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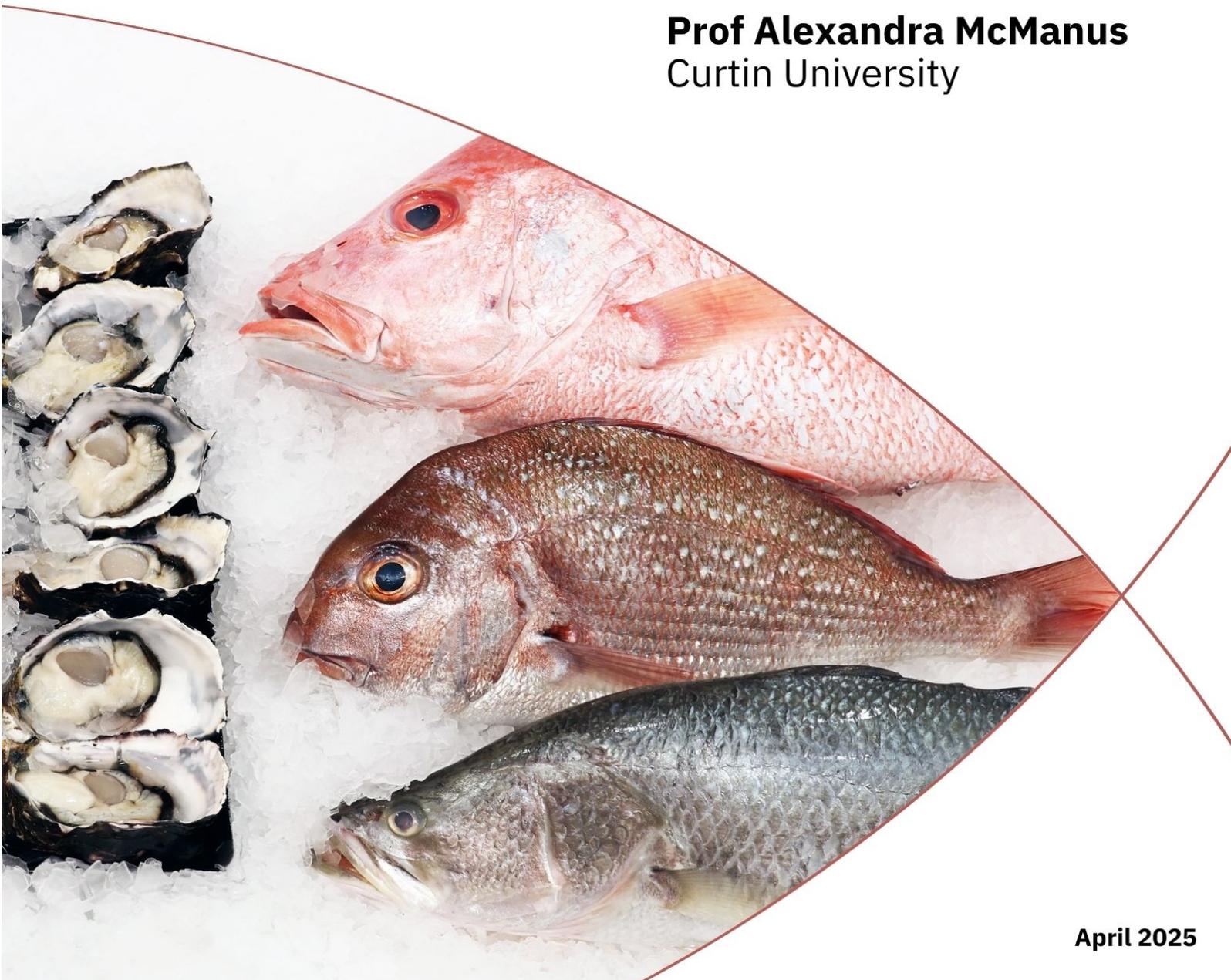
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The Health Benefits of Eating Seafood

Evidence Based Science

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April 2025

The Health Benefits of Eating Seafood: Evidence Based Science

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Report: # 27032025

Preferred citation:

Hunt W, McManus A. 2025 The health benefits of eating seafood: Evidence based science. School of Medical, Molecular and Forensic Sciences, Murdoch University, Australia and Faculty of Health Sciences, Curtin University, Australia. Report # 27032025

Funders: Fisheries Research and Development Corporation (FRDC) and International Coalition of Fisheries Associations as part of the overall Global Seafood Communicators Nutrition Toolkit Project 2025

The content of this report will be written up as a scientific journal article by Dr Wendy Hunt and Professor Alexandra McManus within four months.

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Acronyms and Glossary of Terms

ALA	Alpha linoleic acid
CHD	Coronary heart disease
CV	Cardiovascular
CVD	Cardiovascular disease
DHA	Docosahexaenoic acid
DPA	Docosapentaenoic acid
EPA	Eicosapentaenoic acid
HDL-C	High density lipoprotein cholesterol
LC PUFA	Long chain polyunsaturated fatty acids
LDL-C	Low density lipoprotein cholesterol
PUFA	Polyunsaturated fatty acids
n-3 PUFA	Omega-3 polyunsaturated fatty acids
n-6 PUFA	Omega-6 polyunsaturated fatty acids
VLDL	Low density lipoprotein cholesterol

Oily Fish: "Oil-rich fish (or oily fish) are those that have oil distributed through their body, in contrast to white fish, where the main concentration of oils is located in the liver. Oily fish (e.g., Anchovies, Herring, Mackerels, Salmons, Trouts, Swordfish and Eels) contain higher levels of long chain polyunsaturated fatty acids (LC PUFA).

Executive Summary

Introduction

Seafood is an excellent source of energy and contains a range of nutrients that are beneficial for human health. These include Omega-3 polyunsaturated fatty acids (n-3 PUFA), protein, Vitamins A, B12, D and E, calcium, iodine, iron, zinc, selenium, copper, manganese, phosphorus and taurine. Each of these nutrients offer a range of health benefits.

This report summarises moderate to high level scientific evidence from peer reviewed journals published from January 2015 to January 2025, that focus on the health benefits of seafood consumption to human health.

Methods

Four academic search engines (PubMed, Medline Ovid, Scopus, Cochrane Reviews) were used to identify peer-reviewed journal articles that met the following Boolean search terms: seafood, fish, omega, nutrient, health and health benefits (n=9,875 articles). A four-stage culling process was independently conducted by two highly experienced reviewers (authors). A total of 281 peer reviewed articles met all criteria and were included in this literature review. Articles were assigned a classification level of graded evidence based on the rigour of study design and a moderate or high level of evidence.

Results

Key findings from published studies that fulfilled the search strategy are presented below under relevant headings.

All-cause mortality

- Fish and n-3 PUFA consumption reduce all-cause mortality
- Moderate consumption of seafood has the greatest effect on health
- The strongest n-3 PUFA evidence relates to DHA consumption
- The greatest benefit is gained from the ingestion of seafood as part of a healthy diet

Asthma and allergies

- Asthma, allergy and wheezing in infants may be mitigated by the ingestion of high n-3 PUFA seafood during pregnancy
- Consumption of fish (particularly seafood high in n-3 PUFA and Vitamin D) in the first year of life is associated with a reduced risk of eczema, allergic rhinitis, asthma and wheeze
- Infant formula fortified with n-3 PUFA aids immune development

Bone health and osteoporosis

- Fish consumption and n-3 PUFA may protect bone health and reduce the risk of hip fracture
- Consumption of ≥ 5 serves of oily fish each week reduces the incidence of osteopenia and osteoporosis, particularly in senior women
- A diet high in n-3 PUFA and low in n-6 PUFA is protective against fractures and helps to maintain bone health
- A high n-3 PUFA status is associated with a lower risk of fracture

Cancer

- A diet high in seafood and n-3 PUFA is protective against a number of cancers
- A high n-3 PUFA status is associated with lower fatigue in cancer patients
- n-3 PUFA as part of a healthy diet increases appetite and nutritional status in chemotherapy patients
- ***Breast cancer***
 - High levels of fish consumption and n-3 PUFA is associated with a reduction in all-cause mortality in women with breast cancer
 - EPA and DHA status may be predictive of breast cancer risk
 - n-3 PUFA are beneficial to the prevention, development and progression of breast cancer

- **Colorectal cancer**
 - ≥ 2 serves of oily fish per week reduces the risk of cancer including colon, liver, and gallbladder cancers in adults
 - Higher n-3 PUFA status (in comparison to n-6 PUFA) reduces the risk of colorectal tumours
 - EPA and DHA consumption and dietary fibre are associated with a lower risk of colorectal cancer

- **Lung cancer**
 - Fish oil supplementation in adults (or ≥ 2 serves of seafood per week) reduces the risk of lung cancer
 - n-6 to n-3 PUFA ratio is inversely associated with the risk of lung cancer
 - n-3 PUFA improves nutritional status and reduces inflammation in lung cancer patients undergoing radio or chemotherapy
 - n-3 PUFA supplementation increases weight and quality of life in patients with lung cancer

- **Other cancers**
 - n-3 PUFA (particularly DHA) reduces the risk of neck, head, oesophageal, pancreatic and endometrial cancers
 - Adequate intake of n-3 PUFA reduces inflammation and improves immune function in cancer patients

Cardiovascular disease (CVD)

- Seafood as part of a balanced diet reduces the risk of CVD mortality, coronary heart disease (CHD), myocardial infarction and stroke
- ≥ 2 serves of seafood per week is recommended to reduce the risk of congestive heart failure, CHD, ischemic stroke, and sudden cardiac death
- Consumption of fatty fish (not lean) reduces the risk of CVD and myocardial infarction

- ***n-3 PUFA supplementation***
 - Adequate intake of n-3 PUFA is associated with many health benefits including: a reduction in the risk of cardiovascular (CV) events, CHD mortality and premature death
 - There is strong evidence supporting the cardioprotective role of marine sourced EPA and DHA across the lifespan
 - Clinical grade fish oil supplementation reduces the length of stay in Intensive Care Units (ICU) and in hospital following coronary artery bypass surgery
 - n-3 PUFA supplementation (especially DHA) reduces heart rate and blood pressure which is beneficial to those at high risk of ischemic stroke
 - High doses of clinical grade n-3 PUFA supplementation are recommended to improve clinical outcomes and reduce cardiac mortality in patients with chronic atherosclerotic disease

