujah Acres Foundation, Ellensburg, WA, USA	Meta-analysis international	Nutrition and <b>cancer</b> : a review of the evidence for an anti cancer diet	Cancer	Review	Fish intake	<ul style="list-style-type: none"> <li>~30-40% of all cancers can be prevented by lifestyle and dietary measures alone.</li> <li>Positive assoc. btwn high ratio of n-3 and n-6 FA's (incl DHA) and <b>reduced risk of breast cancer.</b></li> <li>Diet high in cooked veg, pulses and fish <b>protective against colon cancer.</b></li> </ul>	B
Dullemeijer, et al., Am J Clin Nutr 2007; 86: 1479-1485 <sup>21</sup>	Wageningen Centre Food Sc, Wageningen Uni, Netherlands	807 persons aged 50-70 yrs Netherlands	n-3 fatty acid props in plasma & <b>cognitive</b> performance in older adults	Mental health Cognitive decline	Cohort	Suppl	<ul style="list-style-type: none"> <li>Higher plasma n-3 PUFA proportions predicted less decline in sensori motor speed and complex speed.</li> </ul>	B
Fernandez, et al., J Br Menopause 2006; 12(4): 139-142 <sup>22</sup>	Cancer Prevention and Control Unit, Institute Catala d'Onocologia, Barcelona, Spain	Meta-analysis international	Nutrition and <b>cancer</b> risk	Cancer	Review	Fish intake	<ul style="list-style-type: none"> <li>Mediterranean diet (adequate consumption of fruit, veg, cereals, whole-grain foods and fish) is associated with low mortality rates for CVD</li> <li>Omega-3 fatty acids found in fish inhibit the growth in vitro of colon, breast and prostate cancers</li> </ul>	C



Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Fung, et al., Arch Intern med 2003; 163(3): 309-314 <sup>23</sup>	Dept of Nutrition, Harvard School of Public Health, Boston, USA	76,402 women aged 38-63 yrs USA	Major dietary patterns and the risk of <b>colorectal cancer in women</b>	Cancer – colorectal	Cohort Follow up 12 yrs	Fish intake	<ul style="list-style-type: none"> <li>Observed a RR for colon cancer of 1.46 when comparing the highest with the lowest quintiles of the Western diet of high intakes of red and processed meats, sweets, desserts, French fries and refined grains.</li> <li>Diet with high intakes of fruit, vegetables, legumes, fish, poultry and whole grains had a non significant inverse association with colon cancer (RR 5<sup>th</sup> quintile compared to 1<sup>st</sup> of 0.71).</li> <li>Finding was a significant positive assoc btwn Western diet and the risk of colon cancer.</li> </ul>	B
Geelen, A J Epi 2007; 166(10): 1116-1125 <sup>24</sup>	Division of Human Nutrition, Wageningen Uni, The Netherlands.	Review International	Fish consumption, n-3 fatty acids and <b>colorectal cancer</b> : a meta analysis of prospective cohorts	Cancer – colorectal	Cohort Meta analysis	Fish intake	<ul style="list-style-type: none"> <li>The pooled RR for colorectal cancer incidence were 0.96 for each extra occurrence of fish consumption/wk and 0.97 for each extra 100gm of fish/week.</li> <li>The effect was more pronounced in women and in studies with a large exposure contrast.</li> <li>In cohort studies, fish consumption was shown to slightly reduce colorectal cancer risk.</li> </ul>	B
Gillum, Mussolino & Madans. Arch Intern Med 1996; 156(5): 537-542 <sup>25</sup>	Centers for Disease Control, Hyattville, Md, USA	2,351 (A) 2,059 (B) USA	The relationship between fish consumption and <b>stroke</b> incidence in (A) females and (B) males.	CVD – Stroke	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Fish consumption was associated with a reduced risk of stroke.</li> </ul>	B

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Gochfeld and Burger. Neuro Toxicology 2005; 26: 511-520 <sup>26</sup>	Environmental & Occupational Health Sciences Institute, Piscataway, USA	Review international	Good fish/bad fish: a composite <b>benefit-risk</b> by dose curve	Pregnancy	Review	Fish intake Fish oil Suppl	<ul style="list-style-type: none"> <li>The duration of pregnancy and birth weight improve at a benefit threshold of about 8-15 g/day maternal fish intake.</li> <li>Meta-analysis revealed adult CVD benefits around 7.5-22.5 g/day bracket.</li> <li>Using EPA Ref Dose of 0.1ug/kg/day, the fish intake threshold for harm converts to 27 g/day to 65 g/day for someone choosing fish low in MeHg (0.1 ppm).</li> <li>Benefits of fish consumption replaced by fish oil suppl remains uncertain.</li> <li>Visual acuity and neural pathways assoc with language acquisition showed a positive relationship to DHA in breast milk.</li> <li>Choosing fish low in mercury and PCB's and high in PUFA is clearly desirable.</li> <li>Documenting the margin of safety btwn the benefit threshold and the harm threshold is both an individual and public health priority.</li> </ul>	B
Guldner, et al., BioMed central Online 2007: 6(33): 1-18 <sup>27</sup>	National School of Public Health, Campus de Beaulieu, Rennes, France	2,398 pregnant women with low background risk of adverse pregnancy outcomes and high seafood consumption France	Maternal fish (salt water only) & shellfish & <b>pregnancy</b> outcomes.	Pregnancy	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Fish &amp; shellfish together – decrease in risk of small-for-gestational-age (SGA) birth with increasing freq of fish intake: (OR 0.57) for women who eat fish at least twice/wk compared with those once mth.</li> <li>Risk of SGA sign higher in those eating shellfish at least twice week compared with those eating shellfish once mth (OR 2.14).</li> <li>Each add mthly meal incl fish sign related to increase in gestational length of 0.02 week.</li> <li>Suggests diff categories of seafood may be diff assoc with birth outcomes.</li> <li>Increased fish consumption assoc with increased length of gestation.</li> <li>High shellfish intake assoc with increased risk of SGA births.</li> </ul>	C
Harper & Jacobson Arch Intern Med 2001; 161: 2185-2192 <sup>28</sup>	Dept of Medicine, Office of Health Promotion & Disease Prevention, Emory Uni, Atlanta, USA	Systematic review international	The role of Omega-3 fatty acids in the prevention of <b>Coronary Heart Disease</b>	CVD – CHD	Cohort Review	Fish intake. Fish oil Suppl Other food	<ul style="list-style-type: none"> <li>Fish is an important source of n-3 PUFA's in the US diet, however, vegetable sources, including grains and oils, offer an alternative source for those who are unable to regularly consume fish.</li> <li>Current evidence suggests that the 'quantity' and 'quality' of dietary fat intake determine CHD risk.</li> </ul>	C

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
He et al. JAMA 2002; 288(24): 3130-3136 <sup>29</sup>	Dept Preventive Medicine, North Western Uni Feinberg School of Medicine, Chicago, USA	43,671 USA	Fish consumption and risk of <b>stroke</b> in <b>men</b>	CVD – Stroke men	Cohort Meta-analysis	Fish intake	<ul style="list-style-type: none"> <li>Intake of fish is inversely related to risk of stroke, particularly ischemic stroke.</li> <li>RR for stroke 0.91 for fish intake 1-3 serves/mth 0.87 for 1serve/ wk 0.82 for 2-4 serves/ wk and 0.69 for ≥ 5 serves/wk</li> <li>Consumption of fish 1-3 serves/mth may protect against the incidence of ischemic stroke.</li> </ul>	B
He, Song et al. Circulation 2004; 109:2705-2711 <sup>30</sup>	Dept Preventive Medicine, North Western Uni Feinberg School of Medicine, Chicago, USA	222,364 USA Netherlands Italy Finland UK Denmark	Accumulated evidence on fish consumption and <b>CHD</b> mortality: A meta-analysis of cohort studies	CVD – CHD	Cohort Meta-analysis	Fish intake	<ul style="list-style-type: none"> <li>Fish consumption is inversely associated with fatal CHD.</li> <li>Mortality from CHD may be reduced by eating fish at least once per week.</li> <li>Relative risks for CHD mortality – 0.89 for fish intake 1-3 serves/wk, 0.85 for once/wk, 0.77 for 2-4 serves/wk, 0.62 for 5 or more serves/wk.</li> <li>Each 20 g/d increase in fish intake was related to a 7% lower risk of CHD mortality.</li> </ul>	A
He, Song et al. Stroke 2004; 35:1538-1542 <sup>31</sup>	Dept Prev Med, Nth Western Uni Feinberg School of Medicine, Chicago, USA	Meta analysis international	Fish consumption and incidence of <b>stroke</b>	CVD – Stroke	Cohort Meta-analysis	Fish intake	<ul style="list-style-type: none"> <li>Intake of fish is inversely related to risk of stroke, particularly ischaemic stroke.</li> <li>Fish consumption as seldom as 1-3 serves/mth may protect against incidence of ischaemic stroke.</li> </ul>	A
Helland, et al., Pediatrics 2003, 111: e39-e44 <sup>32</sup>	Institute of Nutrition Research, University of Oslo, Norway	590 pregnant women and 341 women after birth Norway	Maternal suppl. With very-long-chain n-3 FA's during <b>pregnancy</b> and lactation augments children's IQ at 4 years of age.	Cognition Brain dev	Cohort	Fish oil Suppl	<ul style="list-style-type: none"> <li>Children's mental processing scores at 4 years of age correlated sign. with maternal intake of DHA and EPA during pregnancy (only variable of sign).</li> <li>Maternal intake of very-long-chain n-3 FA's during pregnancy and lactation may be favourable for later mental development of children.</li> </ul>	B
Hibbeln, Davis, et al. The Lancet 2007;369(9561); 578-585 <sup>33</sup>	US national Institute on Alcohol Abuse and Alcoholism, NIH, USA.	11,875 pregnant women at 32 wks gestation UK	Maternal seafood consumption in pregnancy and <b>neuro developmental outcomes in childhood</b>	Cognition Brain dev	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Found beneficial effects on child development with maternal seafood intakes of more than 340 g/wk therefore advice to limit seafood consumption could actually be detrimental.</li> <li>Low seafood intake during pregnancy could lead to fetal deficiency in essential long-chain omega-3 FA's such as DHA and EPA, resulting in adverse effects on neurodevelopment.</li> </ul>	A
Hirayama, et al., Euro J Clin Nutr 2004; 58: 467-473 <sup>34</sup>	40 children aged 6-12 yrs with ADHD	Dept of Early Childhood Educ & Care, Japan	Effect of docosahexaenoic acid - containing food admin on symptoms of ADHD - a placebo controlled double blind study	ADHD Attention disorder	Cohort	Fish oil	<ul style="list-style-type: none"> <li>Previous study by authors reported aggression-controlling effects of DHA.</li> <li>This study showed a downward trend in aggression in the DHA group.</li> <li>Treatment of ADHD with fatty acids deserves further investigation but careful attention should be paid as to which fatty acid(s) is used.</li> </ul>	C

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Hodge, et al., MJA 1996; 164: 137-140 <sup>35</sup>	574 children with asthma	Instit Resp Med, Royal Alfred Hosp, Sydney, Australia	Consumption of oily fish and childhood asthma risk	Asthma	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Consumption of oily fish may protect against asthma</li> </ul>	B
Holub & Holub Mol Cell Biochem 2004; 263: 217-225 <sup>36</sup>	Dept of Psychiatry & Behav Neurosc, McMaster Uni, Ontario, Canada	Review, international	Omega-3 fatty acids from fish oils and <b>cardiovascular disease.</b>	CVD	Review	Fish oil	<ul style="list-style-type: none"> <li>The suitability of fish oil suppl and EPA/DHA enriched concentrates for any eventual clinical application will need to ensure accurate content claims, oxidative stability, negligible levels of environmental contaminants, the appropriate accompanying presence of physiological antioxidants, plus other factors.</li> </ul>	B
Holub. CMAJ 2002; 166(5): 608-615 <sup>37</sup>	Dept of Human Biology & Nutr Sciences, Uni of Guelph, Ontario, Canada	Review, Canada	Omega-3 fatty acids in <b>cardiovascular care.</b>	CVD	Cohort Review	Fish intake	<ul style="list-style-type: none"> <li>There is evidence for the beneficial effect of regular fish consumption (up to 2-3/wk) both in healthy subjects and in those at considerable risk for CHD or with established coronary artery disease.</li> <li>Current mean intakes of EPA &amp; DHA (combined) are about 130 mg/day or 14-20% of these target intakes of 650 mg/day and 900 mg/day.</li> </ul>	C
Hooper, et al., BMJ Online 2006; 1136: 1-9 <sup>38</sup>	School of Medicine, Health Policy & Practice, Uni of East Anglia, Norwich, UK	Systematic review 48 RCTs and 41 cohort studies. International	Risk and benefits of omega 3 fats for mortality, <b>CVD</b> and <b>cancer</b>	CVD – Stroke Cardiac Cancer	Cohort 48 RCT's and 41 cohort studies	Fish intake Fish oil	<ul style="list-style-type: none"> <li>Long chain and shorter chain omega 3 fats do not have a clear effect on total mortality, CVD events or cancer.</li> <li>Guidelines encourage the general public to eat more oily fish and higher amounts are advised after MI. This advice should continue at present but the evidence should be reviewed regularly.</li> <li>Probably not approp to recommend high intake of omega 3 fats for people who have angina but have not had a M I.</li> <li>Some effects of fish on health may be due to components other than omega 3 – for example selenium or vitamin D.</li> <li>People who ate white or oily fish at least once per week had a sign reduced risk of stroke.</li> </ul>	A

