

Healthy eating advice as part of drug treatment in prisons

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Introduction

Evidence-based healthy eating advice is being introduced as part of drug treatment interventions in High Security prisons. Such advice will be modelled around the Food Standard Agency's main messages, such as choosing healthier fats, eating at least five portions of fruit and vegetables a day, eating less salt, eating more fish, and following the dietary recommendations represented by the 'eatwell plate' — the FSA's pictorial representation of a balanced diet.

Additional emphasis will be placed on how diet and eating patterns can affect mental health (mood and behaviour). Since negative mood often accompanies, and is a trigger for, drug use, this is of particular significance to prisoners undergoing treatment who wish to remain drug-free.

In addition to their mental health, drug users have other specific health concerns which can be improved or worsened with quality of diet. Poor food choices and disordered eating patterns are common amongst active drug users and these habitual behaviours can persist, even when individuals abstain from drug use. Hepatitis C and other drug-related infections are widespread amongst people who use drugs. Deteriorating health and the prospect of premature death can impact on mood, so the maintenance or improvement of physical health through diet is an added incentive for those in treatment to improve their diets.

Physical exercise, which has a positive impact on both physical health and mood, is already encouraged for prisoners undergoing drug treatment, and healthy eating advice complements this.

It is important that dietary advice relating to mood and behaviour is backed up with relevant research, some of which is presented here.

Nutrient intervention behaviour studies in prisons

Over recent years, research has demonstrated that improving the nutritional status of prisoners through

micronutrient supplementation can improve their anti-social and offending behaviour.

In the United States, Stephen Schoenthaler conducted a study involving 402 young adult male prisoners, making up 90 per cent of the population of two California institutions¹. He found that offenders with low blood vitamin concentrations were significantly more likely to commit rule violations than offenders with normal concentrations. When given multi-vitamin and minerals at either 100 per cent or 300 per cent of US recommended daily allowance (RDA) or placebo for 15 weeks, behaviour in the placebo group deteriorated, but improved in both active intervention groups, with a statistically significant improvement between the 100 per cent RDA group compared to placebo. In another placebo-controlled study, the Oklahoma trial, Schoenthaler demonstrated behavioural improvements amongst juvenile delinquents in a correctional facility, following micronutrients supplementation (plus nutrition advice to individuals who displayed physical signs of micronutrient deficiency at the start of the study)². Blood tests demonstrated that the greatest decreases in violence were seen in individuals whose low micronutrient levels were corrected over the course of the study.

In the UK, Bernard Gesch conducted a rigorous randomised double-blind, placebo controlled study of 231 young offenders at Aylesbury YOI and found that supplementation with vitamins, minerals and fatty acids resulted in 26.3 per cent fewer offences in a treatment group than with a placebo control group³. This research is now being extended to a larger three-year trial involving 1,000 young offenders. The Dutch Prison Service found similar improvements in their own recent study, which is soon to be published, and they, like Schoenthaler, found a deterioration of behaviour in their placebo group.

Earlier this year, the Associate Parliamentary Food and Health Forum⁴ gave support to these findings in the report on their inquiry into the link between diet and behaviour. They recommended that:

1. Schoenthaler S, Bier I D (2002) Food addiction and criminal behaviour – The California randomized trial. *Food Allergy and Intolerance* 731–746. Saunders.
2. Schoenthaler S et al (1997) The effect of randomized vitamin-mineral supplementation on violent and non-violent antisocial behaviour among incarcerated juveniles. *Journal of Nutritional & Environmental Medicine* 7:343–352.
3. Gesch C B et al (2002) Influence of supplementary vitamins, minerals and essential fatty acids on the antisocial behaviour of young adults. *British Journal of Psychiatry* 81:22–28.
4. Associate Parliamentary Food and Health Forum (2008) *The Links between Diet and Behaviour*.

1. NOMS give serious consideration to any dietary intervention that can be used to improve the behaviour and mental wellbeing of offenders.
2. NOMS look positively at the case for introducing nutrient-based standards for meals in prisons, similar to those introduced for schools, but based on recommended daily intakes for adults.
3. Effective measures should be taken in all prisons to inform prisoners about the benefits of a good diet and to persuade and encourage them to make healthy choices, both while they are in custody and after their release.

Diet and factors affecting substance misuse

Prison studies to date have not specifically looked at nutrition in relation to drug-taking behaviour. Substance-misuse remains a major factor in recidivism and if this could be reduced through improvement of nutritional status, it could be a cost effective means of helping to tackle this problem. Micronutrient supplementation is used in some residential drug treatment programmes in the United States, often with intravenous infusion during detoxification. Although practitioners of these methods are convinced by their results, the reported benefits of such treatment in relapse prevention are not yet backed up by rigorous double-blind, randomised placebo controlled trials. Also the wisdom of providing a 'magic pill' or, even more so, a syringe to individuals already having a substance dependency is questionable.

Certain dynamic factors are recognised as contributing to drug relapse and recidivism; amongst them are mental health and particular negative behaviours⁵. If it were possible to influence these by improving diet, this would mean that such an improvement in diet could indirectly contribute to reducing risk of drug relapse.

A number of studies have suggested links between poor diet and depression, anxiety, impulsivity and aggression. Specific micronutrients have been studied in relation to mood and behaviour and these include:

omega-3 fatty acids, folic acid, zinc, magnesium and vitamin D. For some individuals, the amount of refined carbohydrates, the timing of meals and caffeine levels may also impact on their mood and behaviour.

Omega-3

The omega-3 polyunsaturated fatty acids EPA and DHA, which are found in oily fish and other marine life, are important to the structure and function of human nerve cells. It is these two fatty acids that have predominantly been studied in relation to mood and behaviour. Although the human body can manufacture some EPA and DHA for itself from ALA, another omega-3 fat found in plants, it will do this inefficiently when a diet is high in omega-6 fatty acids. Omega-6 is the predominant fat of plant oils such as soya, maize and sunflower, which are ubiquitous in the modern Western diet. It therefore seems likely that such diets poor in omega-3, but high in omega-6, might negatively impact on brain function and neurotransmission. Joseph Hibbeln calculated for separate countries, what an individual's required daily dietary intake of total omega-3 would be in order for that country to match Japan's low levels of cardiovascular and mental illness⁶. This calculation took into account the average daily consumption of omega-6 in

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that country, and for the UK, he estimated 1.6g omega-3/day (equivalent to several standard fish oil capsules) would be needed. This figure would reduce dramatically if less omega-6 was consumed.

