Evidence Review on Fish and Seafood and Health

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A large proportion of the health literature contextualizes studies within a disease framework, whether in the prevention and/or treatment of specific diseases. Although this is a valid and commonly used strategy, it risks portraying health messages in a negative context. An alternative strategy involves a strength-based approach, which encourages consumption of fish and other seafood for healthy growth and development, independent of any reference to disease. This approach offers a range of advantages over a deficit (disease)-based approach. It constructs a positive health promotion framework for fish and other seafood consumption. While the evidence base is largely disease-focussed, we have included any available strength-based literature.

Lifelong Health through Fish and other Seafood Consumption

There is an extensive body of literature providing an evidence base for recommending seafood intake as an important positive component of healthful diets.

Terminology challenge: fish vs seafood

The majority of studies on seafood and health have focused on fish as the main source of seafood. Since many of the positive health benefits of seafood have been attributed to the oils and micronutrients for which fish and other seafood are recognized as rich sources, national dietary recommendations have generalised advice to refer to seafood, rather than fish, consumption. However, scientific reports cited in this document are more precise in terms of specifying intake, for example fish, oily fish or seafood. This is an ongoing challenge for translating scientific evidence into messages suitable for communications targeting the general public. One strategy is to use the term 'fish and other seafood', which may reduce confusion. We have used this term throughout, except when the evidence specifies one or the other. Notwithstanding this challenge, current recommendations for seafood integrate well with the promotion of health, wellbeing and development over the lifespan (embracing the various stages of human development, maturation and ageing).

The general recommendation of at least two fish meals per week is consistent across many national policy documents, including the Heart Foundation (Australia), American Heart Association (Rimm et al 2018) and the Australian Dietary Guidelines (Australian Dietary Guidelines). This is recognised as a lower limit and higher intakes can deliver further health advantages. However, for certain species, and only in certain vulnerable populations, upper limits have been established due to their higher mercury content. These species include Blue Shark, Cat Shark, Swordfish and Tuna, and upper limits are suggested for pregnant and/or breastfeeding women, very young infants, as well as regular and high seafood consumers especially those living in areas where fishing is extensive (Gil and Gil 2015).

Fish and other seafood is nutritionally important for more than just long chain (LC) omega-3 fatty acids. Fish and other seafood is also a good source of selenium, iodine, taurine, vitamin D and vitamin B12. There is some potential for synergy between these nutrients. For example, the protective effect of fish and other seafood for cardiovascular diseases (CVD) via LC omega-3 fatty acids may indeed be enhanced by selenium (Lund 2013).

As a general summary, regular consumption of seafood according to most national dietary recommendations is associated with longer and healthier lives. There is substantial evidence accumulating that this regular consumption is relevant to all life stages from in utero through to old age, as the following content confirms.

Two fish (and other seafood) meals a week is often recommended

Perinatal Nutrition

Seafood plays a significant role in human fertility. Seafood intake is positively associated with several sperm quality parameters and apparent fecundity (Afeiche, Gaskins et al. 2014, Salas-Huetos, Bullo et al. 2017). Seafood consumption is also associated with lower risk of small for gestational age newborns (Amezcua-Prieto, Martinez-Galiano et al. 2018) and lower risk of spontaneous preterm birth in lean women. However, it should be noted that the evidence suggests that seafood consumption is associated with higher risk of preterm birth in obese women (Smid, Stuebe et al. 2018).

The Japan Environment and Children's Study, comprising approximately 75,000 women during and after pregnancy, found that fish intake was associated with reduced risk of psychological distress during pregnancy. Associations with fish oil intake were weaker than for whole fish. (Hamazaki, Takamori et al. 2018). Looking at the issue of mental health in pregnancy more broadly, a systematic review found 22 out of 35 studies showed multivitamin supplementation, fish and PUFA intake, calcium, Vitamin D, zinc and possibly selenium protected against perinatal depression. Fish and other seafood are recognised as being good sources of most of these nutrients (Sparling, Henschke et al. 2017).