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Hu, Bronner et al. JAMA 2002; 287(14): 1815-1821 <sup>39</sup>	Dept of Nutrition & Epidemiology, Harvard Medical School, Boston, USA	84,688 females nurses aged 34-59 yrs free from CVD and cancer USA	Fish and omega-3 FA intake and risk of <b>CHD in women</b>	CVD – CHD	Cohort Follow up 14 yrs	Fish intake	<ul style="list-style-type: none"> <li>Among women, higher consumption of fish and omega-3 FA's is assoc with lower risk of CHD, particularly CHD deaths.</li> <li>Strong evidence to support current dietary guidelines recommending fish consumption twice/wk for the prevention of CHD.</li> </ul>	A
Hu, Cho et al. Circulation 2003; 107:1852-1857 <sup>40</sup>	Dept of Nutrition & Epidemiology, Harvard School of Public Health, Boston, USA	5,103 females nurses with T2 diabetes but free of CVD or cancer at baseline USA	Fish and long chain ω-3 FA intake and risk of <b>CHD and total mortality in diabetic women</b>	CVD – CHD	Cohort Follow up 17 yrs	Fish intake	<ul style="list-style-type: none"> <li>Higher consumption of fish and long chain ω-3 FA's was assoc with a lower CHD incidence and total mortality among diabetic women.</li> <li>Findings suggest that regular fish consumption should be considered as part of a healthy diet for diabetic management</li> </ul>	A
Iso, et al., Circulation 2006; 113: 195-202 <sup>41</sup>	Dept of Public Health Med, University of Tsukuba, Japan	41,578 Japanese men and women aged 40-59 yrs Japan	Intake of fish and n-3 FA's and risk of <b>CHD</b> among Japanese	CVD – CHD	Cohort Follow up 10 yrs	Fish intake	<ul style="list-style-type: none"> <li>Compared with a modest fish intake of once/wk or ~20 g/day, a higher intake was assoc with substantially reduced risk of CHD, primarily nonfatal cardiac events, among middle aged persons.</li> <li>The risk of CHD was ~ 40% lower among persons at the highest quintile of fish intake (8 serves/wk or ~ 180 g/day).</li> <li>Findings suggest that a high fish intake may add a further beneficial effect for the prevention of CHD among middle aged persons.</li> </ul>	A
Iso, et al., JAMA 2001; 285:304-312 <sup>41</sup>	Div Prev Med, Brigham & Women's Hosp, Boston, USA	79,839 women aged 34-59 yrs	Intake of fish and omega-3 fatty acids and risk of <b>stroke in women</b>	CVD – Stroke women	Cohort Follow up 14 yrs	Fish intake Other food	<ul style="list-style-type: none"> <li>1,086,261 person/yr follow up, 574 incident strokes.</li> <li>Compared with women who ate fish &lt; once/mth, those with higher intake of fish had a lower risk of total stroke RR 0.93 fish &lt; 1-3 serves/mth, RR 0.78 1-3 serves/wk, RR 0.73 4-5 serves/wk, RR 0.48 5 or &lt; serves/wk).</li> <li>Higher consumption of fish and omega-3 polyunsaturated fatty acids was assoc with a reduced risk of thrombotic infarction, primarily among women who did not take aspirin regularly, but was not related to risk of hemorrhagic stroke.</li> </ul>	A

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Kalmijn, et al., Am J Epidemiol 1997, 145(1): 33-41 <sup>42</sup>	Dept Chron Diseases & Environ Epi. Nat Instit PH & Environ, Netherlands	342 men aged 69-89 yrs Netherlands	Polyunsaturated fatty acids, antioxidants and <b>cognitive function</b> in very old <b>men</b>	Mental health Cognitive decline men	Cohort	Fish intake	<ul style="list-style-type: none"> <li>High fish consumption tended to be inversely assoc with cognitive impairment (OR = 0.63) and cognitive decline (OR= 0.45).</li> </ul>	C
Kamphuis, et al., Am J Clin Nutr 2006; 84(6): 1513-1517 <sup>43</sup>	Julius Center for Health Science & Primary Care, Uni Medical Center Utrecht, the Netherlands	332 men aged 70-90 yrs Netherlands	<b>Depression and CV mortality: a role for n-3 fatty acids?</b>	Depression	Cohort Follow up 10 yrs	Fish intake Fish oil	<ul style="list-style-type: none"> <li>Compared with low intake (21mg/d), high intake (407mg/d) of n-3 fatty acids was assoc with fewer depressive symptoms (OR 0.46).</li> <li>An ave intake of ~ 400 mg/d of n-3 FA's may reduce depression.</li> <li>No support for hypothesis that the intake of n-3FA's explains the relation btwn depression and CVD.</li> </ul>	C
Kremer, Am J Clin Nutr 2000; 71 (suppl): 349s-351s	Div Rheumatology, Albany Med Center, NY, USA	Review international	n-3 fatty acid supplements in rheumatoid arthritis	Arthritis Inflammatory disorders	Cohort Review	Fish intake Fish oil Suppl	<ul style="list-style-type: none"> <li>Some evidence to support the use of n-3 fatty acid supplements (fish oil) in patients with rheumatoid arthritis.</li> <li>It is recommended that patients consume 3-6gm n-3 fatty acids daily for ≥ 12 wks.</li> <li>Further clinical studies required to demonstrate the efficacy of n-3 fatty acids in the management of rheumatoid arthritis.</li> <li>Further research required to assess the effectiveness of fish oil in the management of a variety of inflammatory conditions.</li> </ul>	B
Kris-Etherton, Harris et al. Artheroscler Thromb Vasc Biol 2003; 23: e20-e30 <sup>44</sup>	American Heart Association, Dallas, USA	AHA Statement	Fish consumption, fish oil, omega-3 FA's and <b>cardiovascular disease</b>	CVD	Cohort Review	Fish Intake Suppl	<ul style="list-style-type: none"> <li>A dietary (i.e. food based) approach to increasing omega-3 fatty acids is preferable.</li> </ul>	B

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Kris-Etherton, Harris et al. <i>Circulation</i> 2002; 106: 2747-2757 <sup>45</sup>	American Heart Association, Dallas, USA	American Heart Assoc Scientific Statement international	Fish consumption, fish oil, omega-3 FA's and <b>CVD</b>	CVD – Cardiac	Cohort Review	Fish intake Suppl	<ul style="list-style-type: none"> <li>• Omega-3 FA's have been shown in epi and clinical trails to reduce the incidence of CVD.</li> <li>• Evidence from prospective secondary prevention studies suggests that EPA+DHA suppl ranging from 0.5 to 1.8 g/day sign reduces subsequent cardiac and all cause mortality.</li> <li>• AHA Dietary Guidelines to include at least two serve of fish per wk.</li> <li>• Consumption of a variety of fish is recommended to minimise any potentially adverse affects due to environmental pollutants and, at the same time, achieve desired CVD health outcomes.</li> </ul>	A
La Vecchia, et al., <i>Nutr Metab Cardiovasc Dis</i> 2001; 11(4 Suppl): 10-15 <sup>46</sup>	Instituto di Ricerche Farmacologiche Mario Negri, Milano, Italy	Analysis of epi studies Italy	Nutrition and health: epi of diet, <b>cancer and CVD</b> in Italy	CVD, Cancer	Review	Fish intake Other food	<ul style="list-style-type: none"> <li>• A low risk diet for CVD and cancer includes high consumption of fish, veg and fruit.</li> </ul>	B
La Vecchia. <i>Public Health Nutr</i> 2004; 7(7): 965-968 <sup>47</sup>	Instituto di Ricerche Farmacologiche Mario Negri, Milano, Italy	>20,000 intervention 10,000 controls Nthn Italy	Mediterranean diet and <b>cancer</b>	Cancer	Review	Fish intake	<ul style="list-style-type: none"> <li>• Fish intake was a favourable diet indicator of cancer risk</li> </ul>	D
Laidlaw & Holub, <i>Am J Clin Nutr</i> 2003; 77:37-42 <sup>48</sup>	Dept of Human Biology & Nutr Sc. Uni of Guelph, Ontario, Canada	30 women, Canada	Effects of suppl with fish oil-derived n-3 fatty acids and $\gamma$ -linolenic acid on circulating plasma lipids and <b>fatty acid profiles in women.</b>	Women	Cohort	Fish oil	<ul style="list-style-type: none"> <li>• A mixture of 4gm EPH+DHA and 2gm GLA favourably altered blood lipid and fatty acid profiles in healthy women.</li> </ul>	C
Leaf, Albert et al. <i>Circulation</i> 2005; 112: 2762-2768 <sup>49</sup>	Dept of Medicine, Harvard Medical School, Boston, USA	402 patients with implanted cardioverter defibrillator USA	Prevention of <b>fatal arrhythmias</b> in high-risk subjects by fish oil n-3 FA intake.	CVD – Cardiac	Cohort Randomised double-blinded study	Fish oil	<ul style="list-style-type: none"> <li>• This study provides evidence that for individuals at high risk of fatal ventricular arrhythmias, regular daily ingestion of fish oil acids may significantly reduce potentially fatal ventricular arrhythmias.</li> </ul>	C

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Logan. BioMed Central Online 2004; 3(25): 1-8 <sup>50</sup>	Integrative care Centre of Toronto, Toronto, Canada	Review international	Omega-3 FA's and major depression: a primer for the <b>mental health</b> professional.	Mental health Depression	Review	Fish intake Fish oil	<ul style="list-style-type: none"> <li>• Omega-3 FA's play a critical role in the development and function of the CNS.</li> <li>• Emerging evidence of assoc btwn omega-3 FA's and major depressive disorder.</li> <li>• Evidence suggests that dietary lipids and other assoc nutritional factors may influence vulnerability and outcome in depressive disorders.</li> <li>• Emerging evidence that omega-3 FA's may be of therapeutic value in the treatment of depression.</li> <li>• <b>Sign. negative correlations btwn worldwide fish consumption and rates of depression.</b></li> <li>• Fish/seafood consumption also correlated with protection against post-partum depression, bipolar disorder and seasonal affective disorder.</li> <li>• Freq seafood consumption in gen popn assoc with decreased risk of depression and suicidal ideation,</li> <li>• Fish consumption sign assoc with higher self-reported mental health status.</li> <li>• 25mg of zinc suppl sign increased omega-3 status in plasma phospholipids at the expense of saturated fats.</li> </ul>	B
MacLean, et al., JAMA 2006:295:403-415 <sup>51</sup>	Sth California Evidence-based practice Center, Los Angeles, USA	Review	Effects of Omega-3 fatty acids on <b>cancer</b> risk	Cancer	Cohort Review	Fish oil Suppl	<ul style="list-style-type: none"> <li>• A large body of evidence from numerous cohorts from many countries and with diff demographic characteristics does not provide evidence to suggest a sign. Assoc btwn omega-3 fatty acids and cancer incidence.</li> <li>• Dietary suppl with omega-3 fatty acids is unlikely to prevent cancer.</li> </ul>	B
Mahaffey, et al., Environ Res 2007; doi:10.10.1016 <sup>52</sup>	US Environ Protection Agency, Washington, USA	3,614 women	Methylmercury and omega-3 fatty acids: co-occurrence of dietary sources with emphasis on fish and shellfish	Contaminant	Cohort	Fish intake Fish oil Suppl	<ul style="list-style-type: none"> <li>• Salmon followed by shrimp as principal sources of omega-3 fatty acids and are lesser sources of MeHg in contrast to tuna which provides omega-3 fatty acids, but considerably higher levels of MeHg.</li> <li>• The quality of fish that can be consumed reflects the concentration of mercury in the fish and the frequency of fish consumption.</li> </ul>	B



Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Marchioli, et al., Circulation 2002; 105:1897-1903 <sup>53</sup>	Dept Clin Pharmacology & Epi, Santa Maria Imbaro, Italy	11,323 patients	Early protection against sudden death by n-3 polyunsaturated fatty acids after <b>myocardial infarction.</b>	Cardiac	Cohort  Follow up 12 mths	Suppl	<ul style="list-style-type: none"> <li>• Four arms, n-3 PUFA suppl, Vit E suppl, n-3 PUFA &amp; Vit E and controls.</li> <li>• Needs formally testing however n-3 PUFA suppl appeared to take an anti arrhythmic and/or anti fibrillatory role in the treatment of patients with MI in relation to a reduction in sudden death..</li> </ul>	C
Marckmann P. Am J Clin Nutr 2003;78:1-2 <sup>54</sup>	Medical Dept, Roskilde Hospital, Denmark	Editorial USA	Fishing for <b>heart</b> protection	CVD –  CHD	Cohort  Review Editorial	Fish intake Fish oil	<ul style="list-style-type: none"> <li>• Fish consumption was assoc with decreased CAD mortality but not with total CAD mortality in high-risk subjects.</li> <li>• In general terms, an average daily intake of 50g fish was reported to halve mortality.</li> <li>• Consumption of fish and fish oil lowers CAD and total mortality in post MI patients, but only as long as consumption of fish and fish oil is continued.</li> <li>• Fish is more beneficial than fish oil.</li> <li>• For patients with stable angina, this is no benefit from eating fish and there may even be harmful effects of consuming fish oil capsules.</li> </ul>	C
McKellar, et al., Ann Rheum Dis 2007; 66: 1239- 1243 <sup>55</sup>	130 women with rheumatoid arthritis aged 30- 70 yrs	Glasgow Royal Infirmary, Scotland	A pilot study of a mediterranean-type diet intervention in female patients with rheumatoid arthritis living in areas of social deprivation in Glasgow	Arthritis  CVD	Cohort	Fish intake	<ul style="list-style-type: none"> <li>• Patients with RA at high risk of CVD</li> <li>• Diet – high in fruit, veg, legumes, fish and unsaturated fats and low in dairy and red meats.</li> <li>• Pain score sign better at 3 and 6 mths.</li> <li>• Intervention group also lost weight.</li> </ul>	C
McManus, et al., BMC Public Health 2007; 7(119):1-7 <sup>56</sup>	Western Australian Centre for Health Promotion Research, Curtin Uni, Australia	Qualitative study Australia	Factors influencing the <b>consumption</b> of seafood among young children	Intake	Cohort  QI study	Fish intake	<ul style="list-style-type: none"> <li>• Interventions seeking to promote seafood as an integral part of a healthy diet should address existing negative attitudes and beliefs around the storage and preparation of seafood.</li> <li>• The influence of dominant male influences within the family unit should be considered.</li> <li>• Strategies directed at parents and children should include experimental hands on components to encourage experimentation, particularly focussing on use of preparation and the variety of lower cost seafood available.</li> </ul>	C
McMichael & Butler, Am J Prev Med 2005; 29(4): 322-323 <sup>57</sup>	National Centre for Epi & Popn Health, Aust National Uni, Australia	Editorial international	Fish, <b>health</b> and sustainability	CVD	Editorial	Fish intake	<ul style="list-style-type: none"> <li>• Plenty of evidence that the consumption of fish reduces the risk of CVD.</li> <li>• Fish consumption, most probably because of the oils, is also beneficial to the developing fetus and infant brain (and perhaps the ageing brain).</li> </ul>	D