- ***Heart surgery***
 - n-3 PUFA, particularly EPA, is associated with a substantial decrease in the risk of requiring coronary revascularizations (procedure to restore blood flow)
 - n-3 PUFA together with Vitamin C supplements significantly reduces postoperative fatigue and some adverse outcomes (including excessive bleeding) in coronary patients
 - The anti-inflammatory properties of n-3 PUFA assist in recovery following most heart-related surgeries

- ***Blood lipids***
 - n-3 PUFA supplementation and consumption of seafood high in n-3 PUFA impact favourably on maintaining appropriate cholesterol levels in the body
 - High levels of triglycerides (which increase the risk of cardiac events) may be mitigated with adequate intake of n-3 PUFA
 - Fish oil and Vitamin E supplementation are effective in reducing high cholesterol levels in menopausal women

Diabetes

- Regular consumption of seafood (or n-3 PUFA supplementation) as part of a healthy diet is inversely associated with all-cause mortality and CVD in those with type 2 diabetes mellitus
- High levels of serum DHA improve the biomarkers of insulin sensitivity
- Adequate intake of n-3 PUFA, reduces inflammation and improves retinal health
- Fish oil supplementation in pregnant women with type 2 diabetes has significant benefits to insulin resistance

Fertility

- There is strong emerging evidence that seafood consumption or n-3 PUFA supplementation can improve semen quality, concentration and motility

Healthy ageing

- The significant benefits offered by n-3 PUFA associated with healthy ageing include reduced all-cause mortality, improved cognitive function, preservation of muscle strength and improved balance (leading to a reduction in disabling falls)
- The anti-inflammatory properties of n-3 PUFA are beneficial to the ageing process
- There is strong evidence that a diet high in seafood (≥ 2 serves of seafood per week), as part of a healthy diet, has a positive effect on health across the lifespan
- **Alzheimer's disease and dementia**
 - Two serves of fish a week is protective against cognitive decline (10% reduction in all-cause dementia and 30% reduction in Alzheimer's disease risk)
 - High seafood or n-3 PUFA consumption improves executive function, cognition, memory, and neuro inflammation (association with cognitive decline)
 - There is significant evidence that a high intake of n-3 PUFA delays the onset to Alzheimer's disease and slows progression of the disease following onset
 - A high intake of fish in mid-life may reduce the likelihood of developing dementia

- ***Other age-related issues***
 - ≥ 2 serves of oily fish or the equivalent in n-3 PUFA improves brain function and slows the rate of cognitive decline
 - Higher consumption of oily fish (or fish oil supplements) may prevent frailty in older adults
 - Oily fish consumption and n-3 PUFA (EPA and DHA) are inversely related to the incidence of pain in older adults

Hospitalisation

- The n-3 PUFA status of critically ill patients is associated with a reduced risk of infection plus shorter hospital and ICU lengths of stay
- Increased EPA and DHA emulsions improve survival rates in critically ill septic patients

Inflammatory conditions

- Consumption of oily fish and n-3 PUFA mitigate inflammatory markers which indicate levels of inflammation (particularly in those affected by diabetes and CVD)
- Consumption of a Mediterranean diet (including two meals or a minimum of 300 g of oily fish each week) significantly reduces airway inflammation in children
- n-3 PUFA supplementation reduces inflammation associated with many health-related conditions (e.g., diabetes, CV events, arthritis, metabolic syndrome, gut-related problems, systemic lupus, peripheral vascular conditions, kidney disease)

Kidney health

- Higher consumption of marine n-3 PUFA is associated with a lower risk of chronic kidney disease
- Marine n-3 PUFA supplementation significantly improves cardiac function in renal transplant patients
- n-3 PUFA supplementation reduces CV mortality in patients on haemodialysis

Liver health

- n-3 PUFA improve metabolic indicators, liver enzymes and reduce liver fat content in patients with non-alcoholic fatty liver disease

Maternal health

- There is significant evidence supporting n-3 PUFA supplementation in later pregnancy (24 weeks onwards) to prolong pregnancy (reduce incidence pre-term birth) and improve birth weight
- n-3 PUFA consumption during pregnancy can reduce the risk of preeclampsia
- Maternal n-3 PUFA intake during pregnancy and lactation reduces the risk of infant food allergy and food sensitisation and is more efficacious than consumption of n-3 PUFA during childhood
- n-3 PUFA and iodine from fish consumption reduce maternal depression and anxiety and increase neurocognitive child development

Infant health

- Consumption of fatty fish during pregnancy benefits infant cognitive function
- Consumption of fish in the first year of life reduces the risk of eczema and allergic rhinitis (severe hay fever)
- Maternal fish consumption during pregnancy may reduce the risk of neurodevelopmental delay in the domains of fine motor, problem-solving, and personal-social traits
- Consumption of n-3 LC PUFA throughout life may have a positive effect on neurodevelopment including communication, working memory, executive function and visual attention

Menopause

- n-3 PUFA can reduce night sweats in menopausal women
- Fish oil and Vitamin E supplementation reduces total and LDL cholesterol in menopausal women

Mental health – anxiety and depression

- A Mediterranean diet and supplementation with fish oil reduces depressive and dementia symptoms and improves mental health and quality of life
- High adult fish consumption (≥ 4 serves per week) is associated with 26% lower odds of depression compared with low fish consumption (< 1 serve per week), especially in females
- n-3 PUFA supplementation had a significant effect on perinatal depression
- Mild to moderate depression in pregnant and postpartum women is significantly improved by high EPA: DHA (≥ 1.5) supplementation
- n-3 PUFA (EPA and DHA) supplementation reduces the symptoms of depression

Mental health – behavioural disorders

- Low intakes of marine n-3 PUFA increases the risk of attention deficit hyperactivity disorder, autism, bipolar disorder, depression and suicide ideation
- Child n-3 PUFA supplementation can improve health status and quality of life in children especially where hyperactivity, inattention, problems with conduct or aggression exist
- Treatment with n-3 fatty acid supplementation has proven effective in improving the social and interpersonal skills of children with some personality disorders

Mental health - other issues

- Greater consumption of oily fish is associated with better sleep quality
- DHA is associated with health benefits related to autistic spectrum disorder, Alzheimer's disease, schizophrenia, stroke and traumatic brain injury
- n-3 PUFA supplementation benefits younger adults with lower n-3 PUFA status and schizophrenia in the prodromal stage of disease

Metabolic syndrome

- n-3 PUFA lower the risk of developing metabolic syndrome
- Short term fish oil supplementation in adults with metabolic disorder increased insulin sensitivity
- n-3 PUFA together with Vitamin E improves blood lipid profiles of patients with metabolic syndrome

Muscle health and performance

- n-3 LC PUFA may maintain or increase neuromuscular function during ageing
- n-3 PUFA may lead to small increases in muscle strength
- n-3 PUFA improve recovery from onset muscle soreness and improve muscle function
- Fish oil supplementation of athletes benefits the central nervous system, CV system, skeletal muscle and reduces proinflammatory cytokines

Health benefits associated with eating seafood

- The benefits of fish consumption and the role of n-3 PUFA in health at all stages of life from conception to ageing outweigh the potential risks (with the exception of a few selected species in sensitive populations)

1. Introduction

Seafood as a whole food is an important source of human nutrition. Evidence of benefits to health derived from seafood consumption is clear for many physiological systems and functions. The health benefits from specific components of seafood such as marine sourced n-3 LC PUFA (omega-3 long chain polyunsaturated fatty acids) have generated extensive research activity as well as a proliferation of fortified or functional foods and dietary supplements.

n-3 LC PUFA provide benefits to human health through the prevention and management of conditions such as coronary heart disease (CHD), stroke and cardiovascular disease (CVD) ¹. The consumption of fish or seafood offers greater benefits to health than consuming n-3 LC PUFA or other individual nutrients as supplements ². Seafood and fish are sources of complete protein, are rich in essential amino acids and also contain many bioavailable nutrients including Vitamins A, B and D as well as the minerals iodine, selenium, zinc, calcium, phosphorous, iron, copper, manganese, and taurine ^{3,4}. Table 1 outlines the main nutrients and minerals found in seafood and some of the health benefits that result from regular consumption of seafood as part of a healthy diet.

Dietary patterns that are characterised by seafood and fish consumption such as the Mediterranean diet, are linked to human health. There are many reviews and meta-analysis that provide substantive evidence for a whole of diet approach including fish and seafood. For instance a diet rich in wholegrain cereals, fruits, vegetables, nuts, legumes, dairy and fish, but not egg, red meat and processed meat and sugar sweetened beverages, is associated with reduced risk of CHD, stroke and heart failure ⁵. ^[L1, M] Dietary consumption of virgin olive oil, nuts, legumes, wholegrains and fish improve high density lipoprotein cholesterol (HDL-C) functions in adults with a high cardiovascular risk (CV) ⁶. Fish consumers and vegetarians have lower rates of ischaemic heart disease compared to meat eaters although vegetarians have a higher incidence of stroke ⁷.

