Feeding Minds

The impact of food on mental health

Mental Health Foundation

CONTENTS

The time is now right for **nutrition** to become a ***mainstream***, ***everyday*** component of **mental health care**

FOREWORD

The brain is the platform for the mind and therefore the platform for our mental health. While our understanding of how the brain works is less advanced than our understanding of the body's other organs, much of the practical knowledge we do have of the brain has yet to be embraced and put to good use. This represents a spectrum of wasted opportunities to promote mental health and prevent mental ill-health in our society.

One of the clearest examples is the role of nutrition in relation to mental health. We know that the brain is made up in large part of essential fatty acids, water and other nutrients. We know that food affects how we feel, think and behave. In fact, we know that dietary interventions may hold the key to a number of the mental health challenges our society is facing. Yet we rarely invest in developing this knowledge, and a relatively tiny - but growing - number of professionals are putting it to effective use.

But there is a growing body of evidence, and a number of significant voices are championing the role of diet in the care and treatment of people with mental health problems. The potential of dietary interventions in treating depression and Attention Deficit Hyperactivity Disorder, for example, are being increasingly recognised. We would be foolish to underestimate their importance.

An integrated approach, recognising the interplay of biological, psychological, social and environmental factors is key to challenging the growing burden of mental ill-health in western nations. Diet is a cornerstone of this integrated approach.

The time is now right for nutrition to become a mainstream, everyday component of mental health care, and a regular factor in mental health promotion. But this won't happen without the recognition and commitment of the major stakeholders outlined in this report.

The potential rewards, in economic terms, and in terms of alleviating human suffering, are enormous.

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Chief Executive
The Mental Health Foundation

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1 There is a companion report to this volume, produced by the Foundation's partner in the Feeding Minds Campaign, Sustain: the alliance for better farming and food. "Changing Diets, Changing Minds: how food affects our mental well being and behaviour" is available at www.sustainweb.org

Introduction

There appears to be no respite in the pace or impact of the growing burden of mental ill-health on us as individuals and as a nation. The UK costs of mental ill-health are now approaching £100 billion a year. Many explanations have been offered for this trend – from globalisation and changes in economic stability to changing social trends and diminishing interpersonal networks.

Mental health problems are believed to be the result of a combination of factors, including age, genetics and environmental factors. One of the most obvious, yet under-recognised factors in the development of major trends in mental health is the role of nutrition. The body of evidence linking diet and mental health is growing at a rapid pace. As well as its impact on short and long-term mental health, the evidence indicates that food plays an important contributing role in the development, management and prevention of specific mental health problems such as depression, schizophrenia, attention deficit hyperactivity disorder, and Alzheimer's disease.

Increasingly, the links between diet and mental health are gathering support from academic and clinical research communities. Studies have ranged from examining individual responses to diet changes in randomised controlled trials, to population-based cross-cultural comparisons of mental health and food intake.

But the role of diet in the nation's mental health has yet to be fully understood and embraced, and shifts in policy and practice have been slow to materialise. Possible reasons include a lack of awareness of the evidence, scepticism as to its quality and vested interests in other treatments and approaches.

For decades the prevailing treatment for mental health problems has been medication (and psychotherapy to a lesser extent), and mental health promotion methods have centred around information and education. The treatment implications of research into nutrition and mental health have rarely been acknowledged by mainstream medicine, yet the potential returns are enormous. The mental health promotion implications are also of the utmost importance, and deserve much greater attention.

How food and food production are implicated in mental health

Most of the brain is derived directly from food. The last fifty years have witnessed remarkable alterations to what we eat, how we process and refine it, food additives, use of pesticides and the alteration of animal fats through intensive farming. Changes to our diet in recent years mean that what we consume daily is very different in its nutritional content from that of even our closest ancestors.

It has been estimated that the average person in the UK and other industrialised countries will eat more than 4 kilogrammes of additives every year. The impact of this situation is still controversial as Governments have appeared reluctant to fund, conduct or publish rigorously controlled studies examining the effects of additives.