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Morris, et al., Arch Neurol 2003; 60: 940-946 <sup>58</sup>	Rush Institute for Healthy Aging, Rush-Presby. St Luke Medical Center, Chicago, USA	815 persons aged 65-94 yrs USA	Consumption of fish and n-3 fatty acids and risk of incident <b>Alzheimer Disease</b>	Alzheimer Disease	Cohort Follow-up 3.9 yrs (9ave)	Fish intake Other food	<ul style="list-style-type: none"> <li>Participants who consumed fish once/wk or &gt; had 60% less risk of Alzheimer disease compared with those who rarely or never ate fish (RR 0.4) in a model adjusted for age and other risk factors.</li> <li>Dietary intake of at least one fish meal /wk, oil-based salad dressings and nuts may reduce the risk of Alzheimer disease</li> </ul>	B
Morris, et al., Arch Neurol 2005; 62: 1849-1853 <sup>59</sup>	Rush Institute for Healthy Aging, St Luke Medical Center, Chicago, USA	6,158 persons aged 65 yr or over USA	Fish consumption and <b>cognitive decline</b> with age in a large community study	Mental health Cognitive decline	Cohort	Fish intake	<ul style="list-style-type: none"> <li>One or more fish meals/wk may protect against cognitive decline assoc with old age.</li> <li>Fish consumption may be associated with slower cognitive decline with age.</li> </ul>	C
Mosca et al., Circulation 2007; 115: 1481-1501 <sup>60</sup>	American Heart Association, Dallas, USA	Systematic review international	Evidence-based guidelines for <b>CVD</b> prevention in <b>women</b> : 2007 update AHA	CVD Women	Cohort Review	Fish intake Fish oil	<ul style="list-style-type: none"> <li>Recommend consumption of fish twice/wk from prevention of CVD in women.</li> <li>Pregnant and lactating women should consume up to 12 oz of a variety of fish/wk and shellfish low in mercury.</li> </ul>	A
Mozaffarian and Rimm. JAMA 2006;296: 1885-1899 <sup>61</sup>	Dept of Medicine & Epidemiology, Harvard Medical School, Boston, USA	Meta-analysis International	Fish intake, <b>contaminants</b> and <b>human health</b>	CVD – CHD	Cohort Meta-analysis	Fish intake	<ul style="list-style-type: none"> <li>Benefits of fish intake exceed the potential risks.</li> <li>For women of child bearing age benefits of modest fish intake, excepting a few selected species, also outweigh risks.</li> <li>Modest consumption of fish (1-2 serve/wk), esp species higher in n-3 fatty acids (EPA and DHA) reduces risk of coronary death by 36% and total mortality by 17% and may favourably affect other clinical outcomes.</li> <li>Intake of 250 mg/d of EPA and DHA appears sufficient for primary prevention.</li> <li>Women of childbearing age and nursing mothers should consume two seafood servings/wk.</li> <li>Individuals with very high consumption (≥ 5 serve/wk) should limit intake of species high in mercury levels.</li> <li>A variety of seafood should be consumed.</li> </ul>	A

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Mozaffarian, Bryson, et al., J Am Coll Cardiol 2005; 45(12): 2015-2021 <sup>62</sup>	Dept of Medicine & Epidemiology, Harvard Medical School, Boston, USA	4,738 adults aged 65 yrs or over free of CHF on recruitment USA	Fish intake and risk of incident <b>heart failure</b>	CVD – Cardiac	Cohort Follow up 12 yrs	Fish intake	<ul style="list-style-type: none"> <li>Consumption of broiled or baked fish (mainly tuna) was correlated with plasma phospholipid n-3 fatty acids</li> <li>955 participants developed coronary heart failure (CHF) during 12 yr follow-up.</li> <li>20% lower risk of CHF if consumed broiled or baked fish 1-2 times/wk, 31% lower risk if consumed 3-4 times/wk and 32% lower risk if consumed at least 5 times/wk compared with intake 1/mth.</li> <li>Dietary long chain n-3 fatty acid intake was inversely associated with CHF with 37% lower risk in the highest quintile of intake compared with the lowest.</li> <li>Consumption of fried fish was positively associated with CHF</li> <li>In older adults, consumption of broiled or baked fish is associated with lower incidence of CHF.</li> </ul>	A
Mozaffarian, Geelen et al. Circulation 2005; 112:1945-1952 <sup>63</sup>	Dept of Medicine & Epidemiology, Harvard Medical School, Boston, USA	Meta-analysis international	Effects of fish oil on <b>heart rate</b> in humans: a meta analysis of RCT's	CVD	Cohort Meta analysis	Fish oil	<ul style="list-style-type: none"> <li>Strong evidence that fish oil consumption directly or indirectly influences cardiac electrophysiology in humans.</li> <li>This effect may directly account for part of the observed benefits of fish intake on CVD risk, particularly risk of arrhythmic events.</li> <li>Fish oil lowers blood pressure in humans, possibly by reducing systemic vascular resistance.</li> </ul>	A
Mozaffarian, Gottdiener, et al., Am J Cardiol 2006; 97(2): 216-222 <sup>64</sup>	Dept of Medicine & Epidemiology, Harvard Medical School, Boston, USA	5,073 adults aged 65 yrs or over USA	<b>Physiological effects</b> of tuna or other broiled or baked fish on <b>cardiovascular system</b>	CVD – Cardiac	Cohort Follow up 12 yrs	Fish intake	<ul style="list-style-type: none"> <li>Intake of tuna and other broiled or baked fish was associated with improved cardiac hemodynamics</li> <li>Fried fish was associated with structural abnormalities indicative of systolic dysfunction and potential coronary arteriosclerosis</li> <li>Potential species physiological mechanisms that may in part account for the effects of fish intake on CV health.</li> </ul>	A

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Mozaffarian, Lemaitre et al. Circulation 2003; 107: 1372-1377 <sup>65</sup>	Dept of Medicine & Epidemiology, Harvard Medical School, Boston, USA	3910 adults 65 yrs or over free of known CVD USA	<b>Cardiac</b> benefits of fish consumption	CVD – Cardiac	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Modest consumption of tuna or other broiled or baked fish, but not fried fish or fish sandwiches, among adults aged ≥65 yrs, is associated with lower risk of IHD death, especially arrhythmic IHD death.</li> <li>Cardiac benefits of fish consumption may vary depending on the type of fish meal consumed.</li> <li>The authors support the recommendations of fatty fish consumption at least 1 to 2 servings per week.</li> </ul>	A
Mozaffarian, Longstreth et al. Arch Intern Med 2005; 165(2): 200-206 <sup>66</sup>	Dept of Medicine & Epidemiology, Harvard Medical School, Boston, USA	4,775 adults aged 65 yrs and over free of cerebrovascular disease at baseline USA	Fish consumption and risk of <b>stroke</b>	CVD – Stroke	Cohort	Fish intake	<ul style="list-style-type: none"> <li>626 experienced stroke during 12 yr follow-up including 529 ischemic stroke.</li> <li>Consumption of tuna/fish inversely assoc. with incidence of all stroke</li> <li>27% lower risk ischemic stroke with consumption of broiled or baked fish 1-4 times/wk and 30% lower risk if consumed at least 5 times/wk.</li> <li>44% higher risk of ischemic stroke if fried or sandwich fish is consumed more than once/wk.</li> <li>Fish consumption not assoc. with hemorrhagic stroke.</li> <li>Overall broiled or baked fish assoc with lower risk of ischemic stroke while intake of fried or sandwich fish is assoc. with higher risk.</li> <li>Suggestion that fish consumption could influence stroke risk later in life.</li> </ul>	A
Mozaffarian, Psaty, et al., Circulation 2004; 110(4): 368-373 <sup>62</sup>	Dept of Medicine & Epidemiology, Harvard Medical School, Boston, USA	4,815 adults 65 yrs & over USA	Fish intake and risk of incident of <b>atrial fibrillation (AF)</b>	CVD – Cardiac	Cohort	Fish intake	<ul style="list-style-type: none"> <li>12 year follow-up.</li> <li>980 cases of AF.</li> <li>Consumption tuna or other broiled or baked fish inversely associated with AF.</li> <li>28% lower risk with intake 1-4 times/wk and</li> <li>31% lower risk with intake 5 or more times/wk</li> <li>Broiled or baked fish (but not fried fish or fish sandwiches) assoc. with lower incidence of AF</li> </ul>	A

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Mozaffarian,, Ascherio, et al., Circulation 2005; 111(2): 157-164 <sup>67</sup>	Dept of Medicine & Epidemiology, Harvard Medical School, Boston, USA	45,722 men free of CVD USA	Interplay btwn diff polyunsaturated fatty acids and risk of <b>CHD</b> in men	CVD – CHD	Cohort Follow up 14 yrs	Fish intake Other food	<ul style="list-style-type: none"> <li>From baseline to 14 yrs – 2306 total CHD events including 218 sudden deaths and 1521 non-fatal MI's.</li> <li>Both long-chain and immediate-chain n-3 PUFA intake assoc with lower CHD risk</li> <li>Plant-based n-3 PUFA's may particularly reduce CHD risk when seafood-based n-3 PUFA intake is low, which has implications for popn with low consumption or availability of fatty fish</li> </ul>	A
Mozaffarian. The Lancet 2007; 369(9567): 1062-1063 <sup>68</sup>	Dept of Medicine & Epidemiology, Harvard Medical School, Boston, USA	Review International	Fish and fish oil intake and <b>cardiac</b> events	CVD – Cardiac	Cohort	Fish oil	<ul style="list-style-type: none"> <li>Commends investigators on conduction of large clinical trial of fish oil.</li> <li>Although well tolerated and beneficial, need to follow up use of fish oil over long term.</li> <li>Suggested, as research has shown low to moderate intake of fish is most beneficial to cardiac risk, much of Japanese popn already consuming fish to this level weekly.</li> <li>Focus should be placed on fundamental risk factors for CVD (e.g. intake fish at least once/wk).</li> </ul>	B
Myers & Davidson. The Lancet, 2007;369 (9561):537-538 <sup>69</sup>	University of Rochester Medical Center, New York, USA	Review USA	<b>Maternal</b> fish consumption benefits children's <b>development</b>	Pregnancy Neuro development	Review	Fish intake	<ul style="list-style-type: none"> <li>Fish and seafood contain large amounts of essential FA's, as does breast milk.</li> <li>The FA content in breast milk is determined mostly by the mother's diet.</li> <li>All fish contain small amounts of methylmercury in their flesh but they also contain nutrients essential to brain development.</li> <li>The only confirmed cases of perinatal human poisoning by methylmercury from fish consumption was in the 1950s and 1960s after massive industrial pollution of nearby waters.</li> <li>Reduction in fish consumption can lower the amounts of essential FA's below optimum brain development and therefore might result in harm.</li> </ul>	C
Myint, et al., Public Health Nutr 2006; 9(7): 882-888 <sup>70</sup>	Dept of Public Health and Primary Care, Uni of Cambridge, UK	24.312 men and women aged 40-79 yrs UK	Habitual fish consumption and risk of incident <b>stroke</b> : (EPIC)	CVD – Stroke	Cohort Follow up 8.5 yrs (ave)	Fish intake	<ul style="list-style-type: none"> <li>Oily fish consumption was sign lower in women who subsequently had a stroke.</li> <li>Trends in men were similar but not sign.</li> </ul>	B

