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OMEGA-3 FATTY ACIDS AND HEALTH

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A considerable body of evidence has been published linking consumption of very long chain omega-3 polyunsaturated fatty acids (LCω3PUFA) with health benefits (1). LCω3PUFA are typically ≥20 carbons long and include eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA) and docosahexaenoic acid (DHA). The shorter chain PUFA, alpha-linolenic acid (ALA), is the parent essential fatty acid, although conversion from ALA to LCω3PUFA in the human body is slow and inefficient, particularly when intakes of n-6 PUFA are high (2).

PUFA play a key role in the production of eicosanoids, which are biological substances that can reduce or promote inflammatory reactions depending on the parent fatty acid. Eicosanoids from the ω6 PUFA family may contribute to the formation of thrombus, atheromas and inflammatory disorders (3). In contrast, eicosanoids from the ω3 PUFA family exert anti-inflammatory effects and control genes regulating inflammatory signalling and lipid metabolism (3). The LCω3PUFA are major structural components of membrane phospholipids, regulating membrane fluidity and in transport (4) which may explain their broad impact in the body.

There is strong evidence that LCω3PUFA supplementation may be useful in the secondary prevention of cardiovascular (CV) disease.

DIETARY SOURCES

LCω3PUFA are found mainly in seafood, with salmon, trout and herring being particularly rich sources providing around 2.0g per 100g. White fish contains 0.1-0.4g, while shellfish provide 0.2-1.4g per 100g (5). In the most recent National Diet and Nutrition Survey, average intakes of oily fish in the UK were below the target at just over half a portion a week, while only 24 percent of adults surveyed were consumers of oily fish (6). Beef, pork, game and poultry also make a modest contribution to LCω3PUFA intakes (7).

Fish body oil and cod liver oil are used regularly by 46 percent of males and 34 percent of females (6) and are useful alternative sources of LCω3PUFA when fish consumption is low. Typically, fish oil supplements provide 0.2-0.5g LCω3PUFA per recommended dose. The bioavailability of marine-based supplements has been well documented using accepted measures of LCω3PUFA status (1).

INTAKES AND RECOMMENDATIONS

Few studies have reported figures for LCω3PUFA consumption. Givens & Gibbs (7) estimated LCω3PUFA intakes in the UK diet by combining food composition data with survey data from the NDNS, giving a figure of 0.244g per day. In other countries, intakes of LCω3PUFA vary considerably. The Japanese have one of the highest intakes at 1.0g/d (8), greater than that seen in Northern Europe (0.59g/d), Belgium (0.05-0.209g/d), mid-Europe (0.25g/d), or the US (0.2g/d) (7).

Current UK guidelines are couched both in terms of fish consumption (two portions a week of which one should be oily) and daily intakes of LCω3PUFA, i.e. 0.45g (9). However, SACN acknowledged that the guideline did not 'correspond to the level of fish consumption required for maximum nutritional benefit', which suggests that higher amounts may be needed

Table: Recommended daily intakes of EPA+DHA for adults

Country	Recommended intake of EPA + DHA (g/d)	Authority
UK	0.2	Department of Health (32)
UK	0.45	SACN/COT (9)
Europe	0.2-0.5	European Food Safety Authority (33)
USA	1.0 (with CHD) 2.0-4.0 (with raised lipids)	American Heart Association (34)
USA	0.27*	Institute of Medicine (35)
Australia	0.43 (women) 0.61 (men)	National Health and Medical Research Council (36)
Various	0.5	International Society for the Study of Fatty Acids and Lipids (37)
Various	0.2 (pregnant or lactating)	Koletzko et al (38)

Key: *Estimated from percentage of energy intake, assuming an intake of 8.3MJ/d

for optimal health. UK and international guidelines are presented in the table below.

ROLE OF LCω3PUFA IN HEALTH

There is strong evidence that LCω3PUFA supplementation may be useful in the secondary prevention of cardiovascular (CV) disease (10,11,12). In the last five years, key epidemiological studies have confirmed that up to 1.0g/d PUFA may improve CV health (13). Tavazzi et al (14) found that hospital admissions for CV disease were lowest in those individuals taking 1.0g/d LCω3PUFA when followed up for a four-year period. In another intervention study, 1g LCω3PUFA taken daily for three months improved blood flow, viscosity and inflammatory status in patients with arterial disease (15). Cao et al (16) also reported that daily supplementation with 1.3g EPA and 0.9g DHA for eight weeks significantly increased the omega-3 index (i.e. the sum of EPA + DHA in RBCs as a percentage of total fatty acids), which is a validated marker of CV disease risk (17).