Omega-3 and depression

Several placebo-controlled studies have looked at the effects of marine-derived omega-3 on various states of depressed mood, including bipolar and clinical (unipolar) depression, non-clinical depression and chronic fatigue syndrome. A meta-analysis of 12 of these studies found that, although there was a lack of evidence about the positive effect of omega-3 fatty acids on other states of depressed mood, the data suggested that omega-3 supplementation

5. Andrews D A (1989) Recidivism is predictable and can be influenced: using risk assessments to reduce recidivism. *Forum on Correction Research* 1(2):11–18.
 6. Hibbeln J R et al. (2006) Healthy intakes of n-3 and n-6 fatty acids: estimations considering worldwide diversity. *American Journal of Clinical Nutrition* 83(suppl):1483S–1493S.

could positively affect major clinical depression⁷. Another meta-analysis, which looked at the effect of omega-3 in treating a range of psychiatric disorders, found that there was a significant benefit for treatment of major and bipolar depression, though less benefit for schizophrenia⁸. A more recent Cochrane review looked at the effect of omega-3 on bipolar disorder alone⁹. Although only a small number of studies met their rigorous criteria for inclusion and only one of these provided data for analysis, it suggested that as an adjunct, omega-3 could relieve the depressive but not the manic symptoms of bipolar disorder.

Omega-3 and anxiety

Fewer studies have looked at omega-3 and anxiety. Two studies have shown that omega-3 supplementation is associated with a lowering of the production of stress-related chemicals^{10,11} and for one of these chemicals, cortisol, lowered levels are associated with reduced anxiety.

More interestingly, Laure Buydens-Branchey studied the relationship between anxiety and omega-3 in drug users¹². A group of cocaine, heroin and alcohol users undergoing treatment (although not all abstained during the period of the trial), who were given omega-3 for three months, showed a significant decrease in anxiety compared to a placebo control group, which continued for three months after the omega-3 had been discontinued.

Omega-3 and impulsivity

Impulsive behaviour, which includes ADHD, self-harm, homicide and suicide, has been studied in relation to omega-3. Impulsivity is generally recognised to be a risk factor for most types of offending, according to the 'What Works' literature.

Studies looking at omega-3 and ADHD have been conducted only in children, despite it being recognised that ADHD can persist into adulthood and be associated with other mental health problems such as depression, bipolar disorder and schizophrenia. ADHD is one of the most significant predictors of substance misuse in adolescents¹³. In the UK, 3 per cent of adults in the general population are estimated to have ADHD compared to 25 per cent of the prison population¹⁴, and amongst prisoners identified as having ADHD, substance misuse is a common comorbidity¹⁵.

Although some studies using DHA did not have an effect on ADHD^{16,17}, high dose fish oil^{18,19} and fish oil plus micronutrients²⁰ containing both EPA and DHA, resulted in significant improvements in children with ADHD. Fish oil plus evening primrose oil had significant positive effects in children with development coordination disorder, including improvements in behaviour, reading and spelling²¹.

Lower levels of omega-3 in the body have been found to be associated with self-harm and impulsivity²². In a study of patients with a history of acute self-harm, supplementation with high dose omega-3 for 12 weeks, resulted in significant improvements in

7. Appleton K M et al (2006) Effects of n-3 long-chain polyunsaturated fatty acids on depressed mood: systematic review of published trials. *American Journal of Clinical Nutrition* 84:1308–1316.
8. Freeman M P et al. (2006) Omega-3 fatty acids: evidence base for treatment and future research in psychiatry. *Journal of Clinical Psychiatry* 67:1954–1967.
9. Montgomery P, Richardson A J (2008) Omega-3 fatty acids for bipolar disorder. *Cochrane Database of Systematic Reviews Issue 2*. Art No.:CD005169 DOI: 10.1002/14651858.CD5169.pub2.
10. Yehuda S et al (2005) Mixture of essential fatty acids lowers test anxiety. *Nutritional Neuroscience* 8 (4):265–267.
11. Hamazaki K et al (2005) Effect of omega-3 fatty acid-containing phospholipids on blood catecholamine concentrations in healthy volunteers: a randomized, placebo-controlled, double-blind trial. *Nutrition* 21(6):705–710.
12. Buydens-Branchey L, Branchey M (2006) N-3 polyunsaturated fatty acids decrease anxiety feelings in a population of substance abusers. *Journal of Clinical Psychopharmacology* 26(6) 661–665.
13. Gau S S F et al (2007) Psychiatric and psychosocial predictors of substance use disorders among adolescents. *British Journal of Psychiatry* 190:42–48.
14. Anderton P, Brown S (2004) Attention deficit and hyperactivity disorder – a criminal justice based approach. Annual Meeting of the Children and Adults with Attention-Deficit/Hyperactivity Disorder.
15. Rösler M et al (2004) Prevalence of attention deficit/hyperactivity disorder (ADHD) and comorbid disorders in young male prison inmates. *European Archives of Psychiatry and Clinical Neuroscience* 254(6):635–671.
16. Voigt R G et al (2001) A randomized double-blind placebo-controlled trial of docosahexaenoic acid supplementation in children with attention-deficit/hyperactivity disorder. *Journal of Pediatrics* 139(2):189–186.
17. Hirayama S et al (2004) Effect of docosahexaenoic acid-containing food administration on symptoms of attention-deficit/hyperactivity disorder – a placebo-controlled double-blind study. *European Journal of Clinical Nutrition* 58(3):467–473.
18. Richardson A J, Puri B K (2002) A randomized double-blind placebo-controlled study of the effects of supplementation with highly unsaturated fatty acids on ADHD-related symptoms in children with specific learning difficulties. *Progress in Neuropsychopharmacology & Biological Psychiatry* 26(2):233–239.
19. Stevens L et al (2003) EPA supplementation in children with inattention, hyperactivity, and other disruptive behaviors. *Lipids* 38(10):1007–1021.
20. Sinn N, Bryan J (2007) Effect of supplementation with polyunsaturated fatty acids and micronutrients on learning and behavior problems associated with child ADHD. *Journal of Developmental & Behavioural Pediatrics* 28(2):88–91.
21. Richardson A J, Montgomery P (2005) The Oxford-Durham Study: A randomized, controlled trial of dietary supplementation with fatty acids in children with development coordination disorder. *Pediatrics* 115(5): 1360–1366.
22. Garland M R et al (2007) Lipids and essential fatty acids in patients presenting with self-harm. *British journal of Psychiatry* 190:112–117.

depression, suicidal tendencies and daily stress scores compared to the placebo group, but not in impulsivity, aggression and hostility²³.