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Nafstad, et al., J Asthma 2003; 40(4): 343-348 <sup>71</sup>	Division of Epidemiology, Norwegian Institute of Public Health, Oslo, Norway	2531 children tested at 2 and 4 yrs of age Norway	<b>Asthma and allergic rhinitis</b> at 4 years of age in relation to fish consumption in infancy	Asthma, Allergic rhinitis	Cohort  Follow- up over 4 yrs	Fish intake	<ul style="list-style-type: none"> <li>Fish consumption in the first year of life may reduce the risk of developing asthma and allergic rhinitis in childhood.</li> <li>The risk of allergic rhinitis was substantially lower in children who had fish during the first year of life (0.025) compared with children who had fish later in life (0.060).</li> <li>Early introduction to fish showed a consistent negative assoc. with the risk of allergic rhinitis in diff levels of potential confounders – length of breast feeding, parental atopy, early atopic eczema and experience of respiratory tract infection.</li> <li>Results suggest that early intake of fish protects against airway disease in early life.</li> </ul>	B
Nagata, et al., Am J of Epidemiol 2002; 156:824-831 <sup>72</sup>	Dept of Public Health, Gifu Uni School of med, Gifu, Japan	13,355 males and 15,724 females Japan	Soy and fish oil intake and <b>mortality</b> in a Japanese community	All cause mortality	Cohort  Follow up >7yrs	Fish oil	<ul style="list-style-type: none"> <li>For women but not for men, n-3 FA's from fish were sign inversely assoc with total mortality.</li> </ul>	A
Noaghiul, A J Psychiatry 2003; 160:2222-2227 <sup>73</sup>	Laboratory of Membrane Biochemistry & Biophysics, NIAAA/NIH, Rockville MD, USA	Data from 10 countries plus published studies international	Cross-national comparisons of seafood consumption and rates of <b>bipolar disorders</b>	Mental health  Bipolar disorders	Cohort  Review	Fish intake	<ul style="list-style-type: none"> <li>Greater seafood consumption predicted lower lifetime prevalence rates of bipolar I disorder, bipolar II disorder and bipolar spectrum disorder.</li> <li>Bipolar II disorder and bipolar spectrum disorder had an apparent vulnerability threshold below 50 lbs seafood/ person/ year.</li> <li>These data describe a robust correlational relationship between greater seafood consumption and lower prevalence rates of bipolar disorders.</li> </ul>	C
Norris, et al., JAMA 2007; 298(12): 1420- 1428 <sup>74</sup>	Dept Prev Med and Biometrics, Uni of Colorado, Denver, USA	1,770 children at increased risk of Type I diabetes	Omega-3 polyunsaturated fatty acid intake and islet autoimmunity in children at increased risk for type I diabetes	Diabetes	Cohort  Follow up 12 yrs	Fish intake Other food	<ul style="list-style-type: none"> <li>Dietary intake of omega-3 fatty acids is assoc with reduced risk of autoimmunity in children at increased risk for type I diabetes</li> </ul>	B
Oddy, et al., Journal of Asthma 2004; 41 (3) 319-326 <sup>75</sup>	Telethon Institute for Child Health Research, Uni of Western Australia, Aust.	2,602 children aged 6-8 yrs	Ratio of Omega-6 to Omega-3 fatty acids and childhood <b>asthma</b>	Asthma	Cohort	Fish intake Other foods	<ul style="list-style-type: none"> <li>The promotion of a more natural diet rich in n-3 fatty acids (fresh or oily fish at least 1/wk, whole grain cereals, raw sunflower and flax seeds, canola oil) and less n-6 fatty acids (margarines, vegetables oils, processed foods ) may protect against the symptoms consistent with childhood asthma.</li> </ul>	B

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Oh, et al., J Am Board Fam Med 2006; 19: 459-467 <sup>6</sup>	Tripler Army Medical Center, Honolulu & Uni of Washington, USA	223 General practitioners USA	Fish in secondary prevention of <b>heart disease</b> (FISH) survey	CVD – Cardiac	Cohort	Fish oil	<ul style="list-style-type: none"> <li>17% were high fish prescribers.</li> <li>Knowledge of benefits of fish oil in sudden death reduction was assoc. with higher fish prescribers.</li> <li>High fish prescribers more likely to report sufficient time to discuss dietary therapies.</li> </ul>	C
Olsen & Secher, BMJ 2002; 324:1-5. <sup>77</sup>	Danish Epidemiology Science Centre, Copenhagen, Denmark	8,729 pregnant women Denmark	Low consumption of seafood in early <b>pregnancy</b> as a risk for preterm delivery	Pregnancy	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Occurrence of preterm delivery varied from 7.1% in group never consumed fish to 1.9% in those consuming fish at least once/wk.</li> <li>Low consumption of fish was a strong risk factor for preterm delivery and low birth weight.</li> <li>In women with zero or low intake of fish, small amounts of n-3 FA's (provided as fish or fish oil) may confer protection against preterm delivery and low birth weight.</li> </ul>	A
Oomen, et al., Am J Epidemiol 2000; 151(10): 999-1006 <sup>78</sup>	Dept of Chronic Diseases Epi, National Institutes of Public Health & the Environ, Bilthoven, the Netherlands	1,088 Finns 1,097 Italians, 553 Dutch men aged 50-69 yrs	Fish consumption and <b>CHD</b> mortality in Finland, Italy and the Netherlands	CVD – CHD	Cohort Follow up 20 yrs	Fish intake	<ul style="list-style-type: none"> <li>Fatty fish compared with non-fatty fish consumption was assoc with lower CHD mortality.</li> </ul>	A
Panagiotakos, Pitsavos et al. J Amer Diet Assoc 2007; 107:979-987 <sup>79</sup>	Dept-Nutrition & Dietetics, Harokopio Uni, Athens, Greece	1,514 men, 1,528 women aged 18 yr or older Greece	Assoc btwn food patterns and <b>metabolic syndrome</b> using principal component analysis: the ATTICA Study	CVD	Cohort	Fish intake Other food	<ul style="list-style-type: none"> <li>Those who adopted Mediterranean diet of fish, vegetables, legumes, cereals and fruits had a 13% lower likelihood of having metabolic syndrome.</li> <li>Those with high levels of alcohol intake increased their odds of acquiring the syndrome by 26%</li> <li>Mediterranean diet could be protective against metabolic syndrome in adults.</li> </ul>	C
Pedersen, et al., J Rheumatol 2005; 32(7): 1249-1252 <sup>80</sup>	Dept Epi Research, Danish Epi Sc Centre, Denmark	57,053 adults	Diet and risk of rheumatoid arthritis in a prospective cohort	Arthritis Inflammatory conditions	Cohort Follow up ave 5.3 yrs	Fish intake	<ul style="list-style-type: none"> <li>Small number developed RA (n=69) during study</li> <li>Intake of 30g fat fish/day assoc with 49% reduced risk of RA.</li> <li>No assoc with other dietary factors including long chain fatty acids, olive oil, etc.</li> <li>Diet may play an important role in modifying the risk factors assoc with RA.</li> </ul>	B

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Ponce, et al., Risk Analysis 2000; 4:529- 542 <sup>81</sup>	Dept of Environmental Health, Uni of Washington, USA	Case- control study USA	Use of QALY's with dose response for PH decisions: a case study of the <b>risk and benefits</b> of fish consumption	Health benefits  risks	Review	Fish intake	<ul style="list-style-type: none"> <li>Two end points used – MI fatality and developmental delay – to demonstrate use of QALY's and dose-response models.</li> <li>Using this model – across a range of fish methylmercury concentrations (0-1ppm) and intake levels (0-25g/day), indiv would have to weight the neurodevelopmental effects 6 times more (in the whole popn) or 250 times less (among women of childbearing age and their children) than the MI benefits in order to be ambivalent about whether or not to consume fish.</li> </ul>	C
Richardson, A.J. Intern Rev Psychiatry 2006; 18(2); 155-172 <sup>82</sup>	Dept of Psychiatry, Uni of Oxford, England	Review	Omega-3 fatty acids in ADHD and related neuro developmental disorders	ADHD  Brain dev	Review	Fish intake Fish oil	<ul style="list-style-type: none"> <li>Dietary supplements with fish oil appear to alleviate ADHD related symptoms in at least some children.</li> <li>One study found benefits in academic achievement</li> <li>Larger trials are now needed to confirm these findings and to establish specificity and durability of treatments.</li> </ul>	C
Rose & Holub Food Research Intern 2006; 39: 910-916 <sup>83</sup>	Dept Human Biol & Nutr Sciences. Uni of Guelph, Ontario, Canada	15 men aged 30-65 yrs, Canada	Effects of a liquid egg produce containing fish oil on selected <b>cardiovascular disease</b> risk factors: A randomised cross over trial	CVD	Cohort	Fish oil	<ul style="list-style-type: none"> <li>The predominant source of EPA &amp; DHA in the US and Canadian diet is fish which accounts for 90% and 75%, respectively, of the total daily consumption of these n-3 fatty acids.</li> <li>Currently, the US popns are only consuming approx 130-150 mg/day of EPA and DHA combined, well below the recommended intake of 900 mg/day for patients with CVD.</li> <li>A convenient liquid egg breakfast as a novel source of considerable levels of EPA and DHA was very well tolerated as a functional food.</li> <li>This finding may be important to those who eat little fish or no fish for various reasons.</li> </ul>	C
Sakamoto, et al., Inflamm Bowel Dis 2005; 11(2): 154-163 <sup>84</sup>	Dept of Hygiene, Hyogo College of Med, Japan.	239 interv, 219 controls aged 15-34 yrs	Dietary risk factory for inflammatory bowel disease: a multicenter case-control study in Japan.	Inflammatory conditions	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Findings suggest the importance of dietary factors in inflammatory bowel disease prevention.</li> </ul>	C



Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Salam, et al., Journal of Asthma 2005; 42: 513-518 <sup>85</sup>	Dept Prev Med, USC Keck School of Med, LA, USA	691 children age 5 yrs	Maternal fish consumption during pregnancy and risk of early childhood <b>asthma</b>	Asthma	Cohort  279 cases 412 ctrls	Fish intake	<ul style="list-style-type: none"> <li>For children born to mothers with a history of asthma, OR for asthma was 0.20 when mothers ate oily fish at least once /mth during pregnancy compared with no consumption.</li> <li>In contrast, fish sticks (source of trans fats) consumption during pregnancy increased asthma risk in children (OR 2.04).</li> </ul>	B
Sinn & Bryan, J Dev Behav Pediatr 2007; 28(2): 82-91 <sup>86</sup>	Comm Sc & Industrial Res Org Human Nutr, Adelaide, Australia	132 children aged 7-12 yrs, Australia	Effect of supplementation with polyunsaturated fatty acids and micronutrients on learning and behaviour problems associated with child ADHD	ADHD	Cohort	Suppl	<ul style="list-style-type: none"> <li>ADHD related problems with inattention, hyperactivity and impulsivity might respond to treatment with PUFA's and that improvements may continue with suppl up to 30 weeks.</li> </ul>	C
Siscovick, et al Am J Clin Nutr 2000; 71(1) <sup>87</sup> : 208S-212S	CV Hlth Unit, Dept of Med & Epidemiol, Uni of Washington, USA	Case- control study USA	Dietary intake of long- chain n-3 polyunsaturated FA's and the risk of <b>primary cardiac arrest</b>	CVD –  Cardiac	Cohort  Case- control study	Fish intake	<ul style="list-style-type: none"> <li>Dietary intake of long-chain FA's from seafood is assoc with a reduced risk of primary cardiac arrest.</li> <li>Compared with no seafood intake, modest dietary intake of long-chain n-3 PUFA's from seafood (1 fatty fish meal/wk), is assoc with a reduction in the risk of primary cardiac arrest.</li> <li>Compared with modest intake, higher intakes of these FA's are not assoc with a further reduction in risk.</li> <li>Reduced risk of primary cardiac arrest may be mediated, at least in part, by the effect of dietary n-3 PUFA intake on cell membrane FA composition.</li> </ul>	B
Stark, et al., Nutr 2002; 18:627-630 <sup>88</sup>	Dept Human Biol & Nutr Sciences. Uni of Guelph, Ontario, Canada	15 Inuit and 16 non-Inuit women aged 45-65 yrs, Canada	Fatty acid compositions of serum phospholipids of <b>postmenopausal women</b> : A comparison btwn Greenland Inuit and Canadians before and after supplementation with fish oil	Women	Cohort	Fish oil	<ul style="list-style-type: none"> <li>The apparent benefits of the Greenland Inuit marine diet compared with the Western diet was reviewed.</li> <li>The fish oil suppl in the Canadian women increased the EPA and DHA levels and decreased linoleic acid levels to those found in corresponding Inuit women but only slightly lowered arachidonic acid levels.</li> </ul>	C

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Sun, et al., Am J Clin Nutr 2007; 86(1): 74-81 <sup>89</sup>	Dept of Nutr & Epi, Harvard School of Public Health, Boston, USA	306 women aged 43-69 yrs USA	Comparison btwn plasma & erythrocyte fatty acid content as <b>biomarkers</b> of fatty acid intake in US women.	Biomarkers FA intake women	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Erythrocyte n-3 FA's of marine origin and trans fatty acid content are suitable biomarkers for long-term intake.</li> </ul>	B
Terry, et al. Am J Clin Nutr 2003; 77: 532-543 <sup>90</sup>	Dept Epidemiology & Social medicine, Albert Einstein College of Medicine, New York, USA	Review of epidemiological evidence international	Intakes of fish and marine FA's and risk of <b>cancers of breast and prostate.</b>	Cancer	Review	Fish intake	<ul style="list-style-type: none"> <li>Assoc btwn fish consumption or marine fatty acid intake and the risk of hormone-related cancers unclear, however they may be important.</li> <li>Future studies should focus on the assessment of FA's in the diet as dietary constituents have been infrequently examined in humans.</li> <li>Recommendations of the American Heart Assoc of 2 or more serves of fish/wk for the prevention of sudden cardiac death may have additional benefits including those related to blood triacylglycerol concentrations, clotting mechanisms, blood pressure, the immune system, and the developing CNS.</li> </ul>	B
Terry, et al., The Lancet 2001, 357: 1764-1765 <sup>91</sup>	Dept of Nutr & Epi, Harvard School of Public Health, Boston, USA	6,272 Swedish men, Sweden	Fatty fish consumption and risk of <b>prostate cancer</b>	Cancer	Cohort Follow up 30 yrs	Fish intake	<ul style="list-style-type: none"> <li>During 30 yr follow-up, men who ate no fish had a 2 to 3 fold higher frequency of prostate cancer than those who ate moderate or high amounts of fish.</li> <li>Results support hypothesis that fatty fish consumption lowers the risk of prostate cancer.</li> </ul>	A
Thien, Woods & Walters, MJA 1996; 164: 135-156 <sup>92</sup>	Dept of Respiratory Medicine, Alfred Healthcare Group, Melbourne, Australia	Review Australia	Oily fish and <b>asthma</b>	Asthma	Review	Fish intake	<ul style="list-style-type: none"> <li>One large study of 2,526 adults aged 30-70 yrs. Eating fish more than once / wk compared with less than once/wk was assoc with higher lung function but only 2.9% were asthmatics in study therefore no conclusion can be drawn regarding asthma and fish consumption.</li> <li>Another large study of 8,960 adults found high dietary intake of n-3 FA's was inversely related to risk of COPD.</li> <li>Studies urgently needed to assess relationship btwn fish consumption and asthma.</li> </ul>	C