Docosahexaenoic acid (DHA) has been incorporated into infant formulae based on its role in infant cognitive and visual development (Forsyth, Gautier et al. 2017). Evidence has shown that fish intake increases DHA levels in breastmilk (Aumeistere, Ciprovica et al. 2018). There is potential to promote seafood consumption in mothers alongside the recommendation to exclusively breastfeed as the ideal and preferred mode of infant feeding to six months of age.

Seafood consumption is associated with better child health outcomes

Childhood and Adolescence

Animal (including fish) protein intake at 12 months of age is associated with increased fat-free mass at age 2–3 years, which may reduce risk of overweight and obesity in adulthood (Smith-Brown, Morrison et al. 2018). There also appears to be some potential beneficial effect of fatty fish intake on cognitive function in children aged 4–6 years, compared to meat (Oyen, Kvestad et al. 2018). In two European studies, fish consumption was associated with academic achievement in adolescents (Kim, Winkvist et al. 2010, de Groot, Ouwehand et al. 2012), but whether these findings can be generalised to other adolescent populations remains to be tested.

Data from the Western Australian Pregnancy Cohort (Raine) Study in adolescents (comprising 843 adolescents) indicated that a dietary pattern including regular fish intake was beneficial in terms of addressing the increasing prevalence of obesity and its consequences. In particular, a dietary pattern high in fruit, vegetables, fish, and whole-grains was inversely associated with BMI and inflammation at 14 and 17 years of age (Oddy, Allen et al. 2018).

Fish may help in reducing the risk of obesity and improve cognitive performance in children and adolescents

Allergy, Asthma

Recent Australasian guidelines recommend oily fish or omega-3 fatty acid supplements during pregnancy to reduce the risk of eczema in children (ASCIA 2018).

The Lifeways prospective birth cohort study, (Viljoen, Segurado et al. 2018) comprised 897 Mother-child pairs. Analysis of this dataset revealed that lower asthma risk was associated with higher daily intake of oily fish and vegetables. Vitamin D intake was also found to be protective, further strengthening the protective effect of fish consumption.

An extensive systematic review comprising five prospective cohort studies for fish intake in infancy showed that fish intake in infancy reduces the risk of the eczema and allergic rhinitis in children. The intake of fish, rather than n-3 LC-PUFAs, was deemed responsible for this effect (Zhang, Liu et al. 2017).

Similarly, a recent meta-analysis of regular fish consumption from an early age, showed specifically that the introduction of fish at 6–9 months and the subsequent consumption of any fish at least once a week reduced asthma and wheeze in children up to 4–5 years old, compared with no fish consumption. Fatty fish intake in particular was identified as being beneficial for reducing the symptoms of asthma and wheeze in older children (Papamichael, Shrestha et al. 2018).

Fish in the diet of children may reduce their risk of asthma

Healthy Ageing

Life Expectancy

Life expectancy (and its quasi-counterpoint all-cause mortality) is an important overarching descriptor of overall health and well-being. In terms of seafood consumption, current epidemiological evidence is somewhat nuanced. Recent comparisons of large national cohort studies found different effects according to sex and ethnic background, as outlined by the following studies.

A secondary analysis of a large national Chinese dataset indicated that increased fish consumption was associated with decreased all-cause and diabetes-related mortality. Although analysis of the American NHANES study did not find an association with all-cause mortality, it did show that higher fish consumption was associated with lower mortality from CVD, Alzheimer's Disease and Diabetes (Jayedi, Shab-Bidar et al. 2018, Zhuang, Wang et al. 2018). This difference in effect between US and Asian populations is reminiscent of the findings of a previous systematic review (Muley, Muley et al. 2014) which showed that fatty fish consumption can decrease risk of T2DM in Chinese, but not US, populations, the latter may indeed experience increased risk (Zhou, Tian et al. 2012). Various mechanisms for this difference have been proposed, but as yet remained unconfirmed.