Joseph Hibbeln has demonstrated significantly higher rates of homicide amongst countries with lower seafood consumption²⁴. Although confounding factors such as alcohol consumption and law enforcement could not be controlled for in this study, the author pointed out several factors that add confidence to the findings: 1) that the homicide and seafood statistics both come from single sources; 2) that death by homicide is easily identified and 3) that even if Asian countries were omitted because of potential confounds comparing East and West, the results are not significantly different. Hibbeln also found a strong correlation between increasing consumption of the omega-6 in vegetable oils and increasing homicide mortality rates over the period 1961–2000, in five western countries: Argentina, Australia, Canada, the US and the UK²⁵.

A relationship between omega-3 level and suicide was suggested in a study which found that the seasonal dips in levels of omega-3 tested in healthy volunteers were followed by significantly raised levels of violent suicide in the general population in Belgium²⁶. Omega-3 present in neural cell membranes and can influence the functioning of neurotransmitters including serotonin which has a role in depression and suicide, and likewise demonstrates seasonal variation. The reasons for such seasonal variations are not yet fully understood, but may be influenced by light or temperature.

Omega-3 and aggression

Observational studies have looked at how omega-3 levels relate to levels of aggression and violence in different populations. One study suggested that amongst young adults, higher dietary intake of DHA and consumption of oily fish is associated with lower levels of hostility²⁷.

Raised production of stress-induced chemicals, manufactured from omega-6 and associated with fear, anxiety and defensive or violent behaviour, is associated with low levels of omega-3²⁸.

Low levels of the neurotransmitters serotonin and dopamine may be related to low levels of omega-3. This has been noted in alcoholics²⁹ including those with a history of violent, impulsive behaviours³⁰.

A number of placebo-controlled studies have looked at the effect of omega-3 supplementation on levels of aggression. David Benton's meta-analysis of eight studies found aggression to be significantly less in those taking supplements³¹.

Buydens-Branchey found that low fatty acid levels were

associated with aggression in cocaine addicts³² and low fish intakes were associated with a history of assaultive behaviour in substance abusers attending a substance abuse clinic³³. When this group were given high levels of omega-3 for three months while in treatment, they showed a significant decline in anger scores compared to controls. Post supplementation, anger levels increased again over the next three months but did not return to the previous level.

One study suggested that amongst young adults, higher dietary intake of DHA and consumption of oily fish is associated with lower levels of hostility.

23. Hallahan B et al (2007) Omega-3 fatty acid supplementation in patients with recurrent self-harm. *British Journal of Psychiatry* 190:118–122.
24. Hibbeln J R (2001) Seafood consumption and homicide mortality. *World Review of Nutrition and Diet* 88:41–46.
25. Hibbeln J R et al (2004) Increasing homicide rates and linoleic acid consumption among five western countries, 1961–2000. *Lipids* 39 (12):1207–1213.
26. De Vriese S et al (2003) In humans, the seasonal variation in poly-unsaturated fatty acids is related to the seasonal variation in violent suicide and serotonergic markers of violent suicide. *Prostaglandins, Leukotrienes, and Essential Fatty acids* 71(1):13–18.
27. Iribarren C (2004) Dietary intake of n-3, n-6 fatty acids and fish: relationship with hostility in young adults – the CARDIA study. *European Journal of Clinical Nutrition* 58:24–31.
28. Hibbeln J R et al (2004) Omega-3 status and cerebrospinal fluid corticotrophin releasing hormone in perpetrators of domestic violence. *Biological Psychiatry* 56:895–897.
29. Hibbeln J R et al (1998) Essential fatty acids predict metabolites of serotonin and dopamine in cerebrospinal fluid among healthy control subjects and early- and late-onset alcoholics. *Biological Psychiatry* 44:235–242.
30. Hibbeln J R (1998) A replication study of violent and nonviolent subjects: cerebrospinal fluid metabolites of serotonin and dopamine are predicted by plasma essential fatty acids. *Biological Psychiatry* 44:243–249.
31. Benton D (2007) The impact of diet on anti-social, violent and criminal behaviour. *Neuroscience and Biobehavioural Reviews* 31:752–774.
32. Buydens-Branchey L et al (2003) Polyunsaturated fatty acid status and aggression in cocaine addicts. *Drug and Alcohol Dependence* 71:319–323.
33. Buydens-Branchey L, Branchey M (2008) Long-chain n-3 polyunsaturated fatty acids decrease feelings of anger in substance abusers. *Psychiatry Research* 157:95–104.

Omega-3 and drug taking behaviour

Buydens-Branchey also found that amongst the cocaine addicts undergoing treatment, those who relapsed within three months had shown lower blood concentrations of omega-6, and omega-3 (although non-significant) at the start of treatment compared to those who did not relapse within this period³⁴. In fact, levels of these fatty acids at the start of treatment were a better predictor of relapse than cocaine use, socio-demographic or clinical parameters.

Recently, in a small pilot study, Buydens-Branchey followed 35 patients attending drug treatment for one year, during which time dietary questionnaires and blood samples were taken on a quarterly basis and relapse rates monitored on a monthly basis³⁵. Overall, baseline levels of DHA alone and of total omega-3 were significantly elevated in the non-relapsers compared to the relapsers who completed the study, and also compared to these relapsers plus non-completers (the majority of whom had also relapsed).