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Torpy, et al., JAMA 2006; 1296(15):1926 <sup>93</sup> .	JAMA recommendations for physicians and health care professionals	Review of evidence USA	Eating fish: health benefits and risks	Health benefits CVD – Stroke, CHD, Cardiac Pregnancy, Mercury, Depression, Mental decline, Brain development	Review	Fish intake	<p><b>Health benefits fish consumption:</b></p> <ul style="list-style-type: none"> <li>• omega-3 FA's (esp oily fish such as salmon, sardines and herring) can lower bP and HR, and improve of CVD risk factors;</li> <li>• reduces risk of death from CHD;</li> <li>• is linked to lower risk of stroke, depression and mental decline with age; and</li> <li>• for pregnant women, mothers breastfeeding and women in childbearing age, fish intake is important because it supplies DHA, a specific omega-3 FA's that is beneficial for the brain development of infants.</li> <li>• The benefits of fish intake can be maximised by consuming a variety Of different seafood.</li> </ul> <p><b>Possible risks fish consumption:</b></p> <ul style="list-style-type: none"> <li>• not clear that mercury exposure from typical levels of fish intake has any adverse health effect;</li> <li>• mercury exposure from fish intake should not be a major concern for men and women of non-childbearing age;</li> <li>• mercury may have subtle effects on the developing nervous systems of infants;</li> <li>• women who are pregnant, may become pregnant or are breastfeeding plus very young infants should avoid 4 types of fish with higher mercury content: shark, swordfish, king mackerel and golden bass;</li> <li>• Light tuna has relatively low levels of mercury, and other fish (wild /farmed salmon,shrimp), contain very low levels of mercury. These types of fish should be consumed by infants to receive benefits of DHA for brain development.</li> <li>• Chemicals (dioxins and polychlorinated biphenyls) can accumulate in foods, incl fish.</li> <li>• Levels of chemicals are very low in fish and similar to levels in meat and dairy products.</li> <li>• Compared with health benefits of fish intake, the health risks of these chemicals are very low and should not influence individual decisions about fish intake.</li> <li>• Compared with store-bought fish, locally caught freshwater fish may have higher chemical levels.</li> </ul>	C

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Van Gelder, et al., Am J Clin Nutr 2007; 85 (4): 1142-1147 <sup>94</sup>	Centre for Prevention & Health Services Research, Bilthoven, Netherlands	210 persons aged 70-89 yrs Netherlands	Fish consumption, n-3 fatty acids and subsequent 5 yr cognitive decline in elderly men: the Zutphen Elderly Study	Mental health Cognitive decline	Cohort	Fish intake Other foods	<ul style="list-style-type: none"> <li>Fish consumers had significantly (<math>p=0.01</math>) less 5-yr subsequent cognitive decline than did non consumers.</li> <li>A moderate intake of EPA&amp;DHA may postpone cognitive decline in elderly men.</li> </ul>	B
Varraso, et al., Am J Clin Nutr 2007; 86(2): 488-495 <sup>95</sup>	Dept of Nutrition & Epidemiology, Harvard School of Public Health, Boston, USA	72,043 women USA	Dietary patterns and <b>Congestive Obstructive Pulmonary Disease (COPD)</b> among US women	COPD	Cohort Follow up over 16 yrs	Fish intake	<ul style="list-style-type: none"> <li>754 new cases of COPD identified among 72,043 women during 16 yr follow-up.</li> <li>Negative assoc btwn diet rich in fruit, veg and fish and the risk of COPD.</li> <li>Positive assoc btwn diet rich in refined grains, red meats, desserts and French fries and the risk of COPD.</li> <li>Dietary patterns were not assoc with the risk of adult onset asthma.</li> </ul>	A
Verbeke & Vackier, Appetite 2005; 44: 67-82 <sup>96</sup>	Dept of Ag Economics, Ghent Uni, Belgium	Cohort QI study 429 persons	Individual determinants of <b>fish consumption</b> : application of the theory of planned behaviour	Intake	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Favourable attitudes, high subjective norm and high perceived behavioural control have a positive impact on fish consumption decisions.</li> <li>Sign habit effects were detected.</li> <li>Appreciation of taste was the most important driver for eating fish, followed closely by health.</li> <li>Bones and price were negative attitude factors.</li> <li>Women consumed more fish than men and consumption increased with age.</li> <li>Children in the household were assoc with lower consumption rates.</li> <li>Lowest income assoc with lowest consumption.</li> <li>Food involvement correlated positively with fish consumption intention and frequency.</li> </ul>	C
Wang, Harris et al. Am J Clin Nutr 2006; 84: 5-17 <sup>97</sup>	Institute for Clinical Research & Health Policy Studies, Tufts-New England Medical Center, Boston, USA	Systematic review International studies in English	N-3 fatty acids from fish and fish-oil suppl and <b>CVD</b> outcomes	CVD – Cardiac,	Cohort Review	Fish intake Fish oil	<ul style="list-style-type: none"> <li>Evidence suggested that increased consumption of n-3 fatty acids from fish and fish oil suppl, but not of <math>\alpha</math>-linolenic acid, reduced the rates of all-cause mortality, cardiac and sudden death, and possibly stroke.</li> <li>Evidence of the benefits of fish oil was stronger in secondary than primary prevention settings.</li> <li>Adverse effects appeared to be minor.</li> <li>Evidence appeared strong for a beneficial effect of very-long-chain n-3 FA intakes on VD risk in secondary, but not primary prevention.</li> </ul>	B

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Willett WC, Am J Prev Med 2005; 29(4): 320-321 <sup>98</sup>	Harvard School of Public Health, Boston, USA	Review USA	Fish: Balancing <b>health risks and benefits</b>	Health benefits	Review	Fish intake	<ul style="list-style-type: none"> <li>Overall consequences could be adverse if fish consumption is reduced in the general popn.</li> <li>This analysis supports current guidelines that focus on changes in the type of fish eaten by women in the reproductive age, but also highlights concerns that educational messages and the implementation of policies must be carefully crafted to avoid unintended consequences.</li> </ul>	D
Woods, Stoney, et al., Asia Pacific J Clin Nutr 2002; 11(1): 56-61 <sup>99</sup>	Dept of Epidemiology & Preventive Medicine, Central & Eastern Clinical School, Victoria, Australia	4,500 adults aged 20-44 yrs Australia	A <b>valid FF qre</b> for measuring dietary fish intake	Valid measurement tool	Cohort	Fish intake	<ul style="list-style-type: none"> <li>FFQ developed to measure FA intake in large scale epi study where logistics and resources prevent the use of more objective markers.</li> </ul>	B
World Health Organization, 2007 <sup>100</sup>	WHO, Geneva	Systematic review - report WHO	Popn nutrient intake goals for preventing diet-related <b>chronic diseases</b>	CVD – Cardiac	Review	Fish intake	<ul style="list-style-type: none"> <li>Most of the epi evidence related to n-3 FA's is derived from studies of fish consumption in popns or interventions involving fish diets in clinical trials.</li> <li>Fish oil study with survivors of MI – after 3.5 yrs follow up, 20% reduction in total mortality, 30% reduction in CV death and 45% decrease in sudden death.</li> <li>In high risk popn, fish consumption of 40-60 g/day would lead to 50% reduction in death from CHD.</li> <li>Re-infarction trial – 2 yr mortality reduced by 29% in survivors of a first MI in persons receiving advice to consume fatty fish at least twice/wk.</li> <li>Recent study of data from 36 countries reported fish consumption was assoc with a reduced risk of death from all causes as well as CVD mortality.</li> <li>Dietary goal should be a regular intake of fish (one or two times/wk) – protective against CHD and ischaemic stroke.</li> </ul>	B

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Xue, Holzman et al. Environ Health Perspect 2007; 115:42-47 <sup>101</sup>	Michigan State University, USA	Hair segments from 1,024 pregnant women from 52 prenatal clinics USA	<b>Maternal</b> fish consumption, mercury levels and risk of preterm birth.	Pregnancy	Cohort	Fish intake	<ul style="list-style-type: none"> <li>High levels of maternal fish consumption during pregnancy assoc with longer gestation, increased birth weight, reduced risk of intrauterine growth retardation and lower prevalence of pregnancy-induced hypertension.</li> <li>Only a small % of women (10%) consumed sport-caught fish during pregnancy.</li> <li>Women who delivered very preterm (35 wks) were more likely to have had hair mercury levels at or above 90<sup>th</sup> percentile even after adj for maternal characteristics and fish consumption. Assoc not evident in lower threshold levels of mercury.</li> <li>Very few women in study delivered before 35 wks (n=44) therefore further studies are required in this area.</li> <li>Many limitations to the study e.g. 10% of women in study reported not eating fish but had mercury levels in 4<sup>th</sup> and 5<sup>th</sup> quintiles.</li> </ul>	C
Yokayama, et al., The Lancet 2007; 369(9567): 1090-1098 <sup>102</sup>	Kobe Uni, Kobe, Japan	18,645 males and females up aged from 40 to 70 yrs with total cholesterol 6.5mmol/L or greater Japan	Effects of eicosapentaenoic acid on major <b>coronary</b> events in patients with total cholesterol 6.5mmol/L or >	CVD – Cardiac	Cohort Randomised open-ended label, blinded endpoint analysis	Fish intake	<ul style="list-style-type: none"> <li>Pharmacological intervention</li> <li>Baseline plasma fatty acid concentrations as indication of fish consumption and EPA intake</li> <li>19% reduction in major coronary events with therapeutic dose of 1800 mg/day of EPA.</li> <li>No significant difference in all-cause mortality or in rates of cancer and stroke btwn treatment and control groups.</li> <li>EPA is a very promising regimen for prevention of major coronary events.</li> </ul>	C
Young & Conquer Reprod Nutr Dev 2005; 45(1): 1-18 <sup>103</sup>	Dept Human Biol & Nutr Sciences. Uni of Guelph, Ontario, Canada	Review	Omega-3 fatty acids and neuropsychiatric disorders	ADHD Alzheimer's Disease Depression	Review	Fish intake Fish oil Suppl	<ul style="list-style-type: none"> <li>Decreased levels of omega-3 fatty acids have been assoc with several neuropsychiatric conditions – ADHD, Alzheimer's Disease, Schizophrenia and depression</li> <li>Both DHA &amp; EPA assoc with many aspects of brain function.</li> <li>Further research required in this area</li> </ul>	C

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Young et al., Reprod Nutr Dev 2005; 45(5): 549-558 <sup>104</sup>	Dept Human Biol & Nutr Sciences. Uni of Guelph, Ontario, Canada	Review	Effect of randomized supplementation with high dose olive, fax or fish oil on serum phospholipid fatty acid levels in adults with attention deficit hyperactivity disorder	ADHD	Review	Fish intake Fish oil Suppl	<ul style="list-style-type: none"> <li>Further study required to determine whether correction of low levels of long chain omega-3 fatty acids if of therapeutic benefit in ADHD</li> </ul>	C
Yuan, Ross et al. Am J Epidemiol 2001; 154:809- 816 <sup>105</sup>	Dept of Prev Med, Uni of Sthn California, LA, USA	18,244 men aged 45-64 yrs China	Fish and shellfish consumption in relation to death from <b>MI</b> among men in Shanghai, China	CVD – Cardiac	Cohort  Follow up 10 yrs	Fish intake	<ul style="list-style-type: none"> <li>113 deaths from acute MI were identified.</li> <li>Men who consumed <math>\geq 200</math>g of fish/ shellfish per wk had a RR of 0.41 for fatal acute MI compared with men consuming <math>&lt; 50</math>g/wk.</li> <li>Dietary intake of n-3 FA's derived from seafood was sign assoc with reduced mortality from MI.</li> <li>Approx 20% reduction in total mortality assoc with wkly fish/shellfish intake.</li> <li>Study found that weekly intake of fish or shellfish reduces the risk of fatal MI in middle-aged and older men in China.</li> </ul>	A
Zampelas, et al., J Am Coll Cardiol 2005; 46:120-124 <sup>106</sup>	Dept of Nutrition & Dietetics, Harokopio Uni, Athens, Greece	1,514 men aged 18-87 yrs and 1,528 women aged 18-89 yrs Greece	Fish consumption among healthy adults is assoc with decreased levels of inflammatory markers related to <b>CVD</b>	CVD	Cohort	Fish intake	<ul style="list-style-type: none"> <li>Fish consumption was independently assoc with lower inflammatory marker levels among healthy adults.</li> <li>Significant results were observed with quantities as low as 150 to 300 g/wk of fish were consumed.</li> <li>Stratified analysis showed that fish and omega-3 FA intake were inversely assoc with lower inflammatory marker levels in people with diabetes and hypertension, but not in people with hypercholesterolemia.</li> <li>Observed a strong inverse relationship btwn fish consumption and levels of inflammatory markers related to CVD, irrespective of other potential confounders.</li> </ul>	B
Zhang, Sasaki, et al., Preventive Medicine 1999; 28: 520-529 <sup>107</sup>	School of Public Health, Catholic Uni of Leuven, Belgium	Data 36 countries WHO statistics	Fish consumption and mortality from <b>all causes, ischaemic heart disease and stroke</b> : an ecological study	CVD – Cardiac	Cohort  Ecologic al study	Fish intake	<ul style="list-style-type: none"> <li>Fish consumption was assoc with a reduction in all cause, ischaemic heart disease and stroke mortality at the popn level.</li> <li>Further studies required to clarify the strength and consistency of the relation btwn fish consumption and the risk of these diseases.</li> </ul>	B

