



ASSOCIATE PARLIAMENTARY FOOD & HEALTH FORUM



The links between diet and behaviour

3.30-5.30pm, Wednesday 18 April 2007

House of Lords Committee Room G

Minutes

Introduction

Baroness Miller of Chilthorne Domer welcomed members to the meeting, the second of a series considering the links between diet and behaviour.

Professor Carolyn Summerbell, Teeside University

Carolyn Summerbell's explained that her personal area of expertise is obesity. She was asked by the Food Standards Agency (FSA) in 2005 to lead a systematic review of the effect of nutrition, diet and dietary change on learning, education and performance of children of relevance to UK schools. The aim of the review was to identify and synthesise primary research undertaken to evaluate the effect of nutrition, diet and dietary change on learning, education and performance of school aged children (aged 4-18 years) in the developed world.

Carolyn and the review team followed a standard process for conducting a systematic review. They defined the scope of the review, identified potential studies, applied inclusion criteria and then conducted an in-depth synthesis review of the chosen studies.

The review team looked through a number of databases and abstracts to look for information that would be useful for the review. They only considered: randomised controlled trials (RCTs) or controlled trials (CTs); trials using reasonably achievable diets (excluding those where the dosages used exceed twice the daily recommended amount (DRV) of a nutrient); trials focusing on healthy children of compulsory school age (4 -18 years); trials written in English; and trials in the developing world. However they looked at trials undertaken in any setting and at any time between 1996 and 2005. They found 24,000 potentially relevant publications and whittled those down to 29 RCTs and CTs which they looked at in depth. Of those 29 trials, the majority were undertaken in the USA and 6 were undertaken in the UK.

The bulk of the studies they identified looked at breakfast, some focussed on sugar, 5 focused on fish oils and 2 studies looked at vitamin and mineral supplements, whilst one looked at "good food".

Five fish oil supplementation studies fitted their criteria. All these studies examined the effect of fish oil supplementation in a population aged 5-13 years with symptoms of neuro-developmental disorders (dyspraxia or ADHD). All 5 studies were carried out in the last 5 years and used a placebo controlled study design. The studies - 2 from the UK, 2 from the USA, and 1 from Japan were all of good quality, but the study samples were small (40-117 children) and the duration of the studies was relatively short: they lasted between 2 and 4 months.

Only the two USA studies, *Voigt et al 2001*, and *Stevens et al 2003* measured blood bio-chemistry

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as well as taking into account teacher and parent assessments of the children. Professor Summerbell believes the provision of bio-chemical information is a useful reference point for such trials.

Both the US and the UK studies used fish oil capsules whilst the Japanese study incorporated test oil into pre-prepared food and drink. Importantly, the fatty acid composition used differed by study, with 4 out of 5 studies using a mixture rich in DHA (Docosahexanoic acid). The other study (Richardson 2005) used a mixture rich in EPA (Eicosapentaenoic acid), and it contained GLA (Gamma-linolenic acid).

In addition to the use of varied supplements, different tests were used to test changes in behaviour in the different trials, which makes it difficult to compare the results of them.

Despite increases in blood concentrations of long chain omega-3 fatty acids in the treatment groups, *Voigt* found no significant differences in behavioural and educational outcomes between the treatment and control groups.

The *Stevens* trial detected a small improvement in just 2 out of 16 subjective parental and teacher observations, although blood fatty acid concentrations were shown to correlate significantly with these observations.

Of the remaining three studies, *Richardson*, 2002 showed a small statistically significant improvement in 3 out of 14 subjective parental behaviour scores in the fish oil group.

Hirayama found no significant difference between treatment and placebo groups, apart from a small significant improvement in continuous performance and visual short term memory in the control group only.

The most recent *Richardson*, 2005 study was the only study to report consistent significant improvements in both objective and subjective behavioural and educational outcomes assessed in the EPA rich treatment group.