Folic acid

Folic acid is found in dark green leafy vegetables, beans and pulses and brown rice, as well as fortified products such as breakfast cereals and yeast extract.

Folic acid is important for the metabolism of the neurotransmitters serotonin, dopamine and norepinephrine. Folic acid imbalances may alter gene expression leading to imbalances of the glycoproteins needed for neurotransmission in the brain³⁶. Dietary supplementation of folic acid may affect mood by restoring normal gene expression.

A study of 2313 Finnish depressive patients who were followed for over 10 years showed that those with lower levels of folic acid were more likely to be diagnosed with depression again compared to those with higher levels of folic acid³⁷.

Intervention studies have focussed on using folic acid alongside standard medication. A Cochrane review meta-analysis of three double-blind placebo-controlled studies concluded that folic acid may have a potential role as an adjunct to other anti-depressant medication³⁸.

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Zinc

Sources of zinc include meat, dairy, seafood, and cereal products. Zinc is involved in brain and neurotransmitter function. Zinc deficiency may play a role in the aetiology of ADHD: plasma levels of zinc has been found to be low in children with ADHD compared to controls³⁹. In studies of children with ADHD, zinc given alone was significantly better at reducing hyperactivity and impulsivity but not attention

deficiency compared to placebo⁴⁰. When given as an adjunct to methylphenidate medication, zinc was found to significantly decrease ADHD symptoms⁴¹.

Levels of zinc have been found to be depressed and levels of copper elevated in assaultive young males, compare to controls⁴² and in criminal schizophrenic patients when compared to non-criminal schizophrenic patients⁴³.

Zinc deficiency has also been linked to clinical depression. Serum zinc levels have been found to be significantly lower in major depressed subjects compared to normal controls and there is a negative correlation between zinc levels and severity of depression⁴⁴. In a placebo-controlled zinc supplementation trial, where zinc was given as an

34. Buydens-Branchey L et al (2003) Polyunsaturated fatty acid status and relapse vulnerability in cocaine addicts. *Psychiatry Research* 157:95–104.

35. Buydens Branchey L (2008) personal communication – awaiting publication.

36. Sugden C (2006) One carbon metabolism in psychiatric illness. *Nutrition Research Reviews* 19(1):117–136.

37. Tolmunen T et al (2006) Dietary folate and risk of depression in Finnish middle-aged men. prospective follow-up study. *Psychotherapy and Psychosomatics* 73:334–339.

38. Taylor M J et al (2003) Folate for depressive disorders. *Cochrane Database of Systematic Reviews Issue 2*. Art No.: CD003390. DOI: 10.1002/14651858.CD003390.

39. Yorbik O et al (2007) Potential effects of zinc on information processing in boys with attention deficit hyperactivity disorder. *32(3):662–667*.

40. Bilici M et al (2004) Double-blind placebo-controlled study of zinc sulfate in the treatment of attention deficit hyperactivity disorder. *Progress in Neuro-Psychopharmacology and Biological Psychiatry* 28(1):181–190.

41. Akondzadeh S et al (2004) Zinc sulfate as an adjunct to methylphenidate for the treatment of attention deficit hyperactivity disorder in children: a double blind and randomized trial. *4:9*.

42. Walsh W J et al (1997) Elevated blood copper/zinc ratios in assaultive young males. *Physiology and Behavior* 62(2):327–329.

43. Tokdemir M et al (2003) Blood zinc and copper concentrations in criminal on non criminal schizophrenic men. *Archives of Andrology* 49(5):365–368.

44. Maes M et al (1994) Hypozincemia in depression. *Journal of Affective Disorders* 31(2):135–140.

adjunct to standard antidepressant medication, it significantly reduced depression scores compared to antidepressant plus placebo⁴⁵.

Magnesium

The richest sources of magnesium are green leafy vegetables and nuts. Other good sources are bread, fish, meat and dairy foods. Magnesium has many roles in the functioning of the central nervous system including neurotransmission, so it would be expected that low levels of magnesium in the body could negatively influence brain function. Psychiatric symptoms of magnesium deficiency can range from apathy to psychosis.

In heroin addicts with comorbidities, there is significant variation in serum magnesium levels according to comorbidity, with magnesium levels being lower in individuals with personality disorders compared to depression or no comorbidity⁴⁶.

In a group of 155 psychiatric patients low magnesium was not found to correlate with a higher degree of anxiety or tiredness, symptoms characteristic of magnesium deficiency⁴⁷. However there was a strong association of the more disturbed patients having abnormally high or low magnesium levels, suggesting that they might have abnormalities of magnesium metabolism.

Magnesium supplementation studies however, have shown mixed effects on mood. Two studies showed a positive effect on symptoms of pre-menstrual syndrome in women^{48, 49}, while a third found no added benefit over placebo⁵⁰.

Magnesium is essential for the metabolism of vitamin D, which is also implicated in influencing mood.

Likewise many nutrients are dependent on many others, to drive all the different chemical reactions occurring in the body. The complex biochemical relationships of nutrients, and particularly those involved in brain and nervous system functioning, demonstrates the need for a balanced diet to maintain a healthy mind, particularly for those at risk of both nutrient deficiencies and mental health problems, such as drug users.

Vitamin D

Good sources of vitamin D are oily fish, liver and eggs, but it is generally only found elsewhere added to food, such as fortified breakfast cereals, vegetable oil spreads and powdered milk. Vitamin D₃ forms through the action of sunlight on unprotected skin. In the UK this occurs only from April to September when the UVB is strong enough. Amongst prisoners, a lack of time spent in direct sunlight, together

with little oily fish being offered on menus, could well result in low levels of vitamin D.

Low levels of vitamin D have been found amongst in-patients with psychiatric illness⁵¹ and vitamin D deficiency has been associated with low mood in elderly people⁵². There are few intervention studies looking at the effect of vitamin D on mood, but two have looked at the effect of supplementation on seasonal affective disorder (SAD), experienced by many in the UK in winter and characterised by negative mood, carbohydrate craving, hypersomnia and lethargy. In one study vitamin D supplementation resulted in an improvement of measures of depression in people with SAD⁵³ and in the second, vitamin D₃ supplementation was found to have a positive effect compared to placebo in healthy individuals during winter⁵⁴.