Table 1: The health benefits of seafood as part of a healthy diet

Beneficial Nutrients and Minerals in Seafood	Health benefits provided
Omega-3 fatty acids	Essential for health (human bodies do not make them) Essential to brain development and function Reduces heart disease and aids blood vessel function Helps to maintain and improve eyesight May reduce asthma and allergies
Calcium	Works with Vit D to develop and maintain strong bones Vital for muscle, nerve and heart function Helps to prevent osteoporosis
Iodine	Essential for thyroid function, growth, metabolism, cellular oxygenation and maintenance of the central nervous system
Vitamin D	Seafood is the best source of Vitamin D (second only to the sun) Improves immune function, skin condition and muscle strength Oily fish are a rich source of Vitamin D
Iron	Production of energy; necessary for muscle function Facilitates blood oxygenation
Vitamin B12	Aids DNA synthesis and normal blood function Aids neurological function Helps to retain cognitive function in ageing
Zinc	Aids immunity and healing
Protein	Repairs and maintains cells (muscles, bones, fingernails, hair) Vital for digestive function and antibody production Source of energy Basis for hormones such as adrenaline
Selenium	Prevents cellular damage Regulates thyroid function Supports a healthy immune function
Vitamins A and E (antioxidants)	Important to heart and skin Essential for nervous and circulatory systems function
Copper	Keeps nerve cells and immune systems healthy Helps make red blood cells Essential for blood and nervous systems function
Manganese	Helps form connective tissue, bones, blood and sex hormones Helps metabolise fats and carbohydrate Aids calcium absorption and blood sugar regulation Essential for normal brain and nerve function
Phosphorous	Essential for bone and teeth health Helps filter waste from kidneys Helps the body store and use energy Reduces muscle pain following exercise
Taurine	Essential for heart and brain function Supports the nervous system and aids nerve growth Lowers blood pressure

Within a healthful dietary pattern, seafood as a whole food is the best dietary source for many nutrients². This report is the product of a rapid review of peer reviewed journal articles providing evidence for the benefits of seafood and fish consumption to human health. Evidence for marine based n-3 LC PUFA and for dietary patterns that feature seafood and fish consumption are also reviewed.

2. Methodology

The methodology for this rapid literature review is based on several high-level literature reviews published by the authors⁸⁻¹⁴.

The foci of this rapid literature review were to:

- identify and summarise existing moderate to high level evidence around seafood consumption as it relates to human health and health benefits;
- identify known benefits of seafood consumption to specific sectors of the population; and
- identify known benefits of seafood consumption for specific health related issues.

Peer reviewed journal articles were identified from four academic search engines being: PubMed, Medline Ovid, Scopus and Cochrane Reviews using a combination of the following Boolean terms: seafood, fish, omega, nutrient, health and health benefits. The detailed search strategy is presented in Appendix 1. Relevant articles published from January 2015 to January 2025 are included in this review.

The inclusion criterion applied to articles was that they provided moderate to high levels of evidence to support benefits to human health. Articles providing emerging or a low level of scientific evidence were excluded. The criteria for assessing the level and strength of evidence in the results section of this review are presented in Table 2. For example, a high-level systematic review of several high-quality studies with consistent results would be assigned as a Level 1 study of high strength. ^[L1, H]

Table 2: Classification of graded level of evidence¹⁵

Level 1 study design (L1)	High level systematic reviews Randomised controlled studies Meta - analyses
Level 2 study design (L2)	Quasi experimental studies Cohort studies Case - control studies
High strength of evidence (H)	Further research is very unlikely to change confidence in the estimated effect Several high-quality studies with consistent results In special cases: one large, high quality multi-centre study
Moderate strength of evidence (M)	Further research is likely to have an impact and may change estimates of effect One high quality study Several studies with some limitations

A total of 9,875 articles met the criteria under the search terms (Appendix 1). After removal of duplicate citations, 8,530 remained (Figure 1). These were reviewed independently by the authors over four stages or 'culls'. Titles and abstracts were reviewed in the first three culls and full articles for the final cull.

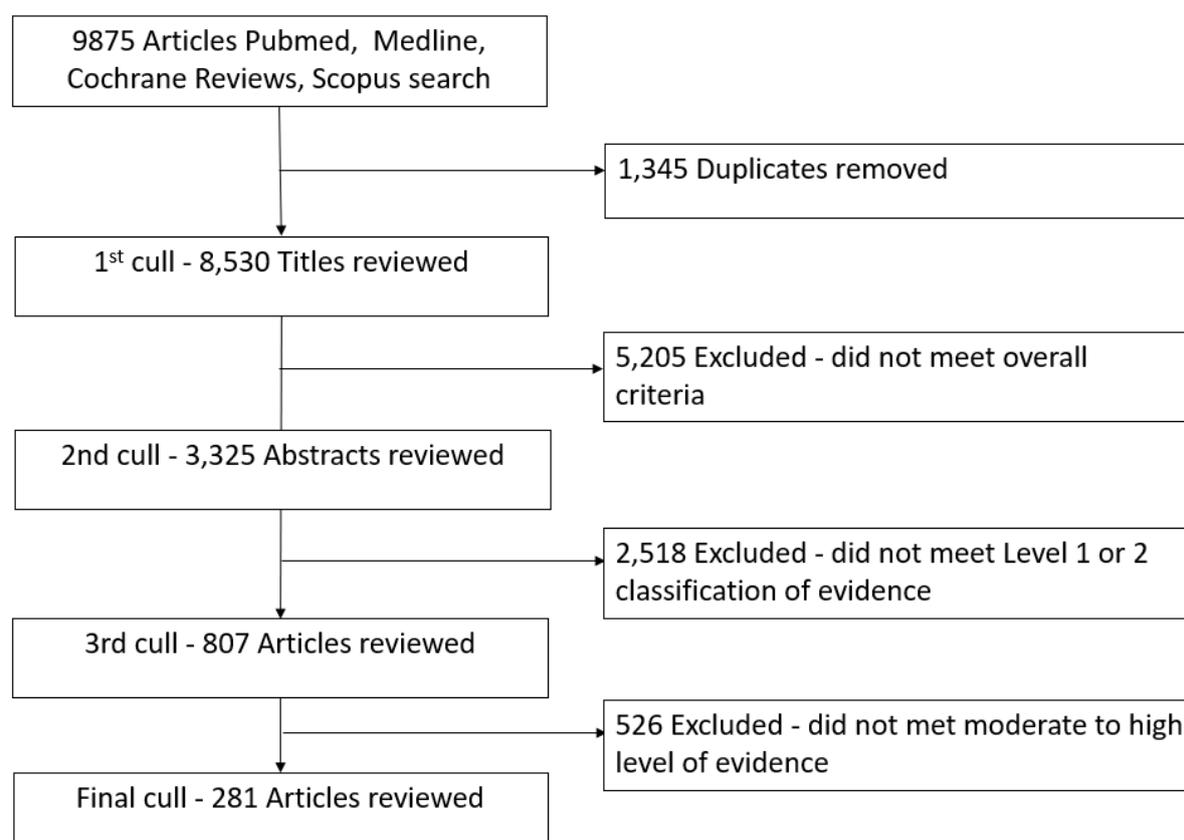


Figure 1: Process for review of peer-reviewed journal articles

3. Literature Review Results

Key findings from published studies that fulfilled the search strategy are presented herein under relevant headings, in dot point form. Each publication reviewed has been assigned a level of evidence based on the Classification of Graded Level of Evidence outlined in Table 1 in the methodology being:

- Level 1 study design, high confidence in quality. ^[L1, H]
- Level 1 study design, moderate confidence in quality. ^[L1, M]
- Level 2 study design, high confidence in quality. ^[L2, H]
- Level 2 study design, moderate confidence in quality. ^[L2, M]

3.1 All-cause mortality

- Fish and n-3 LC PUFA consumption reduce all-cause mortality ^{16,17}. ^[L1, M-H]
- Consumption of fish (not fried) and n-3 LC PUFA is associated with a reduction in mortality ¹⁸. ^[L1, H]
- Fish consumption may have a U-shaped dose response to reducing all-cause mortality, especially in women, where moderate consumption has the greatest effect ¹⁹. ^[L1, M]
- Dietary marine n-3 PUFA has strong links to reduced all-cause mortality ²⁰. ^[L1, H]
- Docosahexaenoic acid (DHA) status reduces the risk of all-cause mortality including cardiovascular disease (CVD) and cancer related death ^{21,22}. ^[L1, H]
- There is strong evidence that high levels of DHA support healthy ageing ²³. ^[L1, H]
- Consumption of fish, whole grains, fibre and n-3 PUFA are inversely associated with all-cause mortality in individuals with type 2 diabetes ²⁴. ^[L1, M]

3.2 Asthma and allergies

- Maternal fish consumption is associated with a reduced risk of infant allergy ²⁵ ^[L1, H] with plasma PUFA inversely related to asthma, wheeze (from 24 weeks gestation) ²⁶ ^[L1, M] and allergic sensitisation ²⁷. ^[L1, H]

- Consumption of fish in the first year of life is associated with a reduced risk of eczema, allergic rhinitis ²⁵ [L1, H], asthma and wheeze ²⁸. [L1, H]
- Fish oil supplementation in children up to five years of age may be protective against the effects of traffic pollution ²⁹. [L1, M]
- Antenatal Vitamin D augments the positive relationship between plasma PUFA and reduced asthma and wheeze ³⁰ [L2, H]. Additionally, Vitamin D and LC-PUFA can reduce asthma and allergic disease in adolescence ³¹. [L2, M]
- n-3 LC PUFA supplementation to reduce asthma and allergies is most effective where there is a family history of allergy and when higher dose supplementation is taken in late pregnancy and early lactation ³²⁻³⁴. [L1, H]
- Maternal supplementation with LC-PUFA during pregnancy and / or lactation reduces the risk of an infant developing any Immunoglobulin E (IgE) mediated allergy to 36 months of age but not beyond ³³. [L1, H]
- Infant formula fortified with n-3 LC PUFA can reduce the risk of allergic disease and respiratory illness suggesting LC PUFA are clinically important to immune development ³⁵. [L2, H]

3.3 Bone health and osteoporosis

- Fish consumption and dietary n-3 PUFA may protect bone health and reduce the risk of hip fracture ³⁶. [L1, M]
- Consumption of ≥ 5 serves of oily fish each week by senior women reduces the incidence of osteopenia and osteoporosis ³⁷. [L1, H]
- A low n-6:n-3 PUFA ratio (higher n-3) is associated with higher bone density ³⁸ [L2, H] and a reduced risk of fragility fractures ³⁹. [L1, M]
- Higher PUFA status is associated with a lower risk of fracture in older adults, especially men ⁴⁰. [L1, H]
- n-3 PUFA supplementation during chemotherapy improves bone density and survival in cancer patients ⁴¹. [L2, M]