The review team's findings were that the current evidence base for the effect of fish oil supplementation on learning, education and performance were mixed and therefore inconclusive, but Carolyn made it clear that this is a typical result for a systematic review. She advised caution is necessary when attempting to translate evidence of effect from children with neuro-developmental disorders to otherwise healthy children. She also noted that the dosages in supplements given in trials are unlikely to be achieved through diet alone and concluded that the optimal dose is unclear. Carolyn suggested that more research is needed in countries of relevance to the UK. She concluded by saying that, whilst the importance of diet in educational attainment is unclear, evidence for promoting a diet low in fat, salt and refined sugar but high in fruits, vegetables and complex carbohydrates, remains unequivocal in terms of health outcomes for all school children.

Questions

Lord Baldwin of Bewdley (EB) noted that Carolyn said that all the school children used in the fish oil supplements had neuro-development disorders, but were otherwise healthy and queried the definition of "healthy". Carolyn said that all the children were in mainstream schools. Only the children involved in the fish oil trials and the sugar trials were children with neuro-development disorders. All the other trials had looked at all school children.

EB commented that the FSA had narrowed the focus of the systematic review by restricting it to school children only and asked if Carolyn was aware of any intention on the part of the FSA to conduct a similar systematic review looking at the effect of diet on the behaviour of offenders. **Carolyn** was unaware of any such intention on the part of the FSA.

Dr Ian Gibson (IG) asked Carolyn to suggest the best possible design for a test to achieve the best results. **Carolyn** said it would have to be a large, well-powered clustered RCT in schools. She suggested that all the children in one class should be given a fish oil supplement, whilst the children in a separate class should be given a placebo. She suggested educational experts should be asked to advise on the best possible assessment tests and the trial should last at least a year, with interim tests during the year, so the effect on children's behaviour over time could be measured. This would enable the researchers to identify whether any improvement was immediate, delayed, persisted over time and remained constant.

Baroness Gibson of Market Rasen (AG) asked whether it was frustrating to find after 16 weeks hard work that the results of the systematic review were inconclusive. **Carolyn** said it would be lovely to have clear results, but systematic reviews do help people – both academics and the commissioners of research – to plan future research by identifying areas in which further research is needed. Carolyn added that their consideration of the studies looking at the effect of eating breakfast had demonstrated clear evidence in support of breakfast clubs, which were popular with children, parents and teachers and which led to clear improvements in attendance and behaviour.

Dr Jackie Stordy commented that the Voigt study had involved the use of long chain fatty acids derived from algae, not fish oils and said that the assessment tests used in the five fish oil trials were standardised tests, which had been used over time and internationally to measure changes in behaviour. She also noted that the Richardson test had used both omega-3 derived from fish oils and omega-6 derived from Evening Primrose oil.

Baroness Miller of Chilthorne Domer (SM) asked if the FSA had been looking for links between diet and educational attainment and/or behaviour. **Carolyn** said they wanted to investigate the effect of healthy eating on children, including particularly the introduction of healthier school meals, though they were more interested in educational attainment than behaviour.

Professor David Benton, Swansea University

Professor David Benton has spent 40 years studying biological influences on behaviour, including dietary influences for 20 years. the effect of diet and behaviour. He has just completed a review of the impact of diet on anti-social, violent and criminal behaviour (Neuroscience Behavioural Reviews 2007). This review had considered four key issues: food intolerance, hypoglycaemia, the role of fatty acids and the role of vitamins and minerals. David emphasised, however, that we should look at diet in its entirety because if a food is added to the diet then it is likely that it will displace another food, with possibly negative consequences.

David noted that there is a difference between food aversion, which may be the result of psychological food intolerance, and a biological intolerance to food which may be the result of enzyme defects, the fermentation of food residues, a food allergy or irritants and toxins in the food. He noted that there is a tendency to exaggerate the significance of food intolerance and to make exaggerated claims about it, which he considers unhelpful in terms of providing the public with advice about healthy eating.

David referred to a case study of a patient, "Joanna" who was depressed, irritable and violent to the point where she had knocked out her 3 year old son, thrown her daughter out of a window and had committed self-harm. Joanna had been an in-patient on 13 occasions, she had been diagnosed with schizophrenia, dementia, epilepsy, depression, and hysteria, but she had not responded to treatment and her doctors had reached the stage of proposing brain surgery.

At that point, food intolerance was suspected and Joanna was asked to fast for 5 days, while her drugs were withdrawn under supervision. For the first two days she suffered an adverse reaction and on the third day she felt better. Foods were reintroduced one at a time, with double-blind

testing of suspect foods. The results showed that eggs produced self-mutilation and depression, whilst she also responded negatively to bacon, egg, porridge, veal, tongue, coffee and chocolate.