Analysis of another large US dataset (NIH-AARP) showed gender differences. Fish consumption was associated with lower total, CVD, Cancer, Respiratory disease and chronic liver disease mortality in men, and lower total, CVD and Alzheimer's disease mortality in

women (Zhang, Zhuang et al. 2018). Increased fish intake also was associated with lower risk of developing Alzheimer's type dementia (Zeng, Cao et al. 2017).

In terms of chronic disease in older adults, the Academy of Nutrition and Dietetics identifies the important role of fatty fish in the attenuation of Alzheimer's disease, cognitive decline, CHD, ischaemic stroke and depression (Vannice and Rasmussen 2014). A meta-analysis by Micha et al (Micha, Penalvo et al. 2017) found protective effects of seafood omega-3 oils across a range of potential disease outcomes.

From the perspective of biological aging, emerging evidence suggests that seafood-derived LC omega-3 oils and diets rich in plant antioxidants can preserve telomere lengths (a marker of biological aging) (Freitas-Simoes, Ros et al. 2016). Oily fish and legume intake are associated with later onset of natural menopause, which is associated with better health outcomes (Dunneram, Greenwood et al. 2018).

Heart Health

The process of atherosclerosis commences early in life and progresses through adulthood. The burden increases with advancing age, although the underlying process can be addressed earlier in life through appropriate diet and lifestyle modification. A recent analysis of systematic reviews and meta-analyses of the effects of dietary factors on health outcomes (Micha, Shulkin et al. 2017) indicated a very strong role for omega-3 oils via seafood consumption in reducing coronary heart disease (CVD) risk.

The majority of evidence for fish and other seafood in primary and secondary CVD prevention is through the study of healthy diets in which fish is an important component, albeit observational and therefore of low quality. The large Malmo cohort study (20 000 adults, 45–74 years) recently showed that a diet comprising high amounts of fibre-rich bread, breakfast cereals, fruits, vegetables, fish and low-fat yoghurt, and low amounts of low-fibre bread was associated with a 35% and 18% reduced risk of type 2 diabetes risk in men and women respectively when comparing highest to lowest diet quintiles. Further results showed a lower risk of coronary events and less pronounced weight gain in both men and women whilst a lower risk of ischemic stroke in men (Ericson, Brunkwall et al. 2018). Analysis of the Norwegian Tromso study (3900 adults, 45–74 years) found total fish and lean fish intakes were associated with less atherosclerotic plaque formation, indicating that the cardioprotective effect of fish may be due to more than just the oil content (Johnsen, Jacobsen et al. 2018). A recent systematic review of national advice for cardiovascular disease risk reduction from seven Western countries showed significant consistency in recommending physical activity levels and diets rich in fruit, vegetables, fish and wholegrains (Khanji, van Waardhuizen et al. 2018). A small number of studies suggest fish consumption may prevent or improve metabolic syndrome, with the evidence being stronger for men than women (Torris, Molin et al. 2014). Both fatty and lean fish are implicated (Torris, Smastuen et al. 2018).

In terms of the amount required to generate a positive effect, quantities vary according to the health condition. Supplementing a diet with 2x250g trout servings twice per week was more effective than fish oil supplements in modifying HDL and LDL levels (and thus CHD risk) in a group of healthy adults (Zibaeenezhad, Ghavipisheh et al. 2017). Lower level fish intake levels seem to be protective for hypertension risk, with the optimal intake of seafood being ≤100g/day, with no apparent added advantage of larger intakes (Schwingshackl, Schwedhelm et al. 2017). The American Heart Association has recently concluded that one to 2two seafood

meals per week be included consumed by adults to reduce the risk of congestive heart failure, coronary heart disease, ischemic stroke, and sudden cardiac death, especially when seafood replaces the intake of less healthy foods (Rimm, Appel et al. 2018). This review particularly highlights the role of seafood in displacing unhealthy foods in the diet. The above American recommendations are consistent with Australian Heart Foundation recommendations (Heart Foundation 2018).