Reference	Institution	# /Country	Title	Theme	Design	Type	Outcome	Evidence
Zhang, Temme et al. Intern J Epidemiol 2000; 29: 615-621 <sup>108</sup>	Dept of Epidemiol, School of Public Health, Catholic Uni of Leuven, Belgium	Data 36 countries international	Fish consumption is inversely assoc with <b>male lung cancer</b> mortality in countries with high levels of cigarette smoking or animal fat consumption	Cancer CVD, chronic respiratory disease, rheumatoid arthritis, ulcerative colitis, all cause mortality.	Cohort Ecologic al study	Fish intake	<ul style="list-style-type: none"> <li>• <b>Fish consumption is assoc with a reduced risk of lung cancer mortality in males</b> (independent of cigarettes, animal fat minus fish fat, vegetable and fruit consumption).</li> <li>• N-3 FA's, abundantly available in fish, have shown to possess an anti-inflammatory effect.</li> <li>• Fish intake protective for cigarette smokers against COPD and the deterioration of lung function (possibly due to anti-inflammatory effects).</li> <li>• Fish oil has been reported to inhibit rectal mucosal cell proliferation in subject with sporadic adenomatous colorectal polyps and the growth of human breast carcinoma maintained in athymic nude mice.</li> <li>• <b>Evidence fish consumption protective against CVD, chronic respiratory disease, rheumatoid arthritis, ulcerative colitis and all cause mortality.</b></li> <li>• It is inferred that increasing the amount of fish consumption could decrease the mortality of lung cancer and other related diseases, esp in popns with high levels of cigarette consumption and animal fat intake.</li> </ul>	A



## 4.0 Seafood Benefits Health Communication Strategic Review.

### 4.1 Capacity needs

The objectives of this section were to:

- Identify which organisations, institutions and spokespeople are currently providing information on seafood health benefits and the level of credibility of those organisations and institutions;
- Undertake an initial assessment of organisations, institutions and spokespeople capacities and relevance to the seafood industry; and
- Assess the availability of trained people to develop the resources and to deliver health benefits information to the target audiences.

### 4.2 Summary

The collated information is presented in four tables:

- *Table 4.1* summarises organisations providing credible and consumer friendly reference material for advice on general seafood health benefits;
- *Table 4.2* summarises information provided on seafood health benefits (and, if referenced, the source of information is from Table 4.1) by a variety of organisations with a stake in the seafood industry. These include health and fisheries government agencies and authorities, peak industry representative bodies, medical/condition/nutrition representative agencies, education and training providers, seafood companies/retailers and environmental groups;
- *Table 4.3* summarises consumer information related to seafood preparation/cooking that may be a conduit to providing information on health benefits; and
- *Table 4.4* summarises personalities/professionals providing health benefits information.

### 4.3 Comments

Many relevant organisations do not provide any advice on the health benefits of seafood, furthermore, many health and food agencies have little information available.

- When information is provided, messages are generally similar. The most common messages refer to omega 3 oils and health benefits (high in protein, vitamins and minerals) and usually a reference recommending two fish meals per week. Some detail relates fish to: slimming; specific health benefits of specific vitamins and minerals (eg iodine, etc); and the omega 3 levels in different fish types. The balance between risks and benefits associated with mercury levels in fish is reported.
- Most discussions reference a particular source of information, however the actual reference details are rarely given.
- Reliable resources are not numerous, most Australian references are to 'What's so healthy about Seafood', National Health and Medical Research Council (NHMRC), Australian Dietary Guidelines and Food Standards of Australia and New Zealand (FSANZ) guidelines. Seafood Services Australia (SSA) website 'Seafood for Health' is excellent and carries a significant amount of information but was rarely referenced.
- It appears very little information on the health benefits of seafood is included in training packages/curricula at primary, secondary and technical level. However, it is noteworthy that there is considerable scope to include such information in already developed competencies and curricula (see Table 3). The research does indicate that a single reference point for seafood health benefits (updated frequently) may be advantageous.
- Few simple pamphlets or educational materials are available for point of sale (except FRDC What's so great about seafood).
- Live demonstrations (real or on television) (particularly as regards cooking classes, demonstration, celebrity chefs) are not yet well researched.
- Professional Spokespeople: Roy Palmer, SSA; Prof Bob Gibson (Flinders University) are two notable examples.
- Personalities: Don Hancey; Ian Parmenter; Ian Bowman are notable examples personalities who promote seafood through various media avenues.

**Table 4.1: Credible and Consumer Friendly Sources of Information About the General Benefits of Seafood (General)**

Organisation	Title	Contents	website	Credibility
FRDC/CSIRO	1. What's so Healthy About Seafood : A Guide for Seafood Marketers (book)	General guide to health benefits of seafood	<a href="http://www.frdc.com.au/fish/health">www.frdc.com.au/fish/health</a>	High level of credibility CSIRO publication
	2. What's so Healthy About Seafood : A Guide for Seafood Marketers (pamphlet)	Pamphlet summarising results of book	<a href="http://www.frdc.com.au/fish/health">www.frdc.com.au/fish/health</a>	High level of credibility CSIRO publication
FRDC/CSIRO	3. Seafood the good food: oil content and composition of Australian commercial fishes, shellfishes and crustaceans.	Source of omega 3 data	<a href="mailto:publishing.sales@csiro.au">publishing.sales@csiro.au</a>	High level of credibility CSIRO publication
CSIRO/FRDC	4. Seafood the good food II	Source of omega 3 data in further species	<a href="mailto:publishing.sales@csiro.au">publishing.sales@csiro.au</a>	High level of credibility CSIRO publication
CSIRO	5. Fact Sheet: Fish Oils Keep the heart Running Smoothly	Summary of omega 3 benefits		High level of credibility CSIRO publication
Seafood Services Australia (SSA)	6. Australian Seafood Users manual – making the most of the world's best.	Cooking , nutritional and other information	<a href="http://www.seafoodservices.com.au/bookshop">www.seafoodservices.com.au/bookshop</a>	High level of credibility
SSA	7. Seafood for Life website	Much general compiled information on health benefits of seafood (including media releases)	<a href="http://www.seafoodservices.com.au/">www.seafoodservices.com.au/</a>	Information site using referenced material
SSA	8. Seafood for Life Workshop	Held November 2006	<a href="http://www.seafoodservices.com.au/">www.seafoodservices.com.au/</a>	International and national experts
National Health and Medical Research Council (NHMRC)	9. Dietary Guidelines for Australian adults (2003)	Scientific summary leading to suggested dietary guidelines (including fish meal recommendations)	<a href="http://www.nhmrc.gov.au">www.nhmrc.gov.au</a>	High level of credibility
NHMRC	10. Dietary Guidelines for Children and Adolescents in Australia (including the infant feeding guidelines for healthy babies) (2003)	Scientific summary leading to suggested dietary guidelines (including recommendations of two fish meals per week)	<a href="http://www.nhmrc.gov.au">www.nhmrc.gov.au</a>	High level of credibility
NHMRC	11. Food for health	Consumer version of scientific summaries on guidelines (including recommendations of two fish meals per week). Also fish is high in Zinc, Vitamin B12 and Omega 3's.	<a href="http://www.nhmrc.gov.au">www.nhmrc.gov.au</a>	High level of credibility

Organisation	Title	Contents	website	Credibility
Food Standards Australia and New Zealand.	12. Guidelines for mercury in fish	List benefits and also set limits for pregnant women and children (mercury risk)	<a href="http://www.foodstandards.gov.au">www.foodstandards.gov.au</a>	High level of credibility
National Heart Foundation of Australia	13. Guidelines a. Plant Sterols, Omega 3 Fats and heart Disease b. Dietary Fats and heart Disease	Recommend two fish meals per week List fish with higher omega 3 fats	<a href="http://www.heartfoundation.com.au">www.heartfoundation.com.au</a>	Panel of experts producing heart foundation guidelines
Institute of Medicine (USA)	14. Article "Seafood Choices: Balancing Benefits and Risks."(SSA media release)	Results of large, long term study on benefits of fish consumption and confirms that seafood is a good source of high-quality protein, low in saturated fat, and rich in many vitamins and minerals.	<a href="http://jama.ama-assn.org">http://jama.ama-assn.org</a>	Peer reviewed journal
Harvard School of Public Health (HSPH)	15 Report "Fish Intake, Contaminants, and Human Health: Evaluating the Risks and the Benefits (SSA media release),		<a href="http://www.iom.edu/CMS/3788/23788/37679.aspx">http://www.iom.edu/CMS/3788/23788/37679.aspx</a>	Peer reviewed journal publication
American Association for the Advancement of Science (AAAS)	16. Recommendation following expert panel (SSA media release)	A panel of experts has confirmed the health benefits of seafood. A. recommendation has emerged to eat seafood not just the usually suggested two to three times a week but instead four to seven times a week.	<a href="http://www.seafoodservices.com.au">www.seafoodservices.com.au</a>	Expert consultation
American Heart Association	17. Recommendation	2 meals per week	<a href="http://www.americanheart.org">www.americanheart.org</a>	Panel of experts producing heart foundation guidelines
NHMRC	18. Nutrient Reference Values for Australia and New Zealand including Recommended Dietary Intakes	Levels of omega 3's that need to be consumed	<a href="http://www.nhmrc.gov.au">www.nhmrc.gov.au</a>	High level of credibility

**Table 4.2: Summary of Current Status of Seafood Health Benefits Communication from Stakeholder Organisations**

Organisation	Key Message	Source of Information	Website
<b>Australian Health and Food Safety organisations</b>			
Western Australian (WA) Dept Health	None		<a href="http://www.fish.wa.gov.au">www.fish.wa.gov.au</a>
Primesafe Victoria a. Better Health Channel	None General health benefits of fish consumption Pregnancy guidelines include fish consumption	7 12	<a href="http://www.betterhealthchannel.vic.gov.au">www.betterhealthchannel.vic.gov.au</a>
Safefood Qld	None		
South Australian (SA) Dept of Health	None		
Tasmanian (TAS) Dept of Health	Fact sheets on general benefits, iodine, omega 3's and managing diabetes.		<a href="http://www.dhhs.tas.gov.au/healthy">www.dhhs.tas.gov.au/healthy</a> living
New South Wales (NSW) Food Authority	General Health benefits of fish consumption Specific advice on mercury, fish and pregnancy	7, 8, 12	<a href="http://www.foodauthority.nsw.gov.au">www.foodauthority.nsw.gov.au</a>
Northern Territory (NT) Dept of Health and Community Services	none		
Food Standards Australia and New Zealand (FSANZ)	Benefits including protein, omega 3's and iodine. Set safe levels of fish for pregnant women and children.	12, 13, 9, 10 and own risk assessment	<a href="http://www.foodstandards.gov.au">www.foodstandards.gov.au</a>
Department for Health and Ageing	Nutrition advice, benefits and Dietary Guidelines (all foods including fish)	9, 10, 11.	<a href="http://www.health.gov.au">www.health.gov.au</a>
<b>Fisheries Management Organisations</b>			
WA Dept of Fisheries	None		<a href="http://www.fish.wa.gov.au">www.fish.wa.gov.au</a>
SARDI			
NSW Dept Plng & Infrastructure (DPI)	none		<a href="http://www.dpi.nsw.gov.au">www.dpi.nsw.gov.au</a>
Queensland (QLD) DPI	General health benefits of fish consumption	7, 8	<a href="http://www.dpi.qld.gov.au">www.dpi.qld.gov.au</a>
Tas Dept Primary Industries and Water	none		<a href="http://www.dpiw.tas.gov.au">www.dpiw.tas.gov.au</a>
Victorian (VIC) DPI	none		<a href="http://www.dpi.vic.gov.au">www.dpi.vic.gov.au</a>
NT Department of Primary Industries, Fisheries and Mines	none		<a href="http://www.nt.gov.au">www.nt.gov.au</a>
AFMF	none		<a href="http://www.afma.gov.au">www.afma.gov.au</a>
FRDC	Publications on website.	1, 2, 3, 4, 6.	<a href="http://www.frdc.com.au">www.frdc.com.au</a>