Joanna returned home, without drugs but armed with a menu. Her GPs's comment was: "Joanna has made a remarkable improvement. She is happy, gay, euphoric... she cares for the children without harming them, looks after her house and generally seems to be almost back to her old self...."

Trials have also been conducted with hyperactive children. David reviewed one study (*Egger et al, Lancet 1985*) which looked at overactive seven year olds with short attention span. These children were fed an oligoantigenic diet consisting of lamb, chicken, potatoes, rice, banana, apple and brassica. Again other foods were reintroduced one by one using double-blind procedures. Slide 13 lists the foods to which children reacted with a percentage figure for the proportion of children reacting to that food. In total a response to 48 foods was noted.

In five similar studies there was a large and consistent effect (the effect size was 0.8 of a standard deviation, a large difference). David noted, however, that all the parents of the children involved in these studies believed – before the studies began – that their children responded to dietary factors, so the results should not be used to generalise about children whose parents do not share this view about their children. David also noted that the frequency of the reaction is not known; no two children's responses were the same; no child only responded to additives; there was no food to which all the children responded; no child responded to only one food. David suggested that this evidence demonstrates that it is not sensible to ban single nutrients, including additives.

David noted that many parents, teachers and pressure groups are concerned about children's sugar intake. His review also looked at hypoglycaemia.

The degree to which blood glucose rises after a meal reflects the amount of carbohydrate and the so-called glycaemic index (GI), the speed at which the carbohydrate is converted into glucose. The presence of protein, fat and fibre are also influential. After a meal, blood glucose levels rise, but then fall when insulin is released. Food stimulated hypoglycaemia is defined as blood glucose levels below 40mg/dl that occur between 2 and 4 hours after eating. Low levels of blood glucose starve the brain and result in blurred vision, slurred speech and even violence.

In normal individuals, fed in a usual manner, clinical hypoglycaemia is uncommon; a normal diet produces remarkably stable levels of blood glucose. However, some people exhibit a tendency to develop low blood glucose levels (higher than those that can be described as hypoglycaemic) associated with irritability and violence. Moreover, criminals with a history of violence have a tendency to develop low levels of blood glucose.

The glycaemia index (GI) depicts some surprising results: where glucose itself has a GI of 100, baked potatoes have a GI of 85, whilst the GI of table sugar is only 65.

David believes the glycaemic load of a meal may be important. He and his colleagues monitored children's ability to attend to work in the classroom and they found that those children who had had breakfast, or who were given a mid morning snack, were better able to attend to the work. So, removing snacks from vending machines in schools may be beneficial in terms of efforts to tackle obesity, whilst being unhelpful in terms of helping children to concentrate.

In another study this year, David and his colleagues took over the running of a breakfast club and provided breakfasts with the same calories but different glycaemic loads to the children on different days. The results showed low glycaemic load was associated with better memory and attention, less frustration and more time was spent on a task in class. David is aware of three or four similar studies, which produced similar results and which, like his, were undertaken since the FSA's 2005 systematic review.

David has looked at three well structured randomised controlled trials (RCTs) which studied the effect of diet on offenders: *Schoenthaler et al 1997*, *Schoenthaler et Biel 2000* and *Gesch et al 2002*. They all showed a consistent pattern of responses and the results are summarised on slide 30. The 1997 trial, using 12 vitamins at 300% RDA and 11 minerals at 100% RDA for 3 months, showed a greater decline in violations with supplements (a difference of 28%). The 2000 trial, using 13 vitamins at 50% RDA and 10 minerals at 50% RDA for 4 months, showed less anti-social behaviour (a difference of 47%) and the 2002 trial, using 13 vitamins, 12 minerals and omega-3 and omega-6 fatty acids for an average of 5 months, showed a decline in violations of 35%.

David distinguished fluid intelligence, described as potential intelligence, from crystallised intelligence (achievement) which is affected by environmental factors. Fluid intelligence can be measured by non-verbal tests.