Psychiatric symptoms of magnesium deficiency can range from apathy to psychosis.

45. Nowak G (2003) Effect of zinc supplementation on antidepressant therapy in unipolar depression: a preliminary placebo-controlled study. *Polish Journal of Pharmacology* 55:1143–1147.
46. Daini S et al (2006) Serum magnesium profile in heroin addicts: according to psychiatric comorbidity. *Magnesium Research* 19(3):162–166.
47. Kirov G K et al (1994) Plasma magnesium levels in a population of psychiatric patients: correlations with symptoms. *Neuropsychobiology* 30:73–78.
48. Facchinetti F et al (1991) Oral magnesium successfully relieves premenstrual mood changes. *Obstetrics and Gynaecology* 78(2):177–181.
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50. Khine K et al. (2006) Magnesium retention and mood effects after intravenous magnesium infusion in premenstrual dysphoric disorder. *Biological Psychiatry* 59(4): 327–3351 Berk M et al (2008) Is this D vitamin to worry about? Vitamin D insufficiency in an inpatient sample. *Australia and New Zealand Journal of Psychiatry*. 42:874–878.
52. Wilkins C et al (2006) Vitamin D deficiency is associated with low mood and worse cognitive performance in older adults. *American Journal of Geriatric Psychiatry* 14(12):132–140.
53. Gloth F M et al (1999) Vitamin D vs broad spectrum phototherapy in the treatment of seasonal affective disorder. *Journal of Nutrition Health and Aging* 3(1):5–7.
54. Lansdowne AT, Provost SC (1998) Vitamin D enhances mood in healthy subjects during winter. *Psychopharmacology* 135(4):329–323.

Carbohydrates

There is concern that diets high in carbohydrates, particularly sugar, can affect the mood and behaviour of some individuals, but in a recent review, David Benton indicated that it is the glycaemic index of food, rather than total sugar content that is more likely to affect blood-sugar levels and potentially cause behaviour problems in certain people⁵⁵.

Consumption of a high glycaemic index (GI) meal or snack, which is generally high in sugar and refined starch, but low in fat, protein and fibre, results in the rapid absorption of glucose from the gut, followed by increased levels of insulin production to bring about fast clearance of sugar from the blood. The ensuing drop in blood sugar results in the release of catecholamines including epinephrine (adrenalin), which accounts for the palpitations, trembling, jitteriness and irritability that some might feel when their blood sugar levels drop. In the anxiety or anger prone this could act as a trigger for the onset of negative mood. Further intake of carbohydrate, particularly sugar, brings about an improvement in mood, probably due to a cessation of catecholamine production⁵⁶. A diet of high GI foods could therefore have a fluctuating positive and negative effect on mood, whereas a lower GI diet, including more protein, fat and fibre, may result in less fluctuation.

In a small number of people, reactive hypoglycaemia may occur, when blood sugar drops below a certain level. Symptoms of hypoglycaemia include a general negative emotional state, anxiety, depression, irritability and abnormal behaviour. Whereas individuals with diabetes may experience medication-induced hypoglycaemia, reactive

hypoglycaemia, which is a food-induced drop in blood sugar, is much rarer, but may be more common amongst offenders than the general population. Young male delinquents have been found to have significantly higher levels of insulin after consuming sugar and lower levels of glucose after fasting compared to non-delinquent controls⁵⁷. Abnormal insulin production is seen in violent suicide attempters⁵⁸, violent offenders⁵⁹ and violent arsonists⁶⁰. Impulsive violent male offenders are more likely to have reactive hypoglycaemia and lower brain serotonin than the general population^{61,62}, although this applies to a subgroup but not all of violent offenders⁶³. A causal link has not yet been demonstrated between diet-induced drops in blood sugar and violent behaviour. Nevertheless, there may well be a higher proportion of prisoners whose mood and behaviour might be worsened by a highly refined starch and sugar, high GI diet, compared to the general population.

Eating patterns are also relevant to this argument, since long spells without eating could result in catecholamine triggers and perhaps for a violent sub-group, reactive hypoglycaemia. Long spells without eating have been reported by prisoners, particularly during long periods of lock-up, when breakfast packs are distributed and often eaten in the evening, so that no food is then available until lunch the next day.

'Carbohydrate craving' is frequently anecdotally reported amongst substance misusers, particularly those with alcohol and heroin dependency. Nutritional assessment has supported this: opiate addicts tend to replace fat and protein rich foods with sugar rich foods⁶⁴ and individuals on methadone maintenance have high sugar diets⁶⁵.

A causal link has not yet been demonstrated between diet-induced drops in blood sugar and violent behaviour.

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55. Benton D (2008) Sucrose and behavioural problems. *Critical Reviews in Food Science and Nutrition* 48:385–401.
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 58. Westling S et al (2004) High CSF-insulin in violent suicide attempters. *Psychiatry Research* 129(3):249–255.
 59. Virkkunen M (1982) Reactive hypoglycemic tendency among habitually violent offenders. A further study by means of the glucose tolerance test. *Neuropsychobiology* 8(1):35–40.
 60. Virkkunen M (1984) Reactive hypoglycemic tendency among arsonists. *Acta Psychiatrica Scandinavica* 69(5):445–452.
 61. Virkkunen M et al (1995) Low brain serotonin turnover rate (low CSF 5-HIAA) and impulsive violence. *Journal of Psychiatry & Neuroscience* 20(4):271–275.
 62. Matykeiwicz L (1996) Adjudicated adolescent males: measures of urinary 5-hydroxyindoleacetic acid and reactive hypoglycaemia. *Personality and Individual Differences* 22(3):327–332.
 63. Virkkunen M (1983) Insulin secretion during the glucose tolerance test in antisocial personality. *British Journal of Psychiatry* 142:598–694.
 64. Morabia A et al (1989) Diet and opiate addiction: a quantitative assessment of the diet of non-institutionalized opiate addicts. *Br J Addict* 84(2):173–80.
 65. Zador D et al (1996) High sugar intake in a group of women on methadone maintenance in south western Sydney, Australia. *Addiction* 91(77):1053–1061.