3.4 Cancer

- Consumption of seafood, fish (non-fried) and n-3 PUFA is associated with a reduced risk of:
 - breast cancer ⁴², [L1, H]
 - colorectal cancer ⁴³, [L1, H]
 - gastrointestinal cancer ⁴⁴, [L1, M]
 - endometrial cancer ⁴⁵, [L1, M]
 - hepatobiliary (liver) cancer ⁴⁶, [L2, H]
 - oesophageal and head and neck cancer ⁴⁷, [L1, M] and
 - pancreatic cancer ⁴⁸, [L1, H]
- Greater serum n-3 PUFA status is associated with lower fatigue in cancer patients ⁴⁹. [L1, M]
- Eicosapentaenoic acid (EPA) supplementation together with dietary counselling increases appetite and nutritional status in chemotherapy patients ⁵⁰. [L1, H]
- n-3 PUFA supplementation during chemotherapy improves bone density and survival in cancer patients ⁴¹. [L2, M]
- n-3 PUFA is beneficial to patients with certain cancers ⁵¹ [L1, M]; they modulate cellular signalling, expression of genes associated with cancer pathogenesis and reduce inflammation with negligible adverse effects ⁵². [L2, M]
- n-3 PUFA supplementation is associated with a reduction (non-significant) in the risk of cancer in adults consuming low levels of seafood ⁵³. [L1, H]

3.4.1 Breast cancer

- High levels of fish consumption and n-3 LC PUFA is associated with a 16-34% reduction in all-cause mortality in women with breast cancer ^{54,55}. [L1, H]
- EPA and DHA status may be predictive of breast cancer risk ⁵⁶. [L1, M]
- n-6 PUFA may be associated with increased breast cancer risk ⁵⁷ [L1, H] and increasing n-3 PUFA (in comparison to n-6 PUFA) can reduce breast cancer risk ⁵⁸. [L1, M]
- n-3 LC PUFA are beneficial to the prevention, development and progression of breast cancer ⁵⁹. [L1, H]

3.4.2 Colorectal cancer

- Fish oil supplementation (or ≥ 2 serves fatty fish per week) reduces the risk of cancers including colon, hepatobiliary and lung cancer in adults ⁴⁶. [L2, H]
- Increasing consumption of n-3 PUFA, and seafood, while decreasing dietary n-6 PUFA and fats, reduces the incidence of colorectal tumours ⁶⁰. [L1, M]
- EPA and DHA consumption are associated with a lower risk of colorectal cancer (by approximately 11%) ⁶¹. [L1, M]
- Fish oil has a beneficial effect on eicosanoids which are associated with colorectal cancer ⁶². [L2, M]
- n-3 PUFA and fermentable dietary fibres are thought to reduce the risk of colon cancer ⁶³. [L2, M]

3.4.3 Lung cancer

- Fish oil supplementation in adults (those consuming ≥ 2 serves fatty fish per week) reduces the risk of hepatobiliary and lung cancer ⁴⁶. [L2, H]
- n-6:n-3 PUFA ratio is inversely associated with lung cancer risk ⁶⁴. [L1, H]
- Lung cancer patients undergoing radio or chemotherapy derive health benefits from n-3 PUFA through improved nutritional status and reduced inflammation ⁶⁵. [L1, M]
- n-3 PUFA supplementation increases weight and quality of life in patients with non-small cell lung cancer and cancer cachexia (loss of muscle mass and fat) ⁶⁶. [L1, H]

3.4.4 Other cancers

- n-3 LC PUFA and non-fried fish consumption is associated with a 20% reduced risk of head and neck and oesophageal cancer ⁴⁷. [L1, M]
- Marine n-3 PUFA and DHA are associated with a reduced risk of pancreatic cancer ⁶⁷. [L1, H]
- High n-3 PUFA status is associated with reduced risk of endometrial cancer ⁴⁵. [L1, M]
- n-3 PUFA provides health benefits to post operative gastrointestinal cancer patients due to anti-inflammatory properties and improved immune function ^{68,69}. [L1, M-H]

3.5 Cardiovascular disease

3.5.1 *Diet and seafood consumption*

- A Mediterranean diet, high in fruit, vegetables, nuts and fish, improves atherothrombosis (arterial health) biomarkers in high CVD risk adults ⁷⁰. [L2, H]
- Higher dietary intake of fish, fruit and vegetables and lower salt intake are associated with a lower risk of CVD mortality ⁷¹. [L2, M]
- Fish and marine n-3 PUFA are inversely related to the risk of CVD mortality ⁷²⁻⁷⁶ [L1, M-H], myocardial infarction ⁷⁷ [L1, H], and stroke ^{78,79}. [L1, M-H]
 - Some studies report mixed results or lower levels of evidence for n-3 PUFA and stroke risk or all-cause mortality ^{80,81}. [L1, M-H]
 - Fish consumption reduces the risk of CHD and CHD mortality ⁸². [L1, M]
 - Fatty fish consumption (but not lean fish) is inversely associated with CHD incidence and mortality ⁸³. [L1, H]
- The American Heart Association recommends 1 to 2 seafood meals per week to reduce the risk of congestive heart failure, CHD, ischemic stroke, and sudden cardiac death, especially where seafood replaces the consumption of less healthy foods ⁸⁴. [L1, H]
 - Two serves of fish each week reduces the risk of CVD outcomes by 10%, one serve per day reduces the risk by 30% ⁸⁵. [L1, H]
 - Some suggestion a U shape relationship where moderate consumption is more beneficial to health than high or low fish consumption ⁸⁶. [L1, M]
 - Two serves of oily fish per week reduces the risk of major CV events and mortality in populations with existing CVD ⁸⁷. [L1, M]
- Consumption of fish 6-7 times a week is associated with healthier lifestyle behaviours and lower non-HDL-C ⁸⁸. [L2, H]
- The CVD protective role is linked to consumption of fatty fish but not lean fish ⁸³. [L1, H]
- Fish consumption (not fried fish) is associated with a reduction in CVD events and the risk of myocardial infarction ⁸⁹. [L1, H]
- Trans fatty acid consumption (but not PUFA) is associated with a greater risk of CVD ⁹⁰. [L1, H]

3.5.2 *n-3 PUFA supplementation*

- Fish oil reduces CHD and cardiovascular events ⁹¹. [L1, M]
- n-3 PUFA is associated with a modestly reduced incidence of fatal CHD ⁹² [L1, H], CVD ^{93,94} [L1, M-H], premature death ⁹⁵ [L1, H], improved suboptimal CV health ⁹⁶ [L1, H] and reduced CV risk in patients with peripheral arterial disease ⁹⁷. [L1, M]
- n-3 PUFA supplementation is associated with a non-significant reduction in CV risk factors in adults with low dietary fish consumption ⁵³. [L1, H]
- Higher intakes of n-3 PUFA, EPA and DHA are associated with a reduced risk of CV events and mortality ⁹⁸. [L1, H]
- Marine n-3 PUFA, EPA and DHA are associated with a lower risk of atherosclerotic CVD ^{99,100}. [L1, H]
- n-3 PUFA supplementation can regulate endothelial dysfunction and arterial stiffness and may slow the progression of atherosclerosis ¹⁰¹. [L1, M]
- n-3 PUFA supplementation reduces blood pressure in patients with a high risk of CVD ¹⁰² [L1, H] and metabolic syndrome ¹⁰³. [L1, H]
- Daily EPA and DHA supplementation as low as 0.7 g per day can reduce blood pressure and CVD risk ¹⁰⁴. [L1, M]
- There is strong evidence for the cardioprotective role of EPA and DHA ¹⁰⁵. [L1, H]
- EPA and DHA supplementation reduce the risk of myocardial infarction and CV death ¹⁰⁶. [L1, M]
- EPA and DHA are protective against CVD ¹⁰⁷ [L1, H] and major ischemic events ⁹⁹ [L1, H] with higher doses being more beneficial ¹⁰⁸. [L1, H]
- n-3 PUFA supplementation moderately reduces the risk of myocardial infarction with EPA alone offering a significant risk reduction for CVD outcomes ¹⁰⁹⁻¹¹¹. [L1, M-H]
- EPA is effective in reducing the risk of CVD events, CVD mortality and myocardial infarction ⁷⁶. [L1, H],
- High doses of n-3 PUFA supplementation (> 1 g per day) may increase the risk of atrial fibrillation and bleeding ¹¹²⁻¹¹⁴ [L1, M-H]; or stroke in patients with previous myocardial infarction ¹¹³. [L1, M]

- Fish or n-3 PUFA consumption is recommended for prevention of adverse coronary events ⁷³. [L1, H]
- Fish oil slightly reduced the length of stay in ICU and hospital following coronary artery bypass surgery and slightly reduced the incidence of associated arterial fibrillation ¹¹⁵. [L1, M]
- There is substantiated evidence that DHA improves heart and CV function although more research is needed to identify the pathways of DHA within the body ²³. [L1, H]
- There is strong evidence that n-3 LC PUFA supplementation (particularly DHA) reduces heart rate. When DHA or EPA is administered alone, heart rate is slowed by DHA rather than by EPA ¹¹⁶. [L1, H]
- n-3 PUFA is effective for secondary CVD prevention in patients with a high risk of CVD; risk is reduced for CHD but not stroke ¹¹⁷. [L1, H]
- High n-3 PUFA status is associated with a lower overall stroke and ischemic stroke risk but not haemorrhagic stroke risk ¹¹⁸. [L1, H]
- Higher levels of serum ALA (alpha linoleic acid) and EPA are associated with lower adverse clinical events in patients with acute myocardial infarction ¹¹⁹. [L2, H]
- Higher adipose marine n-3 PUFA is associated with a lower risk of peripheral arterial disease ¹²⁰. [L2, H]
- Higher doses of n-3 PUFA are recommended to improve clinical outcomes and reduce cardiac mortality in patients with chronic atherosclerotic disease ²². [L1, H]

3.5.3 *Heart surgery*

- n-3 PUFA, particularly EPA, is associated with a substantial decrease in the risk of requiring coronary revascularizations (procedure to restore blood flow) ¹⁰⁹⁻¹¹¹. [L1, M-H]
- Supplementation with n-3 PUFA and Vitamin C significantly reduces patient postoperative fatigue following coronary artery bypass graft surgery ¹²¹. [L1, H]
- High doses of n-3 PUFA reduce adverse left ventricular remodelling following myocardial infarction, non-infarction myocardial fibrosis, and serum biomarkers of systemic inflammation in patients with acute myocardial infarction ¹²². [L2, M]
- Perioperative n-3 PUFA reduces bleeding and frequency of blood infusions ¹²³. [L1, M]