David has looked at trials which studied the effect of vitamin and mineral supplements on intelligence (*Benton et al, Neurosciences Behavioural Review 2001*). He emphasised that we are a long way from understanding what is going on, but 10 of the 13 studies report improved non-verbal intelligence in at least some children. An improvement in verbal intelligence was never reported. A selective improvement in non-verbal scores could be predicted theoretically and it may be that the inconsistencies are explained by only poorly nourished children responding.

David said there was little association between sugar intake and quality of diet in those over the age of 2 years and associations were “always so small as to be of no clinical significance”. Those who eat a lot of sugar also tend to eat more of all nutrients. However, total energy consumption is a better predictor of micro-nutrient status than the level of sugar intake.

David suggested the strongest evidence for a link between diet and behaviour is in the area of iron deficiency. Children under 2 years of age with iron deficient anaemia often show problems of language, motor coordination, attention and mood. It is generally supposed that “the effects of anaemia on development in infants and young children are not reversible” (International Nutritional Anaemia Consultative Group, 1998). The benefits of iron treatment are more apparent in pre-school children (aged 2-5 years) than in infants. The evidence is limited although improvements in attention and cognition from iron supplementation have been reported. For school age children (5-18 years) there is strong evidence that iron deficient anaemia is associated with poorer cognition and school performance. However, the adverse effects of iron deficiency appear to be more transitory than with younger children.

David drew attention to the results of the National Diet and Nutrition Survey (for detailed results see slide 41) which indicates clear iron deficiency in children. Anaemia in toddlers is common with associated developmental delay; those receiving iron had increased weight gain and rate of development.

David suggested that the evidence of any effect of fish oil supplementation on the behaviour of children with ADHD is inconclusive; where behaviour was influenced it was in studies of dyslexia or developmental coordination disorder. The exceptions were studies of hostility and aggression. He found that in eight studies supplementation decreased reports of hostility/aggression and a meta-analysis produced a moderate effect size of 0.61 of a standard deviation.

David concluded by emphasising that any dietary influence can only affect predisposition. Actual behaviour will be influenced by many other factors including environmental factors, such as peer pressure and family attitudes, and wider cultural factors such as sub-cultural norms and societal norms (see slide 49).

Questions

IG asked if there had been studies in the field of diet and behaviour using twins to isolate genetic factors. **David** said there had been some studies of polymorphisms and serotonin. He emphasised that nutrients have multiple effects. All research requires a theoretical approach; one

obvious way forward would be to look at the way in which nutrition is affected by biochemistry. Serotonin and dopamine are known to be important in aggression. Another important factor to bear in mind is the genetic variation in the fatty acid desaturase enzymes.¹

SM commented that David's presentation seemed to suggest it is very hard to reach any conclusions at all about the links between diet and behaviour. **David** said he had been studying the links between diet and behaviour for 40 years and it is like a huge jigsaw and not susceptible to easy answers. **SM** asked where we should begin if we want to be able to offer the next generation advice. **David** said that the evidence that breakfast is important for the behaviour of children is strong, but if parents or schools are going to provide breakfast they should make it a healthy breakfast. He agreed with **SM**'s suggestion that the focus should be on eliminating negative elements from the diet rather than seeking a "magic bullet". **David** said there was no evidence to suggest healthy children would benefit from supplements; the children most likely to benefit are those who are nutrient deficient.

IG asked if there was any evidence to show that behaviour is related to genetics. **David** said that there is no behaviour that does not have a genetic component and evidence for this had come from twin studies. The next step should be to tease apart the genetic inheritance to identify the particular genes that are relevant.

EB expressed interest in David's focus on the need to eliminate "negative" foods - those linked to food intolerance - from the diet. **David** agreed this was important, but said it was very difficult because there are so many foods to which different people respond and the same person can respond differently to the same food over time. David suggested there is an analogy with vitamins and minerals. The daily recommended intake (DRI) is based on averages – what is necessary for the average person – but the DRI will not be accurate for every individual, some people may need higher dosages.

AG asked whether David's view is that food intolerance is more a psychological than a biological matter. **David** said it was both. A meta-analysis of 26 studies in 1995 had shown no evidence that sugar is a problem for children, but many parents and teachers believe it is. He said there is a risk that expectations become self-fulfilling and he suggested parents should not focus on single factors. He also said subjective assessments should be tested in double-blind trials.