Changing methods of farming have also introduced higher levels and different types of fat into our diet. For example, chickens now reach their slaughter weight twice as fast as they did thirty years ago, which has changed the nutritional profile of the meat. Whereas a chicken carcass used to be 2% fat, it is now 22%. Also, the diet fed to chickens has changed dramatically, which has reduced omega-3 fatty acids and increased omega-6 fatty acids in chicken meat. Similarly, the diet fed to farmed fish is changing the ratio of fatty acids in the fish we eat.

How fats and amino acids work in our brains

Because the 'dry weight' of the brain is composed of about 60% fat, the fats we eat directly affect the structure and substance of the brain cell membranes. Saturated fats – those that are hard at room temperature, like lard – make the cell membranes in our brain and body tissue less flexible.

Twenty per cent of the fat in our brain is made from the essential fatty acids omega-3 and omega-6. They are termed 'essential' as they cannot be made within the body, so must be derived directly from the diet. Each fatty acid performs vital functions in the structuring of brain cells (or neurons), ensuring that smooth communication is possible within the brain. Both are found in equal amounts in the brain, and it is believed they should be eaten in equal amounts.

Unequal intakes of omega-3 and omega-6 fats are implicated in a number of mental health problems, including depression, and concentration and memory problems. Experts suggest that most people consuming Western diets eat far too much omega-6 and not enough omega-3.

The recent and widespread appearance of trans-fat in the diet raises great concern, primarily because these fats assume the same position as essential fatty acids (EFAs) in the brain, meaning vital nutrients are not able to assume their rightful position for the brain to function effectively. Trans-fats are prevalent and pervasive, found in processed foods like commercially-made cakes, crisps and ready meals.

Neurotransmitters are messengers passed back and forth within the brain. They allow neurons to communicate information amongst themselves. Neurotransmitters are made from amino acids, which often must be derived directly from the diet. For example, the neurotransmitter serotonin, which is associated with feelings of contentment, is made from the amino acid tryptophan. Adrenaline and dopamine, the 'motivating' neurotransmitters, are made from phenylalanine (see tables for further information about their sources).

The role of diet in relation to mood and mental wellbeing

Just like the heart, stomach and liver, the brain is an organ that is acutely sensitive to what we eat and drink. To remain healthy, it needs different amounts of complex carbohydrates, essential fatty acids, amino acids, vitamins and minerals, and water.

Anyone who has ever smoked, drank alcohol, tea or coffee or eaten chocolate knows that such products can improve one's mood, at least a little and temporarily. What seems to be less common is an understanding that some foods can have a lasting influence on mood and mental wellbeing because of the impact they have on the structure and function of the brain.

A sufficient balance of neurotransmitters is essential for good mental health, as they are influential in the feelings of contentment and anxiety, memory function and cognitive function. Some foods are perfect at temporarily promoting the neurotransmitter that we lack and, as we crave and then consume them, they 'trick' us into feeling better, for a while.

By making the brain less sensitive to its own transmitters and less able to produce healthy patterns of brain activity, these substances encourage the brain to down-regulate. Down-regulation is the brain's instinctive mechanism for achieving homeostasis: when the brain is 'flooded' by an artificial influx of a neurotransmitter (for example, adrenaline triggered by a strong coffee), the brain's receptors respond by 'closing down' until the excess is metabolised away. This can create a vicious circle, where the brain down-regulates in response to certain substances, which in turn prompt the individual to increase their intake of those substances to get the release of the neurotransmitter that their brain is lacking. This is one reason why people sometimes crave certain products.

The role of diet in relation to specific mental health problems

Depression

A number of cross-country and population-based studies have linked the intake of certain nutrients with the reported prevalence of different types of depression. For example, correlations between low intakes of fish by country and high levels of depression among its citizens – and the reverse - have been shown for many types of depression.