Organisation	Key Message	Source of Information	Website
<b>Seafood Industry Representation</b>			
SSA	Extensive reviewed and coordinated information	1, 2, 3, 4, 6, 7, 8, 15, 16, 17	<a href="http://www.seafoodservices.com.au">www.seafoodservices.com.au</a>
National Aquaculture Council	none		<a href="http://www.australiaaquacultureportal.com/nac">www.australiaaquacultureportal.com/nac</a>
WA Fishing Industry Council (WAFIC)	General health benefits, omega 3 levels	1, 12	<a href="http://www.wafic.com.au">www.wafic.com.au</a>
SA Fishing Industry Council	General health benefits, omega 3's.	1,2	<a href="http://www.safic.com.au">www.safic.com.au</a>
Seafood Industry Victoria	none		<a href="http://www.siv.com.au">www.siv.com.au</a>
Qld Seafood Industry Assoc.	Omega 3's, protein, vitamins and minerals and slimmers		<a href="http://www.qsia.com.au">www.qsia.com.au</a>
Tas Fishing Industry Council	none		
NT Seafood Council	reference	1	<a href="http://www.ntsc.com.au">www.ntsc.com.au</a>
Australian Prawn Farmers Association	none		<a href="http://www.apfa.com.au">www.apfa.com.au</a>
Southern Rock lobster	Omega 3 and National Heart Foundation tick of approval	14	<a href="http://www.southernrocklobster.com.au">www.southernrocklobster.com.au</a>
NSW Oyster Growers Assoc	none		
<b>Nutrition/Medical/Condition Specific Representation</b>			
Nutrition Australia	General Omega 3 for health	Own experts	<a href="http://www.nutritionaustralia.org">www.nutritionaustralia.org</a>
NHMRC	Nutritional guidelines, recommend 2 meals per week	9, 10, 11	<a href="http://www.nhmrc.gov.au">www.nhmrc.gov.au</a>
Cancer Council	Reference	9, 10.	
Diabetes Foundation	Factsheets suggesting eat fish three times per week (omega 3's)	Own research and recommendations	<a href="http://www.diabetesaustralia.com">www.diabetesaustralia.com</a>
Heart Foundation	Omega 3's reduce heart disease, oily fish, recommend two fish meals per week	13 (own guidelines)	<a href="http://www.heartfoundation.com.au">www.heartfoundation.com.au</a>
Australian Institute of Health and Welfare			
Omega 3 Centre	Long chain Omega 3 vital for Good Health, 2 meals of oily fish per week, levels of omega 3 in some fish	18, fatty acid levels from RMIT University fatty acid database	<a href="http://www.omega-3centre.com">www.omega-3centre.com</a>

Organisation	Key Message	Source of Information	Website
<b>Seafood Companies/ Retailers/Supermarkets</b>			
Sydney Fish markets	Reference (SSA media releases)	15, 16, 17	<a href="http://www.sydneyfishmarket.com.au">www.sydneyfishmarket.com.au</a>
Seafood Secrets	Slimmers, high in protein, low in fat, high in vitamins and minerals, omega 3.s mercury	12	<a href="http://www.seafoodsecrets.com.au">www.seafoodsecrets.com.au</a>
Kailis Bros	none		<a href="http://www.Kailisbrosleederville.com.au">www.Kailisbrosleederville.com.au</a>
Soareast Australia	Specific health attributes to specific products (abalone and lobster)		<a href="http://www.soareast.com.au">www.soareast.com.au</a>
Clean Seas Tuna	Omega 3 benefits	12	<a href="http://www.cleanseas.com.au">www.cleanseas.com.au</a>
Greenseas Tuna	Omega 3 benefits	9, 12	<a href="http://www.greenseas.com.au">www.greenseas.com.au</a>
American Heart Association	At least two serves of fish per week		<a href="http://www.americanheart.org">www.americanheart.org</a>
Coles Supermarkets	Recommend two fish meals per week Comment on mercury in fish		<a href="http://www.coles.com.au">www.coles.com.au</a>
<b>Environmental NGO's</b>			
Oceans alive	Balance health benefits with contaminant risks	14	<a href="http://www.oceansalive.org.au">www.oceansalive.org.au</a>

**Table 4.3: Education and Training in Relation to Seafood Health Benefits**

Curriculum	Curriculum Units/Resources which may be used to communicate seafood health benefits	Messages	website
<b>Vocational training</b>			
Seafood Industry Training Package	SFIPROC608A: Provide practical or commercial advice to seafood users. SFIDIST201A: Prepare cook and retail seafood products SFIDIST202A: Retail fresh, frozen and live seafood SFILEAD01A: Develop and promote industry knowledge.	To be ascertained	<a href="http://www.ntis.gov.au">www.ntis.gov.au</a>
Retail training package	WRRFM6A: Prepare and Display fresh, frozen and live seafood products WRRFM.6A Advise on seafood products	To be ascertained	<a href="http://www.ntis.gov.au">www.ntis.gov.au</a>
Food Processing Training Package	(no specialist seafood units)	N/a	<a href="http://www.ntis.gov.au">www.ntis.gov.au</a>
Tourism and Hospitality Training Package	THHBCC06B: Prepare and cook seafood. THHBFB11B: Develop and update food and beverage knowledge THHADFB01B: Provide specialist advice on food	To be ascertained	<a href="http://www.ntis.gov.au">www.ntis.gov.au</a>
<b>K-10 Curriculum Learning Area (based on EDWA)</b>			
Health and Physical Education	1. Growth and Development/Sexual Health 2. Lifestyle Awareness	To be ascertained	<a href="http://K10syllabus.curriculum.wa.edu.au/output/outcomes/health-physical-education">http://K10syllabus.curriculum.wa.edu.au/output/outcomes/health-physical-education</a>
Science	1. Sustainability and wise use of resource	To be ascertained	<a href="http://K10syllabus.curriculum.wa.edu.au/output/outcomes/science">http://K10syllabus.curriculum.wa.edu.au/output/outcomes/science</a>
Technology and Enterprise	1. Home Economics	To be ascertained	<a href="http://K10syllabus.curriculum.wa.edu.au/output/outcomes/technology-enterprise">http://K10syllabus.curriculum.wa.edu.au/output/outcomes/technology-enterprise</a>
Kondinin Workbook Series	The story of Seafood (Book and educational resource)	Sustainability of industry Health benefits of seafood	<a href="http://www.kondinin.com.au">www.kondinin.com.au</a>



**Table 4.4: Seafood Cooking/Recipe Resources**

Seafood Cooking Resource	Source	Media	website
<b>Recipes</b>			
Recipes (Australian)	WAFIC	Cards, website	<a href="http://www.wafic.com.au">www.wafic.com.au</a>
	QSIA	Website	<a href="http://www.qsia.com.au">www.qsia.com.au</a>
	Australian Seafood Handbook	Book, website	<a href="http://www.frdc.org.au">www.frdc.org.au</a>
	Cook with SA Seafood	Book	<a href="http://www.safic.com.au">www.safic.com.au</a>
<b>Seafood Cooking Demonstration/Classes</b>			
Sydney Seafood School	Sydney Fish market	Classes	<a href="http://www.sydneyfishmarket.com.au">www.sydneyfishmarket.com.au</a>
Consuming Passions	Ian Parmenter	Television	
	Don Hancey	Print media and television	
	Ian Bowman	Print media	

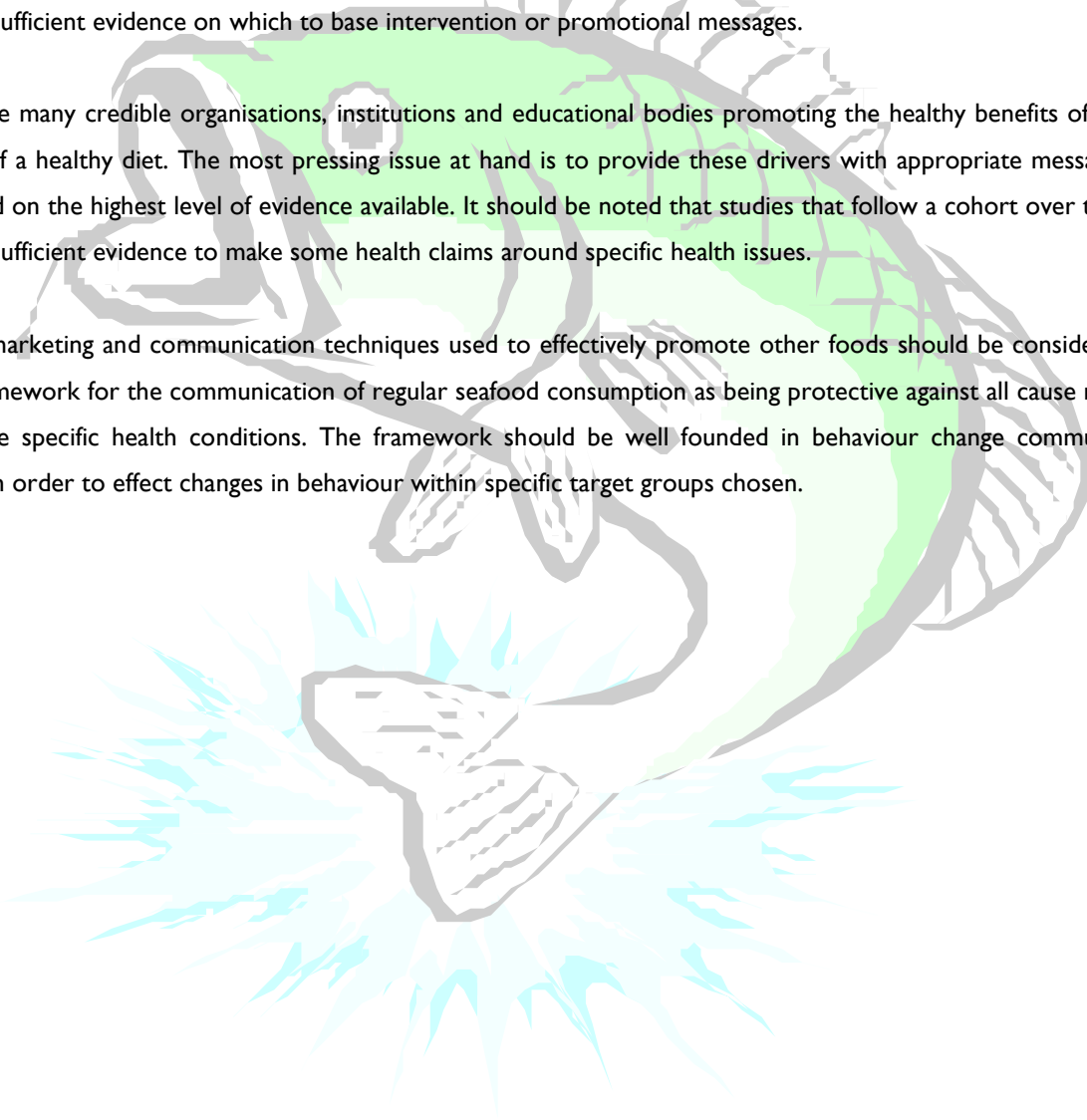
## 5 Conclusions

There is increasing evidence to support regular seafood consumption (particularly fish) as being protective against all cause mortality. There is also differing levels of evidence (ranging from high to very low) to support regular seafood consumption as protective against various health issues.

Based on the available evidence, any interventions or campaigns to promote regular seafood consumption, particularly fish, as part of a healthy diet should be tailored towards specific health issues and well defined target groups. Depending upon the health issue and target group chosen, there may be a need to conduct further research to ensure there is sufficient evidence on which to base intervention or promotional messages.

There are many credible organisations, institutions and educational bodies promoting the healthy benefits of seafood as part of a healthy diet. The most pressing issue at hand is to provide these drivers with appropriate messages that are based on the highest level of evidence available. It should be noted that studies that follow a cohort over time may provide sufficient evidence to make some health claims around specific health issues.

Proven marketing and communication techniques used to effectively promote other foods should be considered as a basic framework for the communication of regular seafood consumption as being protective against all cause mortality and some specific health conditions. The framework should be well founded in behaviour change communication models in order to effect changes in behaviour within specific target groups chosen.