Mrs Valerie Moore and Lianne Quantrill of Eaton Hall School, Norfolk

Valerie Moore spent 15 years working in a large, mainstream comprehensive school before deciding to work with boys with behavioural problems. She has been the Head Teacher at Eaton Hall School since 2000. She and her colleagues had become involved in the fish oil study simply because they wanted to explore every means to get the best out of their children.

Eaton Hall School is the only school in Norfolk for boys with social, emotional and behavioural difficulties. It caters for boys aged 5-11, covering a spectrum from boys who are introverted and emotionally fragile to extremely aggressive children. A large proportion of their boys are from damaged backgrounds and have been excluded from mainstream schools. Many of the boys have histories of child abuse and referrals to child psychiatrists and educational psychologists are common. Characteristically many pupils arrive with low motivation, low self-esteem, classroom learning habits have been forgotten and many are on a variety of prescription drugs.

¹ Members may like to refer to the article from The Nutrition Practitioner, Summer 2006, (Omega-3 fatty acids for child behaviour, learning and mood: ADHD, dyslexia, dyspraxia, autism and related conditions, Richardson) previously circulated. On page 2 it argues some chromosomal regions "contain genes known to code for enzymes involved in fatty acid and membrane phospholipids metabolism." On page 3 it argues "the expression of any such individual genetic differences will depend heavily on the dietary intake of fatty acids, both during development and throughout life."

The school has twin aims: reintegration of the boys into the family setting and, in as many cases as possible, reintegration into mainstream schools.

The school has had good results from CSCI and Ofsted and it is waiting for the results of its application for Special Behaviour Status. It is also in the final stages of securing Team Teach Gold Standard.

Boys begin by boarding fortnightly with gradual progression to non-residential status by the end of year 9. Each pupil has a teacher tutor and a personal tutor, who together devise an Individual Social Programme and an Individual Education Programme for the boy, which are reviewed on a termly basis.

The school runs a full National Curriculum across three key stages and over the last 7 years the school has worked extremely hard to raise the level of achievement for all pupils. The school's "valued added" rating is A and A*. Last summer all year 11 boys passed a full range of GCSEs, including Maths, English and Science.

The school itself is made as physically attractive as possible, with pupils work on display and rooms for displaying pupil achievement. There is also a school reward system, which is respected by the boys.

Since Valerie became Head, the school has also been involved in the Healthy Schools programme and it has gained the standard required in all 5 areas. The Domestic Bursar, Head Cook and the teaching assistant led the healthy eating initiative for all pupils. The staff and pupils became involved in a fitness challenge, led by the Head of PE, which has been highly successful. Valerie commended the highly professional and passionate staff with whom she works and said together they had achieved significant improvements within the school.

Concern about the number of pupils arriving with large amounts of medication led Lianne to approach Valerie with information about fish oil trials that had been conducted elsewhere.

Under the guidance of a consultant psychiatrist the school removes pupils' medication for a trial period to see if they are able to employ other strategies to control their behaviour. Where this is successful the medication is discontinued.

The school held extensive discussions about the use of fish oils and after consultation with the Governors and other recommended authorities decided to pursue the idea, with the support of Dr Ian Gibson (the constituency MP) and Madeline Portwood, a senior educational psychologist from Durham LEA. Many staff were sceptical about the trial and persuading the boys to take the supplements could have been difficult, so they decided to enrol all the staff as well as the boys in the trial. Valerie emphasised that the trial was only one part of an intensive effort to create an environment in which the boys can learn to change their behaviour patterns.

The staff felt the trial was very successful. [NB Valerie did not discuss the results in detail because these have been circulated to members of the inquiry team and they will be circulated again with these minutes.] Some parents have told them that they have definitely seen a change for the better in their son's behaviour and the staff have certainly seen a change in some pupils. They believe if fish oil supplementation can help one child, and help to make the child less dependent on medication, then it is worthwhile. The staff accept that any improvements in the boys' behaviour are likely to be due to a combination of influences, and the staff are constantly striving to improve the lives of their pupils, but Valerie and her colleagues would certainly support more research in this area.