Complex carbohydrates as well as certain food components such as folic acid, omega-3 fatty acids, selenium and tryptophan are thought to decrease the symptoms of depression. Those with low intakes of folate, or folic acid, have been found to be significantly more likely to be diagnosed with depression than those with higher intakes. Similar conclusions have been drawn from studies looking at the association of depression with low levels of zinc and vitamins B1, B2 and C. In other studies standard treatments have been supplemented with these micro-nutrients resulting in greater relief of symptoms in people with depression and bi-polar affective disorder, in some cases by as much as 50%.

One way that vitamins and minerals may improve mental health and cognitive function is through their role in the brain's conversion of amino acids. Much has been said in public fora about the importance of the neurotransmitter serotonin, and its presence in lower levels being linked to depression. Because of this, the precursor to serotonin – the amino acid tryptophan – has been the focus of much research. Some studies have found that combining tryptophan with selective serotonin reuptake inhibitor (SSRI) antidepressants gives better results than SSRIs alone. Other dietary alterations can ease or hinder the entry of tryptophan to the brain.

Schizophrenia

Studies have looked at the impact of specific nutrients on the rates of schizophrenia in the general population, focusing on fats and antioxidants. Epidemiological evidence has shown that people with schizophrenia have lower levels of polyunsaturated fatty acids in their bodies than those with no experience of the illness. Other research has shown that antioxidant enzymes are lower in the brains of people with schizophrenia.

Further work is needed in this area to identify specific mechanisms through which diet can work alongside other care options to alleviate the symptoms of schizophrenia.

Alzheimer's Disease

Specific connections have been found between the occurrence of Alzheimer's and different intakes of foods, including saturated fat, vitamins and minerals. Although there have been few controlled clinical trials testing the effects of nutritional treatments, most evidence points to the role of nutrition in the prevention of, rather than the treatment of Alzheimer's Disease. Many of the studies have shown a positive association between saturated fat intake and the incidence of dementia, and a negative relationship between the incidence of dementia and intake of polyunsaturated fatty acid. One study looking at the total fat intake of eleven countries found a correlation between higher levels of fat consumption and higher levels of Alzheimer's Disease amongst over 65's.

Other studies have explored the protection from Alzheimer's that has been linked with high vegetable consumption. One long term population-based study found that high intakes of vitamins C and E were linked to a lower risk of AD, particularly among smokers, and this finding has been replicated in other studies.

Attention Deficit Hyperactivity Disorder (ADHD)

Many parents, teachers and others have reported great improvements when dietary changes are introduced to children with ADHD. Two food groups that have been implicated through clinical research are essential fatty acids (EFAs) and minerals. Studies have found some EFAs to be significantly low in hyperactive children. A similar relationship has been found with levels of iron in children with symptoms of ADHD.

Conclusion

The body of evidence linking diet with mental health is growing at a rapid pace. As well as its impact on feelings of mood and general wellbeing, the evidence demonstrates its contribution to the development, prevention and management of specific mental health problems.

The implications are far-reaching for all those with a stake in the care, treatment and prevention of mental illness. They must be embraced by stakeholders if current and future generations are to ease the growing health, economic and social burden of mental ill-health.

There is an urgent need for policy-makers, practitioners, industry, service users and consumers to give proper credence to the role that nutrition plays in mental health.

METHODS

A multi-methodological approach was adopted in the production of this report, in order to reflect the breadth and depth of evidence in the field. Methods included:

- A review of existing literature and evidence relating to nutrition and mental health. Although a full systematic review was beyond the scope and purpose of this report, evidence was collected from peer-reviewed journals in addition to non-reviewed literature, the internet, personal communications and conference proceedings

- A National Opinion Poll (NOP) survey was conducted with 2122 adults aged 15 years and over, throughout the UK. The sample was controlled for age, sex and employment status. Questions asked concerned food wastage, frequency of consumption of different foods and drinks, the perceived impact of different foods on mood, reasons for food consumption and experience of mental health problems