It is thought that the brain's biochemical reward pathways evolved to respond to the natural rewards such as food and sex, rather than drugs, but humans found that drugs could stimulate these pathways artificially. A series of studies in rats suggested that sugar is an addictive substance, similar to opiates or cocaine and that similar biochemical changes occur in the brain as with addictive drugs^{66,67,68,69}. However, Benton's recent review of literature on sugar addiction concluded that such a mechanism has not been demonstrated in humans, and it is more likely that highly palatable foods, which are high in both fat and sugar, are associated with cravings rather than physical addiction⁷⁰. It noted that craving for palatable foods often accompanies negative mood such as boredom, anxiety and dysphoria and that 'self-medication' with chocolate tended to occur in people who suffered from depression as a result of feeling rejected.

It makes sense then, that individuals who formerly or currently self-medicate with drugs in an attempt to deal with negative mood, would also attempt to self-medicate in other ways, particularly when poor mood persists but drugs are not an option. Although highly palatable foods may bring about instant gratification as a result of endorphin release⁷¹, for those who binge, consumption may also invoke emotions such of self-loathing, which could contribute to continued negative mood.

Although the relationship between drugs and the craving of highly palatable food is not fully understood, it needs to be considered whether the frequent, repeated instant gratification of cravings with sugary, fatty food is a harmless alternative to satisfying opiate and alcohol cravings amongst former substance misusers, or whether it is helping to perpetuate dependency behaviour.

Also, a diet with a high proportion of sugary, fatty processed food such as sweet biscuits and chocolate is unlikely to be balanced and likely to have a sub-optimal amount and variety of nutrients needed for good physical health, mood and behaviour.

Dietary advice for those in drug treatment should encourage both the consumption of less sugary, more nutrient rich diets and regular patterns of eating, which are less likely to leave an individual hungry and craving the sugary, fatty energy-dense foods.

... a diet with a high proportion of sugary, fatty processed food such as sweet biscuits and chocolate is unlikely to be balanced and likely to have a sub-optimal amount and variety of nutrients needed for good physical health, mood and behaviour.

Caffeine

Caffeine is a psychomotor stimulant with mood altering effects. It is common for individuals with a history of substance misuse to habitually consume caffeine, in the form of coffee, coca-cola and caffeinated 'energy' drinks when abstaining from other drugs.

The effect of caffeine can vary from individual to individual, with some being able to consume larger amounts later in the evening with no ill effects. For many, caffeine can induce wakefulness through its action as

an adenosine receptor antagonist, by preventing the slowing action of adenosine on brain cells. As many are well aware from personal experience, people are particularly vulnerable to feelings of loneliness and hopelessness at night, when cursed with insomnia while it seems that the rest of the world sleeps. Insomnia is a common symptom of anxiety and depression and it is important that those affected by these do not add further to this problem.

Both caffeine itself and caffeine withdrawal are each associated with low mood. Caffeine withdrawal can be accompanied by fatigue, irritability and depressed mood⁷². In a placebo controlled study, caffeine was found to have a negative effect on mood,

66. Colantuoni C et al (2002) Evidence that intermittent, Excessive sugar intake causes enogenous opiod dependence. *Obesity Research* 10:477-478.
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70. Benton (2008) The plausibility of sugar addiction and its role in obesity. Submitted for publication.
71. Dum J et al (1983) Activation of hypothalamic beta-endorphin pools by reward induced by highly palatable food. *Pharmacology, Biochemistry, and Behavior* 18(3):443-447.
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Diet, physical health and mood

particularly after sleep restriction, even when the confounding effects of caffeine withdrawal were controlled for⁷³.

At high doses, caffeine can lead to increased anxiety in anxiety-prone individuals⁷⁴. The positive side of caffeine, and why many people consume it, is that at low doses, caffeine has been shown to enhance individuals' perceptions of being more alert and energetic, but unfortunately for some more anxious⁷⁵. In people with panic symptoms, total avoidance of caffeine, alcohol, chocolate and nicotine has resulted in cessation of panic symptoms, which then recurred with a return to non-compliance⁷⁶.

In a double-blind study, individuals with a history of stimulant drug abuse, received placebo or low to high levels of intravenous caffeine⁷⁷. Caffeine increased positive mood, peaking at two minutes after injection and increased the self-reported desire for cocaine. Caffeine also increased negative mood, significantly at high dose. A similar study using intravenous caffeine and nicotine in a group of individuals with a history of cocaine use, demonstrated a feeling of a stimulant drug high from both caffeine and nicotine⁷⁸.

There are anecdotal reports of substance misusers who, once they abstain from drugs following treatment, consume large amounts of caffeinated high energy drinks to achieve a stimulant-like high. It therefore needs to be considered whether such use is benign or whether caffeine could be harmful. Like stimulant drugs, caffeine can produce pleasurable reward effects and withdrawal causes negative effects, but it is generally used at moderate and consistent levels. It could however be argued that the effects of caffeine, particularly when combined with nicotine, could help perpetuate the effects of stimulant gratification and maintain drug-desiring behaviour.

It is important that an understanding of the potential effects of caffeine is included in healthy eating advice for those undergoing drug treatment, which needs to highlight the negative impact that caffeine can have on mood and sleep patterns, particularly for those prone to mood disorders.

Improvement in physical health brought about by improved nutritional status can also impact on mood. A study of HIV positive individuals given selenium or placebo for 12 months showed increased vigour and less anxiety in the active supplement group, which was thought to have been, at least partially, attributed to the beneficial effects of selenium on the immune system⁷⁹.