SM invited **Lianne Quantrill** to add any additional points which she felt were important. Lianne said that the staff's focus had been the welfare of the pupils, rather than contributing to academic research, so they had wanted to involve all the boys in the trial, which they accepted made it less worthwhile in terms of academic research. Lianne highlighted some of the key findings: a 69%

reduction in physical management statistics were recorded for the boys on fish oil supplements, whilst the reduction for boys who dropped out of the study was 50%. The staff see a correlation between behaviour and attendance for those boys using the supplements, but they accept this does not amount to evidence of cause and effect.

Questions

AG asked how the school was funded and how the boys were selected. Valerie said the school was an LEA school. The boys have all been excluded from mainstream schools and they all have statements. Before they are accepted they go before an Advisers Panel, which considers whether the school can help them. The boys are all quite intelligent.

The Countess of Mar (MM) asked whether the school is going to continue to use fish oil supplements. Valerie said that many of the staff and boys would continue to take supplements, which they had been offered by Equazen, the company responsible for supplying the supplements for the trial. Oily fish is also offered on the school menu three times a week.

SM asked whether breakfast is provided. **Valerie** said the boarders all have breakfast and non-residential boys are offered breakfast if the staff believe they need it. A varied breakfast menu is offered, including porridge, cereals and toast.

Valerie was asked whether snacks were available in the school. She said that the Healthy Schools Project had led to changes in the snacks available, which now include nuts, fruit and carrot sticks.

IG asked whether the staff noticed a change when the boys stopped taking the supplements. **Lianne** said the trial had ended in June, when the school stopped for a 6 week summer holiday, so there had been a natural break. The staff had noticed a deterioration in the boys behaviour, but being at home may have contributed to this, particularly for the boys experiencing family problems.

IG asked if they were aware of similar schools taking part in similar studies. **Lianne** referred to a school in Bolton, which was using flaxseed oil supplements delivered to their pupils in smoothies, but the results of this study are not yet available.

Jennie Lisle of the Royal College of Physicians Faculty of Public Health suggested the extremely supportive environment offered by the school may have contributed to the boys' improved behaviour. **Valerie** agreed that the school environment certainly helped the boys and said that parents typically notice a big improvement when the boys have been at the school for three months. However, the Healthy Eating project had been introduced two years ago and parents and staff had seen an additional improvement in the boys' behaviour over the period of the trial.

Andrew Thomas, Head of the Cotswold Community School, and Dr Jackie Stordy

Andrew Thomas said there were many similarities between Eaton Hall School and the Cotswold Community School (CCS). They worked with a similar client group – boys with Emotional Behavioural and Social Difficulties. The CCS is one of four NCH (The Childrens Charity) independent special schools. It was the first therapeutic community and residential school when it opened in 1967. NCH took it over two years ago, when he became the Principal. Before that it had spent four years without a Principal, so leadership was lacking. He needed to make a number of changes when he arrived and further changes are still necessary. One of his first actions, however, was to focus on the health of the boys and he employed a Health and Therapy Manager to improve the boys' health. This improvement in diet started in February 2005 and nine months later they were awarded the Health Schools Award. In March 2006 the school considered starting food supplementation. The school was introduced to Dr Jackie Stordy by Efamol Ltd, the company who supplied the supplements used in their study following Andrew's initial approach to them.

Jackie Stordy

Jackie Stordy explained that she had worked for 32 years at Surrey University, she then spent a few years in industry and she is now an independent nutrition consultant.

Jackie said the study at CCS had been established to investigate the effect of long chain polyunsaturated fatty acid (LCP) supplementation on boys with severe behaviour and emotional problems.

Before the study began one set of Connors' rating scales were completed for the boys by parents and teachers to establish a baseline and after 20 weeks of supplementation the same tests were completed again. Jackie emphasised that the Connors' rating scales are well established tests that are used to measure changes in behaviour. The school also maintained a continuous record of incidents, restraints and grades of restraint throughout the baseline (11 weeks) and supplementation periods.

The participants were 19 boys at CCS, aged 8-16 years. One of the boys was receiving medication for ADHD (methyl phenidate); one boy refused to take the supplement; and in the case of another boy consent to take the supplement was withheld. The supplement supplied, Efalex, contained 480mg DHA, 108mg EPA, 96 mg GLA, 36mg AA and 30mg vitamin E.