Evidence supports fish (and other seafood) as a cardioprotective food

Diabesity

Diabesity is the term used to describe the increasingly common co-occurrence of obesity and type 2 diabetes, which was once considered to be a mature onset condition. With the increasing prevalence of childhood and adolescent overweight and obesity, this diabetes prevalence has moved to early stages of adulthood and indeed adolescence.

A systematic review and meta-analysis of 14 RCTs (Wu, Cahill et al. 2013) found that fish oil can increase circulating adiponectin, thus having a potentially positive effect on diabetes and obesity risk via influences on insulin sensitivity and adipocyte function. Only a minority of these studies focused specifically on fish consumption, so that present knowledge relates only to the omega 3 oil intake. Although there is some indication that omega-3 fish oil supplementation can improve insulin sensitivity (Gao, Geng et al. 2017), no clear evidence has emerged in relation to the effects of fish intake on this aspect of diabetes aetiology.

Fish or fish oil intake has been shown to reduce waist circumference in adults (Bender, Portmann et al. 2014), a common measure of obesity and risk factor for type 2 diabetes.

Omega-3 fatty acids in fish and other seafood are important for metabolic health

Cancer Risk

Notwithstanding extensive examples of relatively rare childhood cancers, the bulk of the burden of cancer occurs in adults and risk increases with advancing age.

There seems to be no substantial evidence that fish consumption *per se* protects against cancer in general. However healthy dietary patterns including fish have been associated with healthier weight status and may offer indirect risk reduction as weight gain is itself a risk factor for some forms of cancer (Zhang, Chen et al. 2018).

This again emphasises the importance of a total diet approach, of which seafood is an important component. For example, a dietary pattern characterized by high intake of fruits and vegetables, whole grains, nuts and legumes, seafood, milk, and other dairy products, was associated with lower colorectal cancer risk (Tabung, Brown et al. 2017).

Associations between seafood and risk of specific cancers have been reported. Maternal fish consumption during pregnancy was inversely associated with leukaemia risk among children diagnosed at a younger than 5 years old age (OR: 0.27, 95%CI: 0.14–0.53) (Dessypris, Karalexi et al. 2017).

A significant inverse association between every additional serving/week of fatty fish intake and endometrial cancer risk was detected in studies conducted in Europe (Arem et al 2012; Terry et al 2002). The lack of association in Asian studies may be because fish is usually fried. (Hou, Yao et al. 2017).

Higher total red meat, fresh red meat, and processed meat intake may be risk factors for breast cancer (Wu, Zeng et al. 2016), and thus seafood may be beneficial as a substitute for such foods.

Evidence is lacking about whether fish and other seafood protects against cancer, however it is a healthier replacement for red and processed meat in a cardioprotective eating pattern

Bone Mineral Density

Inadequate bone density and osteoporosis are most prevalent in the elderly. A plausible mechanism for the role of fish intake in maintaining optimal bone mineral density (BMD) is through its potential impact on systemic inflammation. Insufficient long chain omega-3 intakes in Western populations are thought to enhance underlying whole-body inflammation. Supplementation with LC omega-3 oils can reduce indicators of inflammation in elderly subjects (Buoite Stella, Gortan Cappellari et al. 2018). Chronic inflammation may increase risk of bone fragility, which can be attenuated by regular intake of fatty fish (Longo and Ward 2016).

A recent review of dietary patterns and bone health (Movassagh and Vatanparast 2017) found that a dietary pattern favouring intake of fruit, vegetables, whole grains, poultry and fish, nuts and legumes, and fat-reduced dairy foods had a beneficial impact on bone health via improved bone mineral status, resulting in lower osteoporosis and fracture risk.