Poor health is common amongst the drug-using population, particularly those who inject drugs. The secondary effect of improved mood as a result of improved physical health is therefore of particular importance to those who have misused drugs. An estimated one in 50 injecting drug users (IDUs) are HIV positive, while hepatitis C infection is estimated to affect half of all IDUs in the UK⁸⁰. In men's prisons it is estimated that 9 per cent of the population is positive for hepatitis C⁸¹. Other ill health related to drug-taking behaviour includes tuberculosis, endocarditis, osteomyelitis, deep vein thrombosis and abscesses at the site of injection. The nutrient poor diets associated with long-term drug dependency may affect immune function and the ability for individuals to fight infections. Diets high in saturated fats and low in antioxidants, as well as a lifestyle of inactivity may increase risk of thromboses and these are factors common to prison life.

Additionally, drug users and prisoners alike tend to have very poor oral health with tooth decay, tooth loss, abscesses and gum disease. In a survey of 220 methadone users in Dublin, 99 per cent of subjects needed some form of dental treatment and the average number of teeth needing intervention was 14⁸². Untreated dental disease is four times greater in the prison population compared to the general population⁸³ and one study found that heroin addict prisoners had significantly greater decayed, missing and filled teeth than the non-addict prisoners⁸⁴. Poor diet, particularly one low in nutrients and high in extrinsic sugars impacts negatively on oral health and in turn poor oral health, particularly tooth loss, impacts on diet. Poor

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73. James J E, Gregg M E (2004) Effects of dietary caffeine on mood when rested and sleep restricted. *Human Psychopharmacology* 19(5):331–341.
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 84. Becart A (1997) The oral health status of drug addicts. A prison survey in Lille, France. *Journal of Forensic Odonto-Stomatology* 15(2):37–39.

dentition is associated with lower intakes of vitamins, minerals, protein and fibre⁸⁵, since individuals with missing teeth are less likely to eat fruit, vegetables and wholemeal bread⁸⁶. Also, the pain of tooth decay and abscesses could act as a trigger for relapse whereby people self-medicate pain relief.

Diets and nutritional status of drug users

The nutritional status of substance misusers whilst actively using drugs is generally poor, particularly in those with associated poor physical health. Many will be underweight and seriously malnourished. In one study of 140 drug addicts admitted to hospital for detoxification, 54 fulfilled criteria for the types of malnutrition more commonly associated with child victims of famine⁸⁷.

Drug users are likely to have lowered body mass index (BMI), haemoglobin and other blood proteins compared to controls and may well have multiple nutrient deficiencies⁸⁸. One study demonstrated low vitamin A, C and E status in drug addicts, which could impact on immunity⁸⁹. In another study of heroin addicts, folic acid and vitamin B6 (needed for folic acid metabolism) were the most common deficiencies, which could have implications for mood⁹⁰.

Vegetable consumption has been shown to be significantly lower for drugs users and sweets/desserts significantly higher compared to non-drug user controls⁹¹. In this study, drug users were more likely to fry food, whereas controls were more likely to bake, boil or steam.

Diets and nutritional status of prisoners

The diets of young offenders involved in the Aylesbury study were found to be broadly in line with

the current dietary recommendations⁹², although the analysis did not take into account potential nutrient loss through cooking methods or length of time food spent in warm holding prior to eating. Exceptions were selenium, iodine, magnesium and potassium, which were low compared to their reference nutrient intakes (RNIs) as was zinc in the vegetarian menus. Vitamin D intake was low compared to recommendations for people with limited exposure to the sun. Omega-3 fatty acids were not analysed.

In the National Audit Office report on diet and exercise in prisons⁹³, menu analysis showed that recommended levels were met, with the exceptions of vitamins A, B12, and E, zinc and manganese which were low in some meals and vitamin D, selenium and iodine levels which was low in all meals. Also, dietary fibre was below recommended levels.

In both instances, the low levels of the particular micronutrients could impact on mood, behaviour and immunity.

Dietary advice and mood change

A non-controlled study of offenders sentenced to home confinement showed that nutrition education could influence food choices⁹⁴. Weekly newsletters promoting fruit and vegetable consumption resulted in a significant increase in reported intake of fruit and vegetables, with an increase in confidence to eat 5 portions of fruit and vegetables a day and a positive movement towards action and maintenance for five portions a day.

Advice on diet and exercise change has had a positive effect on mood in a non-prison environment. In a study of panic disorder, patients received 10 intervention sessions over a 16-week period addressing: diet, fluid intake, exercise, caffeine, alcohol and nicotine⁹⁵.

In both instances,
the low levels
of the particular
micronutrients
could impact on
mood, behaviour
and immunity.

85. Krall E et al (1998) How dentition status and masticatory function affect nutrient intake. *Journal of the American Dental Association* 129:1261–1269.
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94. Sebelia L, Greene G W (2007) A Nutrition education program for prison offenders sentenced to home confinement. *Journal of the American Dietetic Association* 108(8):A95.
95. Lambert (2007) Lambert R et al (2007) Pragmatic, unblinded randomised controlled trial comparing an occupational therapy-led lifestyle approach and routine GP care for panic disorder treatment in primary care. *Journal of Affective Disorders* 99:63–71.

Significant lifestyle changes and a reduction in anxiety were observed in the treatment group compared to controls at 20 weeks, although the gap had narrowed by 10 months.

The effectiveness of nutrition education in drug treatment programmes was studied in the United States⁹⁶. Addiction Severity Index (ASI) scores showed a significant positive relationship between nutrition education services and improvements in psychiatric, medical and family/social ASI scores.

There have been few studies looking at whether dietary change (i.e. whole diet rather than nutrient supplements) affects behaviour of prison populations. In Schoenthaler's Oklahoma micronutrient juvenile delinquent study, referred to previously, all participants were examined for physical signs of deficiency, and received dietary advice according to which foods contained the nutrients that appeared to be lacking in their diets. Unexpectedly, six of the 16 offenders who showed major behavioural improvements did so while taking placebo, but they had changed to eating a healthy diet rich in nutrients, having decreased fat and sugar and increased fruit, vegetable and wholegrain consumption following the dietary advice. Although a small study, with the control group receiving an intervention additional to a placebo capsule, it was backed up by biochemical analysis. Blood and hair samples of these six controls, taken before and after the intervention, demonstrated that most of nutrient deficiencies were subsequently addressed.