After 20 weeks, they measured the changes in behaviour and found that the teacher ratings recorded a 26% decrease in oppositional behaviour; a 22% decrease in cognitive problems/inattention; a 32% decrease in hyperactivity and a 35% decrease in social problems. Overall the teacher ratings showed a 26% decrease as measured by the ADHD Index, a 29% reduction in CGI restless impulsive behaviour and a decrease of 20% in the Conners' Global Total. When the DSM-IV Global Scale results were assessed they found a 27% improvement in inattention, a 25% improvement in hyperactive-impulsive behaviour and an overall total improvement of 26%.

Some things did not change during the supplementation period. They found no improvement in anxious/shy behaviour or for perfectionism or for CGI emotional lability.

Jackie showed some slides which use T scores to measure how the boys' behaviour compares with that of the general population. When T scores are used a low score is good, the ranges are:

- 70+ markedly atypical, significant problem
- 66-70 moderately atypical, significant problem
- 61-65 mildly atypical, possible significant problem
- 56-60 slightly atypical, raise concern
- 45-55 average should not raise concern

The mean T scores of the boys were measured before and after the 20 supplementation period and they were rated by both the teachers and the parents. In almost all cases the T scores fell after supplementation, according to the teacher rating. The exceptions were perfectionism (which was low before supplementation) and the emotional rating which remained the same. The parent ratings (carried out by the boys' house masters) found no or little change for hyperactivity, perfectionism and psychosomatic problems and overall the differences were small.

The school records showed a marked reduction in the number of incidents (39%), the number of incidents requiring restraint (51%) and the grade of restraint necessary (47%) in the boys who took the supplement, there were no statistically significant changes in the boys who did not.

Jackie noted that the individual response of the boys was very variable.

Before he took the supplement the boy who was also taking methyl phenidate had the highest possible score (90) for 10 factors measured by T scores. After taking the supplement his oppositional behaviour T score fell from 90 to 60 (almost normal) and only one factor still had a score of 90.

Jackie pointed out that individuals also respond differently in different environments. There was a marked difference for the boy taking methyl phenidate between the school and “home” environment.

The T score tests showed no significant change in the boys who did not take the supplement.

Jackie summarised the results by saying they showed supplementation was associated with improved scores for social problems and ADHD behaviours, with some boys moving from significant problems to population averages.

Jackie’s working hypothesis is that these behavioural problems can be reinforcing through the generations as a result of a genetic predisposition which results in some people having more difficulty than others in converting essential fatty acids (EFAs) to long chain polyunsaturated fatty acids (LCPs). Parents with genetic problems and low LCP intake find parenting difficult; their babies are born with genetic problems and low LCP status; infants with problem behaviours are difficult to parent; children with genetic problems, LCP deficiencies and a poor parenting history are likely to be children with social, emotional and educational problems.

Questions

AG asked how the CCS is funded and how the boys are selected. **Andrew** said that the fees are normally paid by social services and education departments but in some cases funding is also contributed by Health Departments. Referrals tend to be made by social workers. Age is an important factor when consideration is being given to accepting a boy. The school likes to be able to work with the boys for at least three years. Most of the boys have significant social and emotional problems, but they do not take boys with severely entrenched delinquent behaviours. It works with boys who have suffered significant emotional, sexual or physical abuse. Most of the boys have full care orders.

AG asked for confirmation that all the pupils at CCS were boys. Andrew confirmed they are all boys and **Jackie** added that it is known that the conversion of omega-3 EFAs to LCPs (HUFAs) is less efficient in males than females.

SM asked how CCS measures success. **Andrew** said the school considers it has succeeded if a boy is able to form attachments to other boys, the adults and the school community. Many of the boys will not have had any primary attachment to a parent when they arrive at the school. His key measure of success is whether a boy can manage in the outside world when he leaves.

MM asked what contact if any the school has with boys after they leave and whether some of the boys were able to return to mainstream schools. **Andrew** said none of the boys had made enough progress in the two years he had been Principal to enable them to return to mainstream schools, but some of the boys who had been 52 week a year boarders had been fostered successfully.

Baroness Miller thanked the speakers for their presentations and the meeting ended.

CLC, April 2007