LCω3PUFA may have a role in the management of auto-immune inflammatory conditions such as eczema and rheumatoid arthritis (RA)

LCω3PUFA may have a role in the management of auto-immune inflammatory conditions such as eczema (18) and rheumatoid arthritis (RA) (19). In one randomised, double-blind controlled trial, patients clinically diagnosed with atopic eczema were asked to consume either 5.4g DHA/d (n=21) or a placebo (n=23) for eight weeks (18). The results showed an improvement in atopic eczema symptoms in the active compared with the control group. These results now need to be confirmed by larger studies. A meta-analysis (19) evaluated findings from 17 randomised controlled trials (RCT) on the potential pain relieving effects of LCω3PUFA in patients with RA. Supplementation with DHA and EPA for three to four months was associated with less reported joint pain, morning stiffness, tenderness and use of non-steroidal anti-inflammatory drugs. The authors concluded that LCω3PUFA may be a suitable adjunctive treatment for patients with inflammatory joint disorders.

There has been interest in foetal programming during pregnancy to lower the risk of auto-immune conditions, such as asthma and eczema. Dunstan et al (20) randomised 83 atopic (i.e. 'at risk') pregnant women to receive either fish oil (3.7g LCω3PUFA) or a placebo daily from 20 weeks' gestation until delivery. The results showed that infants from supplemented mothers had significantly higher RBC levels of LCω3PUFA, produced a lower inflammatory response to allergens and, at age one, were three times less likely to have a positive skin prick test to egg. Another RCT provided 311 women with a fish oil supplement containing 0.5g DHA + 0.15g EPA + 400μg folic acid, or a placebo from 22 weeks gestation (21). When the groups were compared, placenta blood levels of allergy-related cells were significantly reduced in the fish oil group. Improving the LCω3PUFA content of breast milk may also deliver immune benefits to infants. An RCT looked at the impact of fish oil supplementation from 20 weeks gestation (3.7g/d LCω3PUFA) on breast milk immunological parameters (22). Breast milk collected three days postpartum from the intervention group was higher in DHA and EPA and there was a significant association between LCω3PUFA levels and beneficial antibodies.

LCω3PUFA during pregnancy and early life also appears to support normal brain and eye development. DHA accumulates rapidly in these organs during the third trimester of pregnancy where it plays a key role in brain neurogenesis, development of visual acuity, neurotransmission and protection against oxidative stress (23). Several studies have examined the impact of maternal LCω3PUFA status on infant development. In a longitudinal survey of 11,875 women, Hibbeln et al (24) found that a lower maternal fish consumption during pregnancy (<340g/wk) was associated with poorer verbal IQ and motor skills in children aged over six months. RCTs of

fish oil supplementation during pregnancy have also found a positive effect on markers of infant development, e.g. better scores in tests of mental processing and improved hand/eye co-ordination (25). An analysis of eight RCTs estimated that increasing maternal DHA intake by 0.1g/day related to an increase in child IQ of 0.13 points (26).

Later in life, LCω3PUFA status may relate to maintenance of cognitive function and reduced risk of dementia (27). In a cohort study, which included 246 subjects aged 63-74 years, a better baseline LCω3PUFA status was associated with a lower risk of cognitive decline four years later (28). A number of studies have also investigated LCω3PUFA or fish consumption in relation to the onset of Alzheimer's disease. In a prospective study of 815 elderly people, Morris et al (29) reported an association between dietary DHA and a significant reduction in the risk of Alzheimer's disease. A review of data from two large observational studies of nearly 6,000 older adults found that regular fish consumption reduced dementia risk by 60 percent and was associated with a slower cognitive decline (30). A systemic review concluded that LCω3PUFA had a role in slowing cognitive decline in healthy elderly people, but that there was insufficient evidence that it prevented or treated dementia, or Alzheimer's disease (31).

While further research is required on emerging areas of health, e.g. cognitive function, there is sufficient evidence on heart health and immune function to continue promoting increased LCω3PUFA consumption across the lifecycle.

CONCLUSIONS

The benefits of consuming LCω3PUFA are clear, but intakes of oily fish remain lower than recommended levels, suggesting that more people could benefit from higher intakes of LCω3PUFA. Concerns about marine sustainability and the perceived risk of fish contamination have increased the popularity of supplements and fortified foods as alternative sources of LCω3PUFA. While further research is required on emerging areas of health, e.g. cognitive function, there is sufficient evidence on heart health and immune function to continue promoting increased LCω3PUFA consumption across the lifecycle. As a result, those people who are consuming no or little oily fish should consider bridging the dietary gap with a marine or algae supplement.

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Questions relating to: *Omega-3 fatty acids and health.*
Type your answers below and then **print for your records.** Alternatively print and complete answers by hand.

Q.1	Why do long chain polyunsaturated fatty acids (LCω3PUFA) impact positively on human health?
A	
Q.2	Which foods provide a good source of LCw3PUFA?
A	
Q.3	Which countries have the highest intake of LCw3PUFA?
A	
Q.4	What evidence is there to indicate that LCw3PUFA may help prevent cardiovascular disease?
A	
Q.5	LCw3PUFA may have a role in improving atopic eczema. Give an example of evidence/findings in this area.
A	
Q.6	What are some of the possible health benefits of taking omega-3 supplementation during pregnancy?
A	
Q.7	Describe one study that links taking fish oils with reduced dementia risk.
A	
Q.8	What recommendations would you make to help increase adult intake of omega-3s in the UK?
A	

Please type extra notes here . . .