Factors affecting food choice

Researchers involved in the National Audit Office (NAO) report and in the Aylesbury study found that prisoners did not have an adequate knowledge of healthy eating to make healthy choices and that they would be able to make better choices if provided with healthy eating information.

A series of focus groups held with staff and prisoners in two High Security prisons found that knowledge of healthy eating varied amongst prisoners and that a number of other factors influenced food choice.

Food choices from menus were influenced by:

1. Appearance and visual appeal of food.
2. Taste.
3. Perceived cost of food (e.g. special diets such as kosher were chosen as they were considered to have ingredients that cost more).

4. Perceived nutritional content of food (e.g. many considered vegetables had all their goodness boiled out of them).
5. Who had cooked the food (general prison population unwilling to eat food prepared by vulnerable prisoners).

Food choices from the canteen were influenced by:

1. Cost.
2. Non-perishability of food to keep unrefrigerated in cells.
3. Food that could be prepared and eaten easily while locked in cells.
4. Food perceived to best keep prisoners full while locked in cells.
5. Food that would give instant gratification (e.g. chocolate).
6. Suitability of food for bartering
7. For those attending the gym, food that would help them 'bulk up'.

Prisoners attending the focus groups also felt that they were unable to influence improvements to food available in prison, although staff identified means, for example, requests could be passed via wing communications officers who attend facilities meetings.

These focus groups highlighted that prisoners in drug treatment programmes need encouragement to think about what barriers they perceive as preventing them from eating more healthily and how they might overcome these barriers. Such problem-solving methods are already a feature of drug treatment programmes in prisons.

A way ahead

Although the quality of research varies, overall there is an indication that inclusion of particular nutrients in the diet can help improve factors that contribute to negative mood and behaviour, drug relapse and recidivism. The specific nutrients identified as being low in prison diets could particularly impact on mood and behaviour as well as the physical health of those with a history of substance misuse.

One option would be the provision of micronutrient supplements for all prisoners. As discussed though, the provision of a daily 'feel good' pill for those who have a history of substance misuse, may create a further psychological dependency. Also, care would need to be taken with some nutrients which interact with prescribed medications, an example of this being warfarin and other anticoagulants prescribed for thromboses, whose effects can be modified by a whole host of micronutrients and other supplements. Similarly,

96. Grant L P et al (2004) Nutrition education is positively associated with substance abuse treatment program outcomes. *Journal of the American Dietetic Association* 104(4):604–610.

caution is necessary with individuals who have livers damaged by hepatitis C, as some supplements may cause further damage.

For substance misusers, and indeed for the whole of the prison population, the ideal route to improved nutritional status would be via improvement of their diets. However, scant research has looked at whether modification of whole diet can improve behaviour in prisons. Nutrient supplement intervention studies are chosen by researchers in preference to whole diet studies because it is possible to double-blind such studies and offer an indistinguishable placebo capsule, whereas it is near-impossible to do this with food. The end aim however, must surely be for individuals to obtain the nutrients for optimum physical and mental health from their diet.

The NAO and the Parliamentary Forum recommended dietary advice for all prisoners to enable them to make healthier food choices. This advice needs to be relevant to their living circumstances and take into consideration the barriers that prisoners feel they face in making healthy food choices. Additionally, dietary advice for those in drug treatment programmes needs to be considerate of their specific health problems — for example, telling someone with only a few remaining decayed teeth to eat more fresh fruit is of little relevance if all they have access to is hard apples and pears, which are awkward and painful to eat.

Evidence-based healthy eating advice as part of drug treatment is fairly new to the drug treatment field, but is being welcomed by many drug professionals and client groups outside of prison environments, as an important contribution to enabling those in recovery to build new, more fulfilling and healthier lives. The Prison Service has the infrastructure to enable the effectiveness of such an intervention to be evaluated and could set a standard for others elsewhere in drug treatment to follow.

Hand in hand with this may be the need to re-examine prison menus, not only looking at the analysis of individual nutrients (which would ideally involve biochemical analysis post warm-holding, at the point of consumption), but also assessing how the menus comply with the Food Standards Agency's key messages on fruit and vegetables, fish, wholegrains, healthy fats etc. Currently, there are at least some prisons menus, from

which it would be impossible to consume the recommended minimum of five portions of fruit and vegetables a day, or even a single portion of oily fish in a week. Change should not necessarily mean an increase in the cost of ingredients, but is more a question of wisely selecting healthier alternatives and preparing ingredients by healthier cooking methods. For example, rapeseed oil has a better ratio of omega-3 and omega-6 fats compared to many other vegetable oils, but is often the cheapest oil available (often labelled only as 'vegetable oil' with a picture of the yellow rape flower on the label, and composed predominantly or entirely of rapeseed oil). Oily fish, such as mackerel are high in omega-3 and an economical choice, whether fresh, tinned or smoked. Fruit and vegetables could be bought according to when they are in season and when cheap gluts are available, then prepared creatively. Catering staff might therefore benefit from additional training in healthier cooking if necessary.

Prison suppliers also need to be included in such planning to ensure more healthy choices are available, both through the kitchens and canteens. Prisoners' views should also have representation, since the series of focus groups highlighted the desire of many prisoners to eat more healthily, as well as showing that poor food and the inability to influence it is the source of much bad feeling and resentment amongst prisoners. Prison staff and prisoners alike commented on the stodginess of food, which they felt induced sluggishness, and

prisoners expressed a desire for more salad to appear on menus. One prisoner commented, 'If there is ever any sort of trouble in this prison, a riot or any sort of disruption, it's going to be over the food. It's not even about association or bang up — it's going to be about the food — the portions they are serving up and the type of food served up.'

So the benefits of providing healthier, more nutritious options for the prison population goes further than just the potential positive effects of certain nutrients on brain biochemistry. Food is of immense psychological importance and the provision of healthier food will surely impact on prison behaviour on another level. The introduction of healthier food and healthy eating advice is overall likely to make sound economic sense in terms of prisoners' physical health, mood and behaviour.⁹⁷

The introduction of healthier food and healthy eating advice is overall likely to make sound economic sense in terms of prisoners' physical health, mood and behaviour.

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