## 6.0 References

- [1] Hodge L, Salome CM, Peat JK, Haby MM, Xuan W, Woolcock AJ. Consumption of oily fish and childhood asthma risk. *Medical Journal of Australia*. 1996;164:137-40.
- [2] Almqvist C, Garden F, Xuan W, Mihrshahi S, Leeder SR, Oddy W, et al. Omega-3 and omega-6 fatty acid exposure from early life does not affect atopy and asthma at age 5 years. *J Allergy Clin Immunol*. 2007;119:1438-44.
- [3] Oddy W, de Klerk N, Kendall G, Mihrshahi S, JK P. Ratio of omega-6 to omega-3 fatty acids and childhood asthma. *Journal of Asthma*. 2004;41(3):319-26.
- [4] Salam M, Li Y, Langholz B, Gilliland F. Maternal Fish Consumption During Pregnancy and Risk of Early Childhood Asthma. *Journal of Asthma*. 2005;42(6):513-8.
- [5] Nafstad P, Nystad W, Magnus P, JJK J. Asthma and allergic rhinitis at 4 years of age in relation to fish consumption in infancy. *Journal of Asthma*. 2003;40(4):343-8.
- [6] Broadfield EC, McKeever TM, Whitehurst A, Lewis SA, Lawson N, Britton J, et al. A case-control study of dietary and erythrocyte membrane fatty acids in asthma. *Clinical & Experimental Allergy*. 2004;34(8):1232-6.
- [7] Thien F, Woods R, De Luca S, Abramson M. Dietary marine fatty acids (fish oil) for asthma in adults and children (Review). *The Cochrane Database of Systematic Reviews*. 2002(2).
- [8] Burgess JR, Stevens L, Zhang W, Peck L. Long-chain polyunsaturated fatty acids in children with attention-deficit hyperactivity disorder. *American Journal of Clinical Nutrition*. 2007;71(suppl):327S-30S.
- [9] Hirayama S, Hamazaki T, Terasawa K. Effect of docosahexaenoic acid-containing food administration on symptoms of attention deficit hyperactivity disorder - a placebo controlled double blind study. *European Journal of Clinical Nutrition*. 2004;58:467-73.
- [10] Richardson AJ. Omega-3 fatty acids in ADHD and related neurodevelopmental disorders. *International Review of Psychiatry*. 2006;18(2):155-72.
- [11] Sinn N, Bryan J. Effect of supplementation with polyunsaturated fatty acids and micronutrients on learning and behaviour problems associated with child ADHD. *Journal of Developmental Behaviour in Pediatrics*. 2007;28(2):82-91.
- [12] Young G, Conquer J. Omega-3 fatty acids and neuropsychiatric disorders. *Reproduction, Nutrition and Development*. 2005;45(1):1-28.
- [13] Young GS, Conquer JA, Thomas R. Effect of randomized supplementation with high dose olive, fax or fish oil on serum phospholipid fatty acid levels in adults with attention deficit hyperactivity disorder. *Reproduction, Nutrition and Development*. 2005;45(5):549-58.
- [14] Mozaffarian D. JELIS, fish oil and cardiac events. *The Lancet*. 2007;369(9567):1062-3.
- [15] Mozaffarian D, Bryson CL, Lemaitre RN, Burke GL, Siscovick DS. Fish intake and risk of incident heart failure. *Journal of the American College of Cardiology*. 2005;45(12):2015-21.
- [16] Siscovick D, Raghunathan TE, King I, Weinmann S, Bovbjerg VE, Kushi L, et al. Dietary intake of long-chain n-3 polyunsaturated fatty acids and the risk of primary cardiac arrest. *American Journal of Clinical Nutrition*. 2000;71(1):208S-12S.
- [17] Zhang J, Temme EHM, Kesteloot H. Fish consumption is inversely associated with male lung cancer mortality in countries with high levels of cigarette smoking or animal fat consumption. *International Journal of Epidemiology*. 2000;29:615.
- [18] Albert CM, Hennekens CH, O'Donnell CJ, Ajani UA, Carey VJ, Willett WC, et al. Fish consumption and risk of sudden cardiac death. *JAMA*. 1998 Jan 7;279(1):23-8.
- [19] Ascherio A, Rimm EB, Stampfer MJ, Giovannucci EL, Willett WC. Dietary intake of marine n-3 fatty acids, fish intake, and the risk of coronary disease among men. *New England Journal Medicine*. 1995 Apr 13;332(15):977-82.
- [20] Chrysohoou C, Panagiotakos DB, Pitsavos C, Skoumas J, Krinos X, Chloptsios Y, et al. Long-term fish consumption is associated with protection against arrhythmia in healthy persons in a Mediterranean region - the ATTICA study. *American Journal of Clinical Nutrition*. 2007;85(5):1385-91.
- [21] Erkkila A, Lichtenstein A, Mozaffarian D, Herrington D. Fish intake is associated with a reduced progression of coronary artery atherosclerosis in postmenopausal women with coronary heart disease. *American Journal for Clinical Nutrition*. 2004;80(3):626-32.
- [22] He K, Song Y, Daviglius M, Liu K, Van Horn L, Dyer A, et al. Accumulated Evidence on Fish Consumption and Coronary heart Disease Mortality: A meta analysis of cohort studies. *Circulation*. 2004;109:2705-11.
- [23] Din J, Newby D, Flapan A. Omega 3 fatty acids and cardiovascular disease - fishing for a natural treatment. *British Medical Journal*. 2004;328:30-5.
- [24] Kris-Etherton P, Harris W, Appel L. Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. *Circulation*. 2002;106:2747-57.
- [25] Yuan J, Ross R, Gao Y, Yu M. Fish and shellfish consumption in relation to death from myocardial infarction among men in Shanghai, China. *American Journal of Epidemiology*. 2001;154:809-16.

- [26] Hu F, Bronner L, Willett W, Stampfer M, Rexrode K, Albert C, et al. Fish and omega-3 fatty acid intake and risk of coronary heart disease in women. *JAMA*. 2002;287(14):1815-21.
- [27] Mozaffarian D, Lemaitre R, Kuller L, Burke G, Tracy R, Siscovick D. Cardiac benefits of fish consumption may depend on the type of fish meal consumed: The Cardiovascular Health Study. *Circulation*. 2003;107:1372-7.
- [28] Bao DQ, Mori TA, Burke V, Puddey IB, Beilin LJ. Effects of dietary fish and weight reduction on ambulatory blood pressure in overweight hypertensives. *Hypertension*. 1998;32:710-7.
- [29] He K, Song Y, Daviglius M, Liu K, Van Horn L, Dyer A, et al. Fish consumption and incidence of stroke: A meta-analysis of cohort studies. *Stroke*. 2004;35:1538-42.
- [30] Mozaffarian D, Geelen A, Brouwer I, Geleijnse J, Zock P, Katan M. Effect of fish oil on heart rate in humans: A meta-analysis of randomized controlled trials. *Circulation*. 2005;112(19):45-52.
- [31] Zampelas A, Panagiotakos D, Pitsavos C, Das U, Chrysohoou C, Skoumas Y, et al. Fish consumption among healthy adults is associated with decreased levels of inflammatory markers related to cardiovascular disease. *Journal of the American College of Cardiology*. 2005;46:120-24.
- [32] Elvevoll E, Barstad H, Breimo E, Brox J, Eilersten K, Lund T, et al. Enhanced Incorporation of n-3 Fatty Acids from Fish Compared with Fish Oils. *Lipids*. 2006;41(12):1109.
- [33] Oh R, Beresford S, Lafferty W. The fish in secondary prevention of heart disease (FISH) survey - Primary care physicians and  $\omega$ 3 fatty acid prescribing behaviours. *J Am Board Fam Med*. 2006;19:459-67.
- [34] Holub DJ, Holub BJ. Omega-3 fatty acids from fish oils and cardiovascular disease. *Mol Cell Biochem*. 2004;263:217-25.
- [35] Augustsson K, Michaud DS, Rimm EB, Leitzmann MF, Stampfer MJ, Willett WC, et al. A prospective study of intake of fish and marine fatty acids and prostate cancer. *Cancer Epidemiology, Biomarkers & Prevention*. 2003;12:64-7.
- [36] Fung T, Hu FB, Fuchs C, Giovannucci E, GHunter DJ, Stampfer MJ, et al. Major dietary patterns and the risk of colorectal cancer in women. *Arch intern Med*. 2003;163(3):309-14.
- [37] MacLean CH, Newberry SJ, Mojica WA, Khanna P, Issa AM, Suttorp MJ, et al. Effects of Omega-3 Fatty Acids on Cancer Risk: A Systematic Review. *JAMA*. 2006 January 25, 2006;295(4):403-15.
- [38] Terry P, Lichtenstein P, Feychting M, Ahlbom A, Wolk A. Fatty fish consumption and risk of prostate cancer. *The Lancet*. 2001;357:1764-5.
- [39] Terry P, Thomas ER, Wolk A. Intakes of fish and marine fatty acids and the risks of cancers of the breast and prostate and of other hormone-related cancers: a review of the epidemiological evidence. *American Journal of Clinical Nutrition*. 2003;77:532-43.
- [40] Zhang J, Sasaki S, Amano K, Kesteloot H. Fish consumption and mortality from all causes, Ischemic Heart Disease and Stroke: An ecological study. *Preventive Medicine*. 1999;28:520-9.
- [41] Beckles-Willson N, Elliott T, Evarard M. Omega-3 fatty acids (from fish oils) for cystic fibrosis. *The Cochrane Database Systematic Reviews*. 2002.
- [42] Gillen LJ, Tapsell LC. Development of food groupings to guide dietary advice for people with diabetes. *Nutrition & Dietetics*. 2006;63:36-47.
- [43] Hu FB, Cho E, Rexrode KM, Albert CM, Manson J, E. Fish and Long-Chain n-3 Fatty Acid Intake and Risk of Coronary Heart Disease and Total Mortality in Diabetic Women. *Circulation*. 2003 9/10/07;107:1852-7.
- [44] Kremer JM. n-3 Fatty acid supplements and rheumatoid arthritis. *American Journal of Clinical Nutrition*. 2007;71 (suppl):349S-51S.
- [45] Sakamoto N, Kono S, Wakai K, Fukuda Y, Satomi M, Shimoyama T, et al. Dietary risk factor for inflammatory bowel disease: a multicenter case-control study in Japan. *Inflammatory Bowel Disorders*. 2005;11(2):154-63.
- [46] McKellar G, Morrison E, McEntegart A, Hampson R, Tierney A, Mackle G, et al. A pilot study of a mediterranean-type diet intervention in female patients with rheumatoid arthritis living in areas of social deprivation in Glasgow. *Annals of Rheumatoid Disease*. 2007;66:1239-43.
- [47] Pedersen M, Stripp C, Klarlund M, Olsen SF, Tjonneland AM, Frisch M. Diet and risk of rheumatoid arthritis in prospective cohort. *Journal of Rheumatology*. 2005;32(7):1249-52.
- [48] Xue F, Holzman C, Rahbar MH, Trosko K, Fischer L. Maternal fish consumption, mercury levels and risk of preterm delivery. *Environmental Health Perspectives*. 2007;115(1):42-7.
- [49] Cohen JT, Belklinger DC, Connor WE, Kris-Etherton PM, Lawrence RS, Savitz DA, et al. A quantitative risk-benefit analysis of changes in population fish consumption. *American Journal of Preventive Medicine*. 2005;29(4):325-34.
- [50] Hibbeln JR, Davis JM, Steer C, Emmett P, Rogers I, Williams C, et al. Maternal seafood consumption in pregnancy and neurodevelopmental outcomes in childhood (ALSPAC study): an observational cohort study. *The Lancet*. 2007;369(9561):578-85.
- [51] Helland IB, Smith L, Saarem K, Saugstad OD, Drevon CA. Maternal supplementation with very-long-chain n-3 fatty acids during pregnancy and lactation augments children's IQ at 4 years of age. *Pediatrics*. 2003;111:e39-e44.
- [52] Myers GJ, Davidson PW. Maternal fish consumption benefits children's development. *The Lancet*. 2007;369(9561):537-8.

- [53] Mahaffey KR, Clickner RP, Jeffries RA. Methylmercury and omega-3 fatty acids: co-occurrence of dietary sources with emphasis on fish and shellfish. *Environmental Research*. 2007;2007(doi.10.1016).
- [54] Lim W, Gammack J, Van Niekerk J, Dangour A. Omega 3 fatty acid for the prevention of dementia (review); 2006. Report No.: Art. No.:CD005379.pub2. DOI: 10.1002/14651858. CD005379.pub2.
- [55] Connor WE, Connor SL. The importance of fish and docosahexaenoic acid in Alzheimer disease. *American Journal of Clinical Nutrition*. 2007;85:929-30.
- [56] Morris MC, Evans DA, Bienias JL, Tangney CC, Bennett DA, Wilson RS, et al. Consumption of fish and n-3 fatty acids and risk of incident Alzheimer Disease. *Arch Neurol*. 2003;60:940-6.
- [57] Morris MC, Evans DA, Tangney CC, Bienias JL, Wilson RS. Fish consumption and cognitive decline with age in a large community study. *Arch neurol*. 2005;62:1849-53.
- [58] Logan AC. Omega-3 fatty acids and major depression: A primer for the mental health professional. *BioMed Central Online*. 2004;3(25):1-8.
- [59] Kalmijn S, Feskens EJM, Launer LJ, Kromhout D. Polyunsaturated fatty acids, antioxidants and cognitive function in very old men. *American Journal of Epidemiology*. 1997;145(1):33-41.
- [60] Kamphuis MH, Geerlings MI, Tijhuis MAR, Kalmijn S, Grobbee DE, Kromhout D. Depression and cardiovascular mortality: a role for n-3 fatty acids? *American Journal of Clinical Nutrition*. 2006;84(6):1513-7.
- [61] Parker G, Gibson N, Heruc G, Rees A, Hadzi-Pavlovic D. Omega-3 Acids and Mood Disorders. *The American Journal of Psychiatry*. 2006;163(6):969-1120.
- [62] Mozaffarian D, Rimm EB. Fish intake, contaminants, and human health: evaluating the risks and the benefits. *JAMA*. 2006 Oct 18;296(15):1885-99.
- [63] Gochfeld M, Burger J. Good fish/bad fish: A composite benefit-risk by dose curve. *NeuroToxicology*. 2005;26:511-20.
- [64] Domingo JL. Omega-3 fatty acids and the benefits of fish consumption: Is all that glitters gold? *Environment International*. 2007;33:993-8.
- [65] Arnold S, Lynn T, Verbrugge L, Middaugh J. Human biomonitoring to optimize fish consumption advice: Reducing uncertainty when evaluating benefits and risks. *American Journal of Public Health*. 2005;95(3):393-7.
- [66] Spinks A, Bose S. Factors affecting households' seafood purchasing decisions in Auckland, New Zealand: an empirical analysis. *International Journal of Consumer Studies*. 2002;26(1):85-94.
- [67] McManus A, Burns S, Howat PC, L, Fielder L. Factors influencing the consumption of seafood among young children in Perth: a qualitative study. *BMC Public Health*. 2007;7(119):1-7.
- [68] Verbeke W, Vackier I. Individual determinants of fish consumption: application of the theory of planned behaviour. *Appetite*. 2005;44:67-82.
- [69] Leek S, Maddock S, Foxall G. Situational determinants of fish consumption: application of the theory of planned behaviour. *British Food Journal*. 2000;102(1):18-39.
- [70] Wahlqvist M. *Australian and New Zealand Food and Nutrition*. 2nd Ed. Crows Nest, NSW: Allen & Unwin 2002.
- [71] Roberts M, Pettigrew S. A thematic content analysis of children's food advertising. *International Journal of Advertising*. 2007;26(3):357-67.
- [72] Dixon H, Scully M, Wakefield M, White V, Crawford D. The effect of television advertisements for junk food versus nutritious food on children's attitudes and preferences. *Social Science & Medicine* 2007;65:1311-23.