3.5.4 Blood lipids

- n-3 PUFA supplementation can induce favourable changes in blood lipids including a reduction in triglyceride levels^{124,125}. [L1, M-H] One study identified a slight increase HDL- and LDL-C (low density lipoprotein cholesterol)^{103,126-130}. [L1, M-H]
- There is moderate evidence for improvements in blood lipids and blood pressure through intake of n-3 PUFA in people without CVD¹³¹. [L1, H]
- The addition of n-3 PUFA to statin treatment reduces the incidence of myocardial infarction, adverse cardiac events, unstable angina and favourable changes in blood lipids¹³²⁻¹³⁵. [L1, M-H]
- Fish oil and Vitamin E supplementation reduce total cholesterol and LDL-C in menopausal women¹³⁶. [L1, M]
- High levels of triglycerides increase the risk of heart disease and pancreatitis. n-3 PUFA reduces blood triglycerides with effects increased with increased doses of EPA¹³⁷. [L1, H]

3.6 Diabetes

- Consumption of fish, whole grains, fibre and n-3 PUFA is inversely associated with all-cause mortality in individuals with type 2 diabetes²⁴. [L1, M]
- Insulin sensitivity markers are significantly associated with serum DHA¹³⁸. [L2, H]
- Short term fish oil supplementation in adults with metabolic disorder increases insulin sensitivity¹³⁹. [L1, M]
- n-3 PUFA is associated with reductions in LDL-C, VLDL-C, triglycerides, proinflammatory cytokines and Haemoglobin A1c in type 2 diabetic patients which indicates a reduced CVD risk¹⁴⁰ [L1, H], improved glycaemia¹⁴¹ [L1, H] and modulation of peripheral nerve health¹⁴². [L1, H]
- Higher dietary n-3 PUFA (ALA and DPA -docosapentaenoic acid) is associated with a reduction in all-cause and CV mortality in adults with diabetes or prediabetes¹⁴³. [L1, H]
- 6 months of fish oil supplementation improves triglyceride and HDL-C levels but not glycaemic control in patients with type 2 diabetes and abdominal obesity^{144,145}. [L1, M]

- 2 g fish oil per day is recommended to reduce inflammation and promote retinal health ¹⁴⁶. [L2, M]
- Consumption of 500 mg of n-3 LC PUFA or two serves of oily fish per week reduces the risk of diabetic retinopathy in people with type 2 diabetes ¹⁴⁷. [L2, H]
- The anti-inflammatory properties of fish oil and marine n-3 PUFA may be beneficial for diabetic neural peripheral neuropathy ^{148,149}. [L1, M]
- Supplementation with n-3 PUFA and Vitamin D improves sleep quality, depression and anxiety in women of reproductive age with pre-diabetes and low Vitamin D status ¹⁵⁰. [L2, M]
- n-3 PUFA supplementation is not associated with a reduced risk of gestational diabetes ¹⁵¹. [L1, H]
- n-3 PUFA is inversely associated with diabetes in overweight females but not males ¹⁵². [L1, H]
- n-3 PUFA have clear benefits to CV health for people with diabetes mellitus or prediabetes ⁷⁵. [L1, H]
- Fish oil supplementation benefits pregnant women with type 2 diabetes; < 200 mg EPA improves HOMA -IR (insulin resistance) ¹⁵³. [L1, M]

3.7 Fertility

- Greater male and female consumption of seafood is associated with a higher frequency of sexual intercourse and fecundity in couples attempting pregnancy ¹⁵⁴. [L2, M]
- Men's intake of omega-3 fatty acids may improve semen quality with increase sperm count, concentration and motility ¹⁵⁵. [L2, M]
- n-3 PUFA supplementation of infertile men significantly improves sperm motility and concentration of DHA in seminal plasma ¹⁵⁶. [L1, H]

3.8 Healthy ageing

3.8.1 *Healthy ageing and seafood consumption*

- A Mediterranean diet featuring vegetables, fruit and fish improves cognition and reduces the risk of depression and dementia. There is emerging evidence for a further benefit from dietary components including n-3 PUFA, polyphenols, Vitamin D and B vitamins ¹⁵⁷. [L2, M]
- n-3 PUFA have an anti-inflammatory effect in ageing ¹⁵⁸. [L1, M]
- n-3 PUFA supplementation can improve executive function in middle aged and elderly people ¹⁵⁹. [L1, M]
- Healthy ageing is associated with higher EPA and DPA status; health ageing was assessed as the absence of chronic conditions such as CV, cancer, chronic kidney or lung disease ¹⁶⁰. [L1, H]
- Fish oil n-3 PUFA can benefit muscle strength, physical performance and body composition and improve serum lipid profiles in older adults plus may help prevent sarcopenia (age related, muscle loss, strength and function) ¹⁶¹. [L2, M]
- Supplementation with n-3 LC PUFA may maintain or increase neuromuscular function during ageing ¹⁶². [L2, H]

3.8.2 *Dementia and Alzheimer's disease*

- Two serves of fish a week is protective against cognitive decline (10% reduction in all-cause dementia and 30% reduction in Alzheimer's disease risk) ¹⁶³. [L1, M]
- One serve of seafood and n-3 LC PUFA each week is protective against multiple cognitive declines ¹⁶⁴. [L2, M]
- Greater fish consumption is associated with a lower risk of dementia ¹⁶⁵ [L1, H] and rate of memory decline ¹⁶⁶. [L1, H]
- A healthy diet improves cognitive function in older adults; long term protective effects were identified with a higher intake of fish and tea combined ¹⁶⁷. [L1, M]
- A high intake of fish in mid-life may reduce the likelihood of developing dementia ^{168,169}. [L1-2, M-H]

- Research has found that adequate intake of n-3 PUFA reduces the neuroinflammation associated with cognitive decline plus delays the onset of Alzheimer's disease and slows disease progression following onset ¹⁷⁰⁻¹⁷². [L1, M-H]

3.8.3 Age related issues including cognitive decline

- n-3 PUFA supplementation in the elderly is beneficial for mild to moderate depression ¹⁷³. [L1, H]
- Higher n-3 LC PUFA status may provide benefit to the ageing brain and reduce the rate of cognitive decline in older adults ^{174,175} [L1-2, M-H] and Alzheimer's disease patients ^{176,177}. [L1-2, M-H]
- A higher n-3 PUFA status may be protective against the influence of air pollution on the brain ¹⁷⁸. [L1, M]
- DHA improves brain function and slows the rate of cognitive decline ²³. [L1, H]
- The benefits to cognition derived from fish oil supplementation in older adults may be affected by: carrier status of the gene APOE-ε4 which increases the chance of developing Alzheimer's disease ¹⁷⁹ [L1, H] and gender. Further research is needed to investigate the influence of the APOE-ε4 gene, and gender ¹⁸⁰. [L2, M]
- Higher consumption of oily fish (or fish oil supplements) may prevent frailty in older adults ¹⁸¹. [L2, H]
- Oily fish consumption and n-3 PUFA (EPA and DHA) are inversely related to the incidence of pain in older adults ¹⁸². [L1, H]

3.9 Hospitalisation

- The n-3 PUFA status of critically ill patients reduced the risk of infection plus shortened hospital and ICU lengths of stay ¹⁸³⁻¹⁸⁵. [L1, M-H]
- n-3 PUFA reduce the risk of infection in surgical and critically ill patients ^{186,187}. [L2, M]
- Increased EPA and DHA emulsions improve survival rates in critically ill septic patients ¹⁸⁸. [L2, M]
- n-3 PUFA improves arterial blood oxygenation; and reduces ICU length of stay and duration of mechanical ventilation in patients with acute respiratory distress ¹⁸⁶. [L1, M]

3.10 Inflammatory conditions

- Consumption of oily fish ¹⁸⁹ [L2, H] and n-3 PUFA mitigate inflammatory markers which indicate lower levels of inflammation ¹⁹⁰. [L1, M]
- n-3 PUFA may reduce bio-inflammatory markers in diabetic and CV patients ¹⁹¹. [L1, M]
- Consumption of a Mediterranean diet (including two meals or a minimum of 300 g of oily fish each week) significantly reduces airway inflammation in children ¹⁹². [L2, M]
- n-3 PUFA supplementation in patients with schizophrenia and metabolic syndrome reduces levels of inflammation ¹⁹³. [L2, M]
- n-3 PUFA and Vitamin E supplementation may improve inflammation in haemodialysis patients ¹⁹⁴. [L1, M]
- n-3 PUFA has an anti-inflammatory effect on ageing ¹⁵⁸. [L2, M]
- n-3 PUFA reduces inflammatory marker C-reactive protein in patients with HIV ¹⁹⁵. [L1, M]
- The anti-inflammatory properties of fish oil and marine n-3 PUFA may be beneficial for diabetic neural peripheral neuropathy ¹⁴⁸. [L2, M]
- n-3 PUFA reduces the leukotriene B4 proinflammatory marker in patients with rheumatoid arthritis ¹⁹⁶. [L1, H]
- Consumption of > 2 g of n-3 PUFA per day, may improve inflammatory rheumatic diseases such as rheumatoid arthritis ¹⁹⁷ [L1, M], and reduce symptoms of swollen and tender joints ¹⁹⁸. [L1, H]
- Fish consumption can reduce rheumatoid arthritis disease activity ¹⁹⁹. [L2, M]
- Increasing unsaturated fats (as a proportion of total dietary fat) reduces the incidence of metabolic syndrome ²⁰⁰ [L1, H].
- The anti-inflammatory properties of n-3 PUFA reduce the risk of developing rheumatoid arthritis or systemic lupus and reduce the severity of symptoms ¹⁹⁰. [L1, M]
- n-3 PUFA can increase survival in patients with systemic inflammatory response syndrome ¹⁶. [L1, M]
- Consumption of n-3 PUFA has a beneficial effect on gut microbiota and may help regulate gut immunity ²⁰¹. [L1, M]

