Long-Chain Omega-3 (EPA/DHA) for Behaviour and Learning in ADHD and related Conditions, and in the General School Population

Dr Alex J. Richardson, Senior Research Fellow, Centre for Evidence Based Intervention, University of Oxford; and Founder Director of the UK charity Food and Behaviour Research (www.fabresearch.org).

ADHD and related conditions – an increasing problem

In the UK and US, at least one in five of all school-aged children are now affected by Attention-Deficit Hyperactivity Disorder (ADHD) or related conditions - including dyslexia or reading disability (RD), developmental coordination disorder (DCD) and Autistic Spectrum Disorders (ASD). These diagnoses remain purely descriptive, as there are no objective markers for these conditions. In practice, they show substantial overlap with each other, and no clear-cut boundaries distinguish them from normal functioning.

These kinds of behaviour and learning difficulties place a heavy burden not only on affected individuals and families, but on society as whole, owing to their negative lifelong impact on educational, occupational and social outcomes. Effective strategies for their prevention and management are therefore urgently needed.

The role of nutrition – and the importance of long-chain omega-3 fatty acids

The causes of ADHD and related conditions are inevitably complex and multi-factorial; and can differ between individuals with the same clinical diagnosis, complicating both research and management. However, both theory and increasing evidence show that nutrition can play a fundamental role - particularly in early life, as mothers' diets during pregnancy can have a lifelong influence on their children's brain development and functioning, as can nutritional factors in early infancy.

Modern western diets are seriously lacking in EPA and DHA - the omega-3 long-chain polyunsaturated fatty acids (LC-PUFA) found in fish, seafood and some algae.[a] Deficiencies of these key nutrients during early development can affect brain structure and function in many important ways, some of which can increase lifetime risks for difficulties with mood (emotional self-regulation), behaviour and learning.

However, research also indicates that 'it is never too late' for dietary interventions to be of some benefit – as controlled treatment trials, including several carried out by myself and colleagues at Oxford University, have shown that an increased intake of omega-3 LC-PUFA can help to improve both behaviour and learning in children of school age.

Blood omega-3 levels in UK children are low, and directly associated with cognition and behaviour.

Our Oxford group recently carried out the first study to investigate blood concentrations of long-chain omega-3 in children from the UK general school population.[1] In 493 healthy children aged 7-9 years, we found that mean blood concentrations of DHA were < 2% of total fatty acids, and concentrations of EPA+DHA < 2.5%. (In adults, concentrations of EPA+DHA < 4% indicate high risk for cardiovascular disease, and >8% would be optimal).

Furthermore, despite the restricted range of values in our sample, we found that lower blood omega-3 status in these children was associated with both poorer cognitive performance (reading and working memory) and problems with concentration and behaviour (ADHD symptoms), as well as with parent-rated sleep problems.[2]

These findings are only correlational, but they are consistent with existing evidence from randomised controlled trials (RCT) showing that increased dietary intakes of long-chain omega-3 can improve children's behaviour and cognition.

---

[a] Short-chain omega-3 (ALA) from plant sources such as flax, walnuts etc do NOT have the same biological effects as EPA and DHA. Conversion of ALA within the body to EPA and DHA is very limited - especially in the case of DHA, which is now regarded as a dietary essential. (*Brenna et al (ISSFAL) 2009, Alpha-Linolenic acid supplementation and conversion to n-3 long-chain polyunsaturated fatty acids in humans, Prostglandins, Leukotrienes and EFAs, 80:85-91*).

Dietary supplementation with long-chain omega-3 can improve behaviour and learning – both in children with ADHD and related conditions, and in the general school population. Preliminary data indicate that DHA may also improve children's sleep.

Several years ago, our Oxford team reported significant improvements in both behaviour (ADHD symptoms, including inattention, hyperacticity and impulsivity) and learning (reading and spelling progress) in children with DCD following 3 months of dietary supplementation with omega-3 LC-PUFA vs placebo.[3] Benefits of omega-3 for ADHD symptoms in children with ADHD or related behaviour and learning difficulties have subsequently been confirmed in meta-analyses of randomised controlled treatment trials.[4,5]

More recently, we have further shown that 4 months of supplementation with DHA improved both the behaviour (parent-rated ADHD symptoms) and the reading progress of healthy but underperforming children aged 7-9 years from mainstream UK schools.[6]

In subsequent analyses of secondary outcomes from the same RCT sample of healthy schoolchildren (n=362), we found improvements in children's sleep following DHA supplementation.[2] These findings are preliminary and require confirmation, but they are in keeping with both theory and other evidence that omega-3 (and omega-6) fatty acids play important roles in sleep regulation.

Implications for Research and Practice

Randomised controlled trials in both clinical and non-clinical populations have now shown that dietary supplementation with long-chain omega-3 can reduce ADHD-type symptoms, and may also have benefits for reading and other aspects of cognitive performance in children. Further research to confirm and extend these findings is needed, especially with respect to dosage, formulation, and the durability of benefits. Given the purely descriptive nature of ADHD and related conditions, further studies to explore and validate potential biomarkers of response to supplementation would be very helpful.

General population intakes of omega-3 are sub-optimal with respect to general health outcomes, and particularly low in children. Given their safety and general health benefits, increased dietary intakes of long-chain omega-3 offer a promising addition to existing methods of managing child behaviour and learning problems.

---

[1] *Montgomery P, Burton JR, Sewell RP, Spreckelsen TF and Richardson AJ. Low blood Long Chain Omega-3 fatty acids in UK children are associated with poor cognitive performance and behavior: A cross-sectional analysis from the DOLAB study. PLoS One, 2013, 8(6): e66697.*

[2] *Montgomery P, Burton JR, Sewell RP, Spreckelsen TF, Richardson AJ. Fatty acids and sleep in UK children: subjective and pilot objective sleep results from the DOLAB study – a randomized controlled trial. Journal of Sleep Research, 2014, 23(4):364-88, EPub Mar 8, doi: 10.1111/jsr.12135.*

[3] *Richardson AJ, Montgomery P. The Oxford-Durham study: a randomized, controlled trial of dietary supplementation with fatty acids in children with developmental coordination disorder. Pediatrics 2005, 115: 1360-1366.*

[4] *Bloch MH and Qawasmi A. Omega-3 Fatty Acid Supplementation for the Treatment of Children with Attention-Deficit/Hyperactivity Disorder Symptomatology: Systematic Review and Meta-Analysis. J Am Acad Child Adolesc Psychiatry, 2011, 50(10): 991-1000.*

[5] *Hawkey E, Nigg JT.* Omega-3 fatty acid and ADHD: blood level analysis and meta-analytic extension of supplementation trials. *Clin Psychol Rev, 2014, 34(6): 496-505.*

[6] *Richardson AJ, Burton JR, Sewell RP, Spreckelsen TF and Montgomery P. Docosahexaenoic Acid for Reading, Cognition and Behavior in Children Aged 7-9 Years: A Randomized, Controlled Trial (The DOLAB Study). PLoS One. 2012, 7(9): e43909.*