Another systematic review and meta-analysis of 10 individual studies (comprising >10 000 subjects), focusing on the omega 3 content of fish, concluded that fish consumption and dietary intake of omega 3 oils in general were associated with enhanced BMD and a corresponding reduction in risk of hip fracture (Sadeghi, Djafarian et al. 2017).

An important dietary role for fish is in its role as a protein substitute for red meat intake. In this context, a systematic review by Perna et al (Perna, Avanzato et al. 2017) determined that diets favouring fish were less harmful to bone mineral density and consequent fracture risk than diets favouring red meat.

In a very specific study on a group of Norwegian men (Rosendahl-Riise, Sulo et al. 2018), diets with low fish intake (18g/1000 kcal energy intake) were associated with higher risk of hip fracture. This relationship was not linear, implying that intake beyond this threshold did not seem to increase protection against hip fracture. In another study (Abdelhamid, Brown et al. 2018, Rosendahl-Riise, Karlsson et al. 2018) by the same research group, this time in older women, higher intakes (50g/1000kcal energy) of lean fish were associated with better BMD.

Fish consumption is associated with better bone health in older people

Mental Health
One systematic review and meta-analysis reviewed a total of 31 studies with a total of 255,076 individuals. Some 21 datasets investigating specifically the relation between fish consumption and depression showed significantly reduced risk. The maximum decreased risk occurred with fish intake that provided 1.8 g/d intake of n-3 PUFA (Grosso, Micek et al. 2016).

The scientific report of the 2015 Dietary Guidelines for Americans Advisory Committee concluded that although current evidence is limited, it consistently shows food patterns emphasising seafood, vegetables, fruits and nuts are associated with reduced risk of depression. (Martinez-Gonzalez and Sanchez-Villegas 2016). Similarly, a large cross-sectional study (n=976) of people with type 1 diabetes showed that a ‘‘Fish and vegetables” dietary pattern was negatively associated with depression score. Importantly in relation to fish consumption, favouring protein over carbohydrate or fat is also associated with lower depression scores. (Ahola, Forsblom et al. 2018)

Fish and other seafood consumption is associated with reduced risk of depression

Eye Health
A large meta-analysis of eight cohort studies (128,988 individuals in total) found that fish consumption protected against age-related macular degeneration, and dark meat fish in particular, eg tuna. (Zhu, Wu et al. 2016).

A major study of 357 Asians with diabetes showed that increased fish consumption was associated with better retinal blood vessel structure and lower risk of severe diabetic retinopathy. Of those subjects without diabetic retinopathy, participants with higher fish consumption had better retinal blood vessel structure (Chua, Chia et al. 2018).

It is important to consider the dietary context within which seafood is consumed. For example, a recent systematic review of 31 studies (3 interventional, 28 observational) showed that higher intakes of dietary fibre, oily fish, and adherence to a Mediterranean diet protected against diabetic retinopathy. However, in this analysis, high total energy intake was associated with higher risk of developing diabetic retinopathy, indicating that overall energy intake should be considered when assessing the health benefits of consuming seafood (Wong, Man et al. 2018).

A further systematic review of 18 food-based interventions showed that high consumption of carotenoid-rich vegetables and fatty fish was beneficial for those at risk of age-related macular degeneration. (Chapman, Jacobs et al. 2018)

Fish consumption supports eye health

Nutrient Composition
The Australian Dietary Guidelines (National Health and Medical Research Council (NHMRC), 2013) say fish and seafood provide energy, protein, selenium, iodine and vitamins A and D as well as omega-3 long chain fatty acids to the Australian diet. Most nutrition-related research on seafood consumption has focused on LC omega fatty acid content as the main component. Comprehensive species-specific information on the fatty acid profiles of seafood can be found at http://www.fishfiles.com.au/Experts/HealthProfessionals/Omega-3-content-of-Australian-seafood for omega-3 content of Australian species. This is not the case for other

micronutrients for which seafood is a recognised good source (iodine, selenium, zinc, vitamin E and vitamin A).