3.11 Kidney health

- Higher consumption of marine n-3 PUFA is associated with a lower risk of chronic kidney disease ^{202,203}. [L1, H]
- Dialysis patients have lower proportions of n-3 and n-6 PUFA than healthy adults ^{93,94}. [L1, M]
- Marine n-3 PUFA supplementation significantly improves cardiac function in renal transplant patients ²⁰⁴. [L2, H]
- n-3 PUFA supplementation reduces CV mortality in patients on haemodialysis ²⁰⁵. [L1, M]
- n-3 PUFA and Vitamin E supplementation may improve inflammation in haemodialysis patients ¹⁹⁴. [L1, M]

3.12 Liver health

- n-3 PUFA improve metabolic indicators, liver enzymes and reduce liver fat content in patients with non-alcoholic fatty liver disease ²⁰⁶. [L1, M]
- n-3 PUFA supplementation (especially DHA) is beneficial in the treatment of non-alcoholic fatty liver disease ²⁰⁷. [L1, H]

3.13 Maternal and infant health

3.13.1 Maternal health

- Consumption of n-3 LC PUFA (through food or supplements) during pregnancy can reduce the incidence of preterm birth and the chance of having a low birthweight baby ²⁰⁸⁻²¹¹. [L1, M-H]
- n-3 PUFA consumption during pregnancy can reduce the risk of preeclampsia ²¹²⁻²¹⁴. [L1-2, M-H]
- n-3 PUFA and n-3 PUFA-rich foods may decrease the risk of pregnancy loss ¹⁵⁵. [L2, M]
- Daily supplementation of n-3 PUFA (2.4 g total DHA and EPA) prolongs pregnancy and increases birthweight; the increase in birth weight is not explained by the longer gestation ²¹⁵. [L1, M]
- n-3 PUFA supplementation is linked to DHA and DHA derived oxylipins which play a role in pregnancy duration ²¹⁶. [L2, M]

- Higher fish consumption reduces the risk of preterm birth in lean women but increases the risk in obese women ²¹⁷. [L1, M]
- n-3 PUFA supplementation of women with a low n-3 PUFA status can reduce the risk of preterm birth ²¹⁸. [L2, M]
- DHA has a potential role in mitigating the effect of prenatal alcohol exposure on the foetus ²¹⁹. [L1, M]
- Maternal n-3 PUFA intake during pregnancy and lactation reduces the risk of infant food allergy and food sensitisation and is more efficacious than consumption of n-3 PUFA during childhood ³⁴ [L1, H].
- Higher maternal serum DHA may influence plasma markers for insulin sensitivity ¹³⁸. [L2, H]
- n-3 PUFA and iodine from fish consumption reduce maternal depression and anxiety and increase neurocognitive child development ²²⁰. [L2, M]
- n-3 PUFA, in pregnancy or postpartum, significantly improves symptoms of depression; the greatest effect is achieved with EPA supplementation in women with mild or moderate depression ²²¹. [L1, M]
- Fish oil supplementation improves the health of pregnant women with type 2 diabetes; EPA doses of < 200 mg improve insulin resistance (HOMA -IR) ¹⁵³. [L1, M]
- There is a need for further studies to identify appropriate dosage ²²² [L1, M], length of treatment time and the effect of interactions between different dietary fatty acids associated with maternal health ²²³. [L1, H]

3.13.2 *Infant health*

- Higher birthweight and a higher maternal PUFA status are associated with a higher infant PUFA status at 3 months of age ²²⁴. [L2, H]
- Consumption of fatty fish during pregnancy benefits infant cognitive function and reduces autism spectrum traits ^{225,226}. [L1-2, M]
- Maternal fish consumption during pregnancy may reduce the risk of neurodevelopmental delay in the domains of fine motor, problem-solving, and personal-social traits ²²⁷. [L1, H]

- Fish oil supplementation from 24 weeks of pregnancy reduces the number of incidences of gastroenteritis in infants to 3 years ²²⁸. [L1, M]
- Consumption of fish in the first year of life reduces the risk of eczema and allergic rhinitis ²⁵ [L1, H].
- n-3 PUFA supplementation improves child psychomotor skills and visual development ²²⁹. [L1, M]
- Consumption of salmon (three times a week for 16 weeks) improves cognition in children ^{230,231}. [L1, M]
- n-3 PUFA supplementation of ≥ 450 mg DHA and EPA per day and an omega 3 index over six percent improves child and adolescent cognition ²³². [L1, H]
- DHA is an essential component of the brain. In cases where amino acid metabolism is compromised, DHA supplementation has proven effective in improving DHA levels within brain structures ^{233,234}. [L1-2, H]
- Consumption of n-3 LC PUFA throughout life may have a positive effect on neurodevelopment including communication, working memory, executive function and visual attention ²³⁵. [L1, M]

3.14 Menopause

- n-3 PUFA can reduce night sweats in menopausal women ²³⁶. [L1, M]
- Fish oil and Vitamin E supplementation reduces total and LDL cholesterol in menopausal women ¹³⁶. [L1, M]

3.15 Mental health

3.15.1 Anxiety and depression

- n-3 PUFA may reduce the symptoms of clinical anxiety ²³⁷ [L1, M] and chilliness associated with anxiety ²³⁸. [L2, M]
- A Mediterranean diet and supplementation with fish oil reduces depressive symptoms and improves mental health as well as quality of life, within three months of the intervention ²³⁹. [L2, M]

- n-3 PUFA (1000 mg) and Vitamin D supplementation (50,000 IU) in women of reproductive age with pre-diabetes and low vitamin D status for eight weeks improves anxiety, depression and sleep quality ¹⁵⁰. [L2, M]
- Mediterranean diets reduce the risk of depression and dementia. There is evidence for the protective role of n-3 PUFA, polyphenols, folate, Vitamin D and B Vitamins ¹⁵⁷. [L1, H]
- A healthy or Mediterranean diet is linearly associated with a lower risk of depression over time; dietary inflammatory index and consumption of fish and vegetables are also associated with lower incidence of depression ²⁴⁰. [L1, M]
- High adult fish consumption (≥ 4 serves per week) is associated with 26% lower odds of depression compared with low fish consumption (< 1 serve per week), especially in females ²⁴¹. [L1, H]
- Some researchers suggest a U-shaped relationship between n-3 PUFA and fish intake with a moderate intake reducing the odds of depression more than a high intake ²⁴². [L1, H]
- Higher n-3 to n-6 PUFA intake is linked to slower development of depressive symptoms especially in women ²⁴³. [L1, H]
- n-3 PUFA supplementation with 100% or $\geq 60\%$ EPA has clinical benefits for people with depression but not 100% DHA or $\geq 60\%$ DHA ²⁴⁴. [L1, M]
- n-3 PUFA supplementation significantly improves depressive symptoms in HIV positive patients ²⁴⁵. [L1, M]
- n-3 PUFA supplementation had a significant effect on perinatal depression; mild to moderate depression in pregnant and postpartum women was significantly improved with high EPA:DHA (≥ 1.5) supplementation being the most efficacious ²²¹. [L1, M]
- Erythrocyte Omega 3 index is inversely associated with depressive symptoms in adults with high levels of oxidative markers ²⁴⁶. [L1, H]
- n-3 PUFA (EPA and DHA) supplementation is effective in the reduction of depression symptoms ²⁴⁷⁻²⁴⁹. [L1, M-H]
- High doses of n-3 PUFA (≥ 2000 mg per day) are more effective in the management of major depressive disorders than low doses (< 2000 mg per day) ²⁵⁰. [L1, M]

3.15.2 Behavioural disorders

- Low intakes of marine n-3 PUFA increases the risk of attention deficit hyperactivity disorder, autism, bipolar disorder, depression and suicide ideation ²⁵¹ [L1, H]; supplementation with n-3 PUFA has value as an adjunct treatment for children and adolescents with bipolar disorder ²⁵² [L1, H]
- Child n-3 PUFA supplementation can improve health status and quality of life in children especially where hyperactivity, inattention, problems with conduct ²⁵³ [L1, M] or aggression exist ²⁵⁴ [L1, H]
- Treatment including n-3 PUFA supplementation in youth with depression or sub syndromic bipolar disorder results in sustained improvements in symptoms and overall functioning ²⁵⁵ [L2, M]
- n-3 PUFA supplementation improves the social and interpersonal skills of children with some personality disorders. Early intervention with dietary or supplementary n-3 PUFA, in conjunction with other known effective treatments, should be considered as these children move into adolescence ²⁵⁴ [L1, M]

3.15.3 Behaviour regulation

- Marine n-3 PUFA improves borderline personality disorder especially impulsive behavioural dyscontrol and affective dysregulation ²⁵⁶ [L1, M]
- Daily intake of n-3 PUFA or 100 g fish high in DHA are beneficial to cognitive and behavioural outcomes in healthy school-aged children. Fortification may be considered as an effective public health initiative ²⁵⁷ [L1, H]

3.15.4 Other mental health issues

- Greater consumption of oily fish is associated with better sleep quality ²⁵⁸ [L1, H]
- n-3 PUFA supplementation benefits older adults with mild to moderate depression ¹⁷³ [L1, M]; higher red blood cell DHA and EPA is independently associated with 12-month psychotropic drug use in older adults ²⁵⁹ [L1, H]

- DHA associated with health benefits related to autistic spectrum disorder, Alzheimer's disease, schizophrenia, stroke and traumatic brain injury; mixed results in research is likely due to background diet heterogeneity ²⁶⁰. [L1, M]
- n-3 PUFA supplementation benefits younger adults with lower n-3 PUFA status and schizophrenia in the prodromal stage of disease ²⁶¹. [L2, M]
- n-3 fatty acid supplementation has beneficial effects on triglyceride metabolism and reduces the level of inflammation in patients with both schizophrenia and metabolic syndrome ¹⁹³. [L1, M]
- n-3 fatty acid supplement of around 1500 mg per day (range 1000-2880 mg per day) has proven effective in reducing the frequency of seizures in both adults and children with epilepsy ²⁶². [L1, M]
- n-3 PUFA supplementation should be considered as a potential beneficial adjunct therapy in all mental health disorders ²⁶³. [L1, M]
- n-3 PUFA supplementation for young people at high-risk of psychosis was found to be a safe, user-friendly and effective treatment with therapeutic benefits at onset and as a long-term treatment option ²⁶⁴. [L1, H]