The FAO (Rittenschober, Nowak et al. 2013) has recently compiled uFiSh 1.0-2016, which is a comprehensive database of publicly available nutrient composition of fish and other seafood.

They note that the predominance of available data focuses on fatty acid profiles, with only 10% or less of the data reporting on micronutrients (vitamins, provitamins and minerals). A Portuguese study (Afonso, Bandarra et al. 2016) outlines the tocopherol (vitamin E) content of about 24 species of seafood. These are largely northern hemisphere fish but indicate the potential value of seafood as a vitamin E source. It is important to note that variations in alpha-tocopherol content occurred according to species. For example, Pike-Perch contained about 2.6mg/100g compared to Salmon (1.7mg/100g) and Mackerel (1.6mg/100g). In a dietary context, 100 g portion of salmon can provide around 14% of the US RDA or about 21% of the Australian NRV.

Fish is recognised as a good source of Iodine. However, a recent Norwegian study (Nerhus, Wik Markhus et al. 2018) including six fish species found significant variation in iodine concentrations, from 18 µg/100 g in Atlantic halibut to 1210 µg/100 g in Pollack, indicating significant limitations in recommending intakes of specific species to meet Iodine requirements.

Australian data on iodine content of seafood is available from the Australian Food Composition Database, previously known as NUTTAB and shows levels (per 100g are highest in fish paste (310ug) and lowest in smoked Salmon (4.7ug). Crustacea and molluscs have higher levels than finfish with Blue Mussels containing 267.8ug, raw Oysters containing 162ug, raw Morwong containing 113ug and Pacific King Salmon containing 5ug.

With regard to selenium, Filippini et al (Filippini, Michalke et al. 2018) estimate that fish and other seafood contribute about 30% of dietary selenium in the northern Italian population, which is the highest individual food source in that population.

Long Chain Omega-3 fat content of Australian Seafood

Many fish species are good sources of LC omega-3 oils. The FRDC has studied the LC omega-3 content of a range of Australian fish species extensively (Nichols, 1998). The fish with the highest levels (>400 mg/100g) comprises Swordfish, Alfonsino, Whitebait, Banded Morwong, Bigeye Trevally, Atlantic Salmon, Black Oreo, Blue Mackerel, Smooth Oreo, and Australian Bonito.

Further information can be found at http://www.fishfiles.com.au/Experts/HealthProfessionals/Omega-3-content-of-Australian-seafood.

Conclusion

Emerging scientific studies across a range of age groups and heath contexts continue to support the national recommendations from many countries to consume seafood at least twice per week. Much of the evidence focuses on fish, however national recommendations often expand advice to the consumption of seafood in general, since the oils and micronutrients considered responsible for the health benefits also occur in abundance in seafood other than fish.

Most research evidence tends to focus on disease prevention. However, there is also ample evidence of the benefits of regular seafood consumption for general health and longevity, as well as optimal growth and development. The latter is a very positive portrayal of the benefits and should be emphasised wherever applicable.

Although some species-specific compositional information on micronutrient content is available, currently species-specific consumption recommendations remain based on oil content until better micronutrient data are available.

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Glossary

Aetiology	The progression of a disease.
Adiponectin	A hormone produced by fat cells. Its physiological effects include the reduction of inflammation and atherogenesis (the formation of fatty deposits in the arteries) and enhancement of the response of cells to insulin.
Alpha-tocopherol	Vitamin E
Antioxidants	(in food) A substance, such as vitamin E, vitamin C, or beta-carotene, thought to protect body cells from the damaging effects of oxidation.
Atherosclerosis	Progressive damage (hardening) of the arteries.
Atherosclerotic plaque	Inflexible lesions formed on the inside of blood vessels as a result of atherosclerosis.
Biological aging	A natural process of maturation and gradual deterioration of the body and its functional characteristics, independent of any inherent disease.
BMI	Body Mass Index. Straightforward measure of weight status based on weight for height.
Bone mineral density (BMD)	Measure of the strength of bone.
Carotenoid	A class of phytonutrients. Yellow, orange and red coloured pigments of plant foods, one of which (beta-carotene) is converted by the body into vitamin A.
Chronic disease	A long-lasting condition with persistent effects, usually non-infectious, examples comprising cardiovascular disease, cancer, diabetes and osteoporosis.
Cohort study	A study design where a group (cohort) of subjects is followed over time.
Crustacean	Aquatic arthropod with chitinous exoskeleton including lobster, crab, prawn (shrimp).
DHA	Docosahexanoic acid; a long chain omega-3 fatty acid.
Fecundity	The extent of ability to reproduce; produce offspring.
Eczema	Chronic, inherited skin inflammatory condition.