3.16 Metabolic syndrome

- Fish and n-3 LC PUFA consumption attenuates long term weight gain ^{265,266}. [L1, M]
- Fish intake is inversely associated with metabolic syndrome ²⁶⁷. [L1, H]
- n-3 PUFA lower the risk of metabolic syndrome ^{268,269}. [L1, H]
- Short term fish oil supplementation of adults with metabolic disorder increased insulin sensitivity ¹³⁹. [L1, M]
- n-3 PUFA together with Vitamin E improve blood lipid profiles of patients with metabolic syndrome ²⁷⁰. [L1, M]

3.17 Muscular health / performance

- Supplementation with fish oil derived n-3 PUFA can benefit muscle strength, physical performance, body composition and serum lipids in older adults and may help prevent sarcopenia (age related, muscle loss, strength and function) ¹⁶¹. [L1, H]
- n-3 LC PUFA may maintain or increase neuromuscular function during ageing ^{162,271}. [L1, M]
- n-3 PUFA may lead to small increases in muscle strength but not muscle mass or function ²⁷². [L1, M]
- n-3 PUFA improve recovery from onset muscle soreness and improved muscle function but not muscle hypertrophy, muscle strength or muscular inflammatory markers ²⁷³. [L1, M]
- n-3 LC PUFA positively associated with muscle mass and strength ²⁷⁴. [L2, M]
- Fish oil is likely to preserve strength and promote recovery from physiological stress in young adults; other muscular benefits are unclear ²⁷⁵. [L1, M]
- Fish oil supplementation of athletes benefits the central nervous system, CV system, skeletal muscle and reduces proinflammatory cytokines ²⁷⁶. [L1, M]

3.18 Health benefits associated with eating seafood

- The benefits of fish consumption and the role of n-3 PUFA in health at all stages of life, from conception to ageing, outweigh the potential risks (with the exception of a few selected species in sensitive populations) ²⁷⁷. [L2, M]
- Studies that examine seafood as a whole food integrate any adverse effect from neurotoxicants and identify benefits to cognition derived from n-3 PUFA and other essential nutrients found in seafood ²⁷⁸. [L1, M]
- Health benefits of fish consumption generally counter the risk of polyfluoroalkyl substances (e.g. from packaging) ²⁷⁹. [L1, M]
- Polychlorinated biphenyl (PCB) contamination (minimal in Australian caught seafood) ²⁸⁰ [L1, M] is linked to an increased risk of myocardial infarction.
- EPA and DHA are protective and associated with a lower risk of CV events ²⁸¹. [L1, H]

4. Conclusion

This report provides a summary of moderate to high level scientific evidence published in peer reviewed literature, from January 2015 to January 2025, around the health benefits of seafood consumption to human health. The evidence clearly supports the consumption of at least two serves of seafood per week as a part of a healthy diet. It is also evident that a variety of seafood should be consumed to gain optimal health benefit. The strongest evidence supports at least one serve of n-3 PUFA rich seafood each week.

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6.1 Appendix 1: Search strategy

Search strategy

Definitions of seafood used in this review

For this report, the term seafood is defined as finfish (vertebrates), cartilaginous fishes (e.g., sharks) and shellfish (invertebrates), whether of marine or freshwater origin, farmed or wild.

- Fish include marine pelagic, marine demersal, diadromous, and freshwater*.
- Shellfish include molluscs (e.g., bivalve molluscs such as clams, oysters, and mussels, and cephalopods such as octopus and squid), crustaceans (e.g. shrimp, crabs, and lobster), and echinoderms (e.g. sea cucumbers and sea urchins) are also included.

**In the context of this work, we include marine species that live part of their life in fresh water (not freshwaters species that live their entire life in freshwater).*

Search Terms

Electronic Database	Search Field	Search Terms Used
PubMed	Abstract, title, keywords, English 2015-present	(fish OR seafood OR Omega 3) AND (health) (fish OR seafood OR Omega 3) AND (health benefits) (fish OR seafood OR Omega 3) AND (nutrient value)
Medline Ovid	Abstract, title, keywords, English 2015-present, Clinically useful journals	(fish OR seafood OR Omega 3) AND (health) (fish OR seafood OR Omega 3) AND (health benefits) (fish OR seafood OR Omega 3) AND (nutrient value)
Scopus	Abstract, title, keywords, English 2015-present	(fish OR seafood OR Omega 3) AND (health) (fish OR seafood OR Omega 3) AND (health benefits) (fish OR seafood OR Omega 3) AND (nutrient value)
Cochrane Reviews	Abstract, title, keywords, English 2015-present	(fish OR seafood OR Omega 3) AND (health) (fish OR seafood OR Omega 3) AND (health benefits) (fish OR seafood OR Omega 3) AND (nutrient value)

Excluded:

- Books, book chapters
- Conference presentations
- Grey literature that is not peer-reviewed or evidence based
- Animal studies with no human health or human nutrient component

Outside the Scope of the review

- Low level and emerging evidence, plus non-scientific and non-evidence-based literature
- Edible aquatic plants, seaweed, microphytes; marine mammals (whales, seals, dolphins, dugongs); aquatic reptiles; jellyfish; waterfowl; frogs; or cell-based cultured seafood.
- Animal feed or production (e.g., impact on size, quality, nutrient value)
- Labelling/mislabelling
- Nutritional profiles and nutritional values of seafood
- Sustainability and environmental impacts
- Comparison between wild catch and aquaculture
- Risks of seafood consumption.

NB: Whilst it was agreed to refer to wild or farmed seafood where mentioned in the literature, very few papers noted this differentiation, particularly where seafood was used in the form of oils or supplements to control intake or dose as per strict clinical study protocols.

6.2 Appendix 2: Summary of key findings for industry

Title: The Health Benefits of Eating Seafood: Evidence Based Science

Subtitle: Summary of the key findings for industry

Authors: Dr Wendy Hunt, Professor Alexandra McManus

Funded by: Fisheries Research Development Corporation (FRDC) and
International Coalition of Fisheries Associations
as part of the Global Seafood Communicators Nutrition Toolkit Project 2025

Date: April 2025

Based on: Hunt W, McManus A. 2025 The health benefits of eating seafood: Evidence based science. Medical, Molecular and Forensic Science, Murdoch University, Australia and Faculty of Health Sciences, Curtin University, Australia. Report # 27032025



Abbreviations and Glossary of Terms

ALA	Alpha linoleic acid
CHD	Coronary heart disease
CV	Cardiovascular
CVD	Cardiovascular disease
DHA	Docosahexaenoic acid
DPA	Docosapentaenoic acid
EPA	Eicosapentaenoic acid
HDL-C	High density lipoprotein cholesterol
LC PUFA	Long chain polyunsaturated fatty acids
LDL-C	Low density lipoprotein cholesterol
PUFA	Polyunsaturated fatty acids
n-3 PUFA	Omega-3 polyunsaturated fatty acids
n-6 PUFA	Omega-6 polyunsaturated fatty acids
VLDL	Low density lipoprotein cholesterol

Oily Fish: "Oil-rich fish (or oily fish) are those that have oil distributed through their body, in contrast to white fish, where the main concentration of oils is located in the liver. Oily fish (e.g., Anchovies, Herring, Mackerels, Salmons, Trouts, Swordfish and Eels) contain higher levels of long chain polyunsaturated fatty acids (LC PUFA).

Introduction

Seafood is an excellent source of energy and contains a range of nutrients that are beneficial for human health. These include Omega-3 fatty acids (n-3 PUFA), protein, calcium, iodine, iron, Vitamins A, B12, D and E, zinc, selenium, copper, manganese, phosphorus and taurine. Details of the impact of the consumption of these nutrients and minerals on the human body are provided in Appendix 1 together with examples of seafood that contain them.

Methods

A rapid literature review of peer reviewed journal articles published between January 2015 and January 2025 was conducted. A summary of the key findings from this literature review¹ are included in dot point form in the results section of this document.

Results

All-cause mortality

- Fish and n-3 PUFA consumption reduce all-cause mortality
- Moderate consumption of seafood has the greatest effect (2-4 serves per week)
- The strong evidence of health benefits relates to DHA consumption
- The greatest benefit is gained from the ingestion of seafood as part of a healthy diet

Asthma and allergies

- n-3 PUFA during pregnancy helps to reduce the incidence of asthma, allergy and wheezing in infants
- Consumption of fish (particularly seafood high in n-3 PUFA and Vitamin D) in the first year of life reduces the risk of eczema, allergic rhinitis, asthma and wheeze
- Infant formula fortified with n-3 PUFA aids immune development.

Bone health

- Fish consumption and n-3 PUFA may protect bone health and reduce the risk of hip fracture
- Consumption of ≥ 5 serves of oily fish each week protects bone health and reduces the risk of fracture, particularly in senior women

Cancer

- A diet high in seafood and n-3 PUFA is protective against a number of cancers
- A high n-3 PUFA status is associated with lower fatigue in cancer patients
- n-3 PUFA as part of a healthy diet increases appetite and nutritional status in chemotherapy patients
- n-3 PUFA supplementation during chemotherapy improves bone density and survival rates in cancer patients

- **Breast cancer**
 - High levels of fish consumption and n-3 PUFA are associated with a reduction in all-cause mortality in women with breast cancer
 - n-3 PUFA are beneficial to the prevention, progression and development of breast cancer

- **Colorectal cancer**
 - ≥ 2 serves of oily fish per week reduces the risk of cancers in adults including liver, gallbladder, colorectal and lung cancer

- **Lung cancer**
 - n-3 PUFA in adults (≥ 2 serves seafood /week) reduces the risk of lung cancer
 - n-3 PUFA improves nutritional status and reduces inflammation in lung cancer patients undergoing radio or chemotherapy
 - n-3 PUFA increases weight and quality of life in patients with lung cancer

- **Other cancers**
 - n-3 PUFA (particularly DHA) reduces the risk of neck, head, oesophageal, pancreatic and endometrial cancers
 - Adequate intake of n-3 PUFA reduces inflammation and improves immune function in cancer patients.

Cardiovascular disease (CVD)

- Seafood as part of a balanced diet is associated with a reduced risk of CVD mortality, coronary heart disease (CHD), myocardial infarction and stroke
- ≥ 2 serves of seafood/week (particularly oily fish) is recommended to reduce the risk of congestive heart failure, CHD, ischemic stroke and sudden cardiac death

- ***n-3 PUFA supplementation***
 - Higher intakes of n-3 PUFA, EPA and DHA (≥ 2 serves per week) are associated with a reduced risk of all-cause mortality, CV events, CHD mortality and premature death
 - There is strong evidence supporting the cardioprotective role of EPA and DHA across the lifespan, particularly from marine based sources
 - There is strong emerging evidence that fish oil supplementation reduces the length of stay in Intensive Care Units (ICU) and in hospital following coronary artery bypass surgery
 - There is strong evidence that n-3 PUFA supplementation (especially DHA) reduces heart rate and blood pressure

- ***Blood lipids - cholesterol***
 - n-3 PUFA supplementation and consumption of seafood high in n-3 PUFA help to maintain appropriate cholesterol levels in the body
 - High levels of triglycerides (increases risk of cardiac events) may be mitigated with adequate intake of n-3 PUFA
 - Fish oil and Vitamin E supplementation has proven effective in reducing high cholesterol levels in menopausal women.

Diabetes

- Adequate intake of n-3 PUFA impacts positively on all nutrition-related aspects of type 2 diabetes treatment and management (≥ 2 serves per week)
- Adequate intake of n-3 PUFA improves eye health
- n-3 PUFA and Vitamin D supplementation improves sleep quality, depression and anxiety in women of reproductive age with pre-diabetes and low Vitamin D status
- Fish oil supplementation in pregnant women with type 2 diabetes has significant benefits associated with insulin resistance

Fertility

- There is strong emerging evidence that seafood consumption or n-3 PUFA supplementation can improve semen quality, concentration and motility

Healthy ageing

- There is strong evidence that a diet high in seafood (≥ 2 serves per week) as part of a healthy diet has considerable, positive health effects across the lifespan
- The anti-inflammatory properties of n-3 PUFA are extremely beneficial during the ageing process
- The significant benefits offered by n-3 PUFA associated with healthy ageing include: reduced all-cause mortality, improved cognitive function, preservation of muscle strength and improved balance (leading to a reduction in disabling falls)
- **Alzheimer's disease and dementia**
 - Two serves of fish a week is protective against cognitive decline
 - ≥ 4 serves per week of seafood improves executive function, cognition, memory, and neuro inflammation (association with cognitive decline)
 - There is significant evidence that a high intake of n-3 PUFA delays the onset to Alzheimer's disease and slows progression of the disease following onset.
 - A high intake of fish in mid-life may reduce the likelihood of developing dementia

- ***Age related cognitive decline***
 - Evidence clearly supports the ingestion of (≥ 2 serves per week) oily fish to improve brain function and slow the rate of cognitive decline
 - Higher consumption of oily fish may prevent frailty in older adults
 - Oily fish consumption and n-3 PUFA (EPA and DHA) may reduce pain associated with inflammatory conditions such as arthritis in older adults

Hospitalisation

- The n-3 PUFA status of critically ill patients is associated with a reduced risk of infection, plus shortened hospital and ICU lengths of stay
- EPA and DHA emulsions improve survival rates in critically ill septic patients

Inflammatory conditions

- Consumption of a Mediterranean diet (including ≥ 2 serves per week) significantly reduces airway inflammation in children
- n-3 PUFA supplementation reduces inflammation associated with many health-related conditions (e.g., diabetes, CV events, arthritis, metabolic syndrome, gut-related problems, systemic lupus, peripheral vascular conditions, kidney disease)

Kidney health

- Higher consumption of marine n-3 PUFA is associated with a lower risk of chronic kidney disease
- n-3 PUFA supplementation reduces CV mortality in patients on haemodialysis

Liver health

- n-3 PUFA improve metabolic indicators, liver enzymes and reduces liver fat content in patients with non-alcoholic fatty liver disease

Maternal health

- There is significant evidence supporting n-3 PUFA supplementation in later pregnancy (24 weeks onwards) to prolong pregnancy and improving birth weight.
- n-3 PUFA consumption during pregnancy can reduce the risk of preeclampsia
- Maternal n-3 PUFA intake during pregnancy and lactation reduces the risk of infant food allergy and food sensitisation during childhood
- n-3 PUFA and iodine from fish consumption reduce maternal depression and anxiety and increase neurocognitive child development

- **Infant health**

- DHA is an essential component of the brain. In cases where amino acid metabolism is compromised, DHA supplementation has proven effective in improving DHA levels within brain structures
- Consumption of fatty fish during pregnancy benefits infant cognitive function
- Consumption of fish in the first year of life reduces the risk of eczema and allergic rhinitis (severe hay fever)

Menopause

- n-3 PUFA can reduce night sweats in menopausal women
- Fish oil and Vitamin E supplementation reduces total and LDL cholesterol in menopausal women

Mental health – anxiety and depression

- Mediterranean diet and supplementation with fish oil reduces depressive and dementia symptoms, improves mental health and quality of life index
- High adult fish consumption (≥ 4 serves per week) reduces rates of depression compared with low fish consumption (< 1 serve per week), especially in females
- n-3 PUFA supplementation has a significant effect on perinatal depression
- n-3 PUFA (EPA and DHA) supplementation is effective in reduction of depression symptoms

- ***Mental health – behavioural disorders***
 - Low intakes of marine n-3 PUFA increases the risk of attention deficit hyperactivity disorder, autism, bipolar disorder, depression and suicide ideation
 - Treatment with n-3 fatty acid supplementation has proven effective in improving the social and interpersonal skills of children with some personality disorders.

- ***Mental health -other issues***
 - Greater consumption of oily fish is associated with better sleep quality
 - DHA associated with health benefits related to Alzheimer's disease, schizophrenia, stroke and traumatic brain injury
 - n-3 fatty acid supplement has proven effective in reducing the frequency of seizures in both adults and children with epilepsy
 - n-3 PUFA supplementation for young people at high-risk of psychosis was found to be a safe, user-friendly and effective treatment therapeutic benefits at both early onset and as a long-term treatment option

Metabolic syndrome

- n-3 PUFA lower the risk of metabolic syndrome
- Short term fish oil supplementation of adults with metabolic disorder increased insulin sensitivity

Muscle health and performance

- n-3 LC PUFA may maintain or increase neuromuscular function during ageing
- n-3 PUFA may lead to small increases in muscle strength
- n-3 PUFA improve recovery from onset muscle soreness during exercise
- Fish oil supplementation in athletes benefits the central nervous system, CV system, skeletal muscle and reduces proinflammatory cytokines

Health benefits associated with eating seafood

- The benefits of seafood and fish consumption and the role of n-3 PUFA in health at all stages of life, from conception through ageing, outweigh the potential risks (with the exception of a few selected species in sensitive populations)

Summary

In summary, there is good evidence that a healthy diet high in seafood provides substantial health benefits including:

- prevention of all-cause mortality;
- improved heart and cardiovascular health;
- reduction and management of asthma and allergies;
- maintenance of bone health and reduction of fractures;
- protection against some cancers (breast, colorectal, lung);
- improved nutritional status during cancer treatment;
- reduced inflammation;
- management and treatment of type 2 diabetes mellitus;
- promotion of healthy ageing across the lifespan;
- significant benefits to both maternal and infant health;
- protection against Alzheimer's disease and dementia;
- improved kidney and liver health;
- significant benefits to many mental health related conditions; and
- significant health benefits may be gained from as little as 2 serves per week.

Scientific research has demonstrated clear evidence that consumption of seafood as part of a healthy diet provides significant health benefits throughout the lifespan.

Reference

1. Hunt W, McManus A. 2025 The health benefits of eating seafood: Evidence based science. Medical, Molecular and Forensic Science, Murdoch University, Australia and Faculty of Health Sciences, Curtin University, Australia. Report # 27032025

Appendix Table 1: The health benefits of eating seafood

Nutrient/mineral	Health benefits provided	Examples of Australian seafood high in nutrient/mineral*
Omega-3 fatty acids	Essential for health (human bodies can't make them) Essential for brain development and function Reduces heart disease and aids blood vessel function Helps to maintain and improve eyesight May reduce asthma and allergies	Atlantic Salmon, Sardines
Calcium	Works with Vitamin D to develop and maintain strong bones Vital for muscle, nerve and heart function Helps to prevent osteoporosis	Salmons, Sardines, Oysters,
Iodine	Essential for thyroid function, growth, metabolism, cellular oxygenation and maintenance of the central nervous system	Scallops, Oysters, mussels
Iron	Production of energy; necessary for muscle function Facilitates blood oxygenation	Oysters, Sardines, mussels
Vitamin A and E (antioxidants)	Important of heart and skin Essential for nervous and circulatory systems function	Mackerels, Salmons, Herring (Vitamin A) Trouts, Abalone, Salmons (Vitamin E)
Vitamin B12	Aids DNA synthesis and normal blood function Aids neurological function - helps to retain cognitive function in ageing	Tunas, Sardines, mussels
Vitamin D	Seafood is the best source of Vitamin D (second only to the sun) Improves immune function, skin condition and muscle strength	Salmons, Silver Perch
Zinc	Aids immunity and healing	Oysters, crab, lobster
Protein	Repairs and maintains cells (muscles, bones, fingernails, hair) Vital for digestive function and antibody production Source of energy	Tunas, Trouts, Barramundi
Selenium	Prevents cellular damage Supports a healthy immune function - regulates thyroid function	Mulletts, Tunas, Gemfish
Copper	Keeps nerve cells and immune systems healthy Helps make red blood cells	Prawns, Salmons (smoked), crab
Manganese	Helps form connective tissue, bones, blood and sex hormones Helps metabolise fats and carbohydrate Aids calcium absorption and blood sugar regulation	Oysters, clams, mussels
Phosphorous	Essential for bone and teeth health Helps filter waste from kidneys Helps the body store and use energy Reduces muscle pain following exercise	Salmons, Mackerels, Herring
Taurine	Essential for heart health, plus nervous system and brain function	Scallops, clams, mussels

*For nutritional information about locally sourced and locally consumed seafood, refer to trusted regional nutritional data.