Epidemiology	The study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems.
Health promotion	The process of enabling people to increase control over, and to improve, their health. It moves beyond a focus on individual behaviour towards a wide range of social and environmental interventions.
HDL	High density lipoprotein. Higher levels generally protective against cardiovascular disease.
Hypertension	High blood pressure.
Inflammation	Part of the body's immune response. When region of the body becomes reddened, swollen, hot, and often painful, especially as a reaction to injury or infection. Chronic inflammation can eventually contribute to some chronic diseases and conditions such as cancers and rheumatoid arthritis.
Insulin sensitivity	The extent to which tissue responds to insulin. An insulin sensitivity decreases as type II diabetes progresses.
Ischemic stroke	A form of stroke caused by brain tissue starved of oxygen.
LC omega-3 oils	Long-chain omega-3 oils comprising a type of essential fatty acid for which seafood are generally the best source.
LDL	Low density lipoprotein; higher levels generally are a risk factor for cardiovascular disease.
Mediterranean diet	Dietary pattern of countries around the Mediterranean Sea characterised by high consumption of vegetables, fruits, cereals, nuts and pulses and olive oil, moderate consumption of animal foods and wine, and low intake of sweets.
Meta-analysis	An analysis method which combines and analyses data from a number of similar studies.
Metabolic syndrome	A group of conditions that often occur together and increase the risk of cardiovascular disease and diabetes, eg obesity, high blood pressure, high blood fats and insulin resistance.
Micronutrients	Vitamins, minerals and trace elements in food.
Mollusc	(seafood) Invertebrate with shell such as mussel, octopus, squid, pippy, oyster.

NHANES	National Health and Nutrition Examination Survey (USA).
Oily/Fatty fish	Fish with a higher content of oil. Examples include sardines, herring, ocean tuna, Atlantic salmon, mackerel, eel, trout, silver warehou, mullet, trevally, sand whiting and snapper.
Perinatal	Close to the time of birth, either before or after.
Preterm birth	A birth that occurs before the due date.
PUFA	Polyunsaturated Fatty Acid.
Quintile	When a dataset is divided into five, each fifth is a quintile.
Retinopathy	Disease of the retina. Diabetic retinopathy is a diabetes complication involving damage to the blood vessels of the eye.
Rhinitis	Irritation and inflammation of the lining inside the nose, often manifested by a runny or stuffy nose.
Small for gestational age	Foetus is smaller than would be expected given the stage of pregnancy.
Systemic inflammation	A state of inflammation that affects the whole body, rather than being localised.
Systematic review	A review of a range of similar studies using a systematic and analysis protocol. Considered to be a high level of evidence.
Telomere	A section of chromosome which affords it protection from deterioration with successive replication. Shortening over time is associated with ageing, mortality and age-related disease.
Type 1 diabetes	Diabetes (usually early onset) due to autoimmune destruction of insulin producing cells of the pancreas.
Type 2 diabetes	A progressive condition in which the body becomes resistant to the normal effects of insulin and/or gradually loses the capacity to produce enough insulin in the pancreas.
Wheeze	A whistling sound made as a person breathes, often indicative of asthma or inflammation of the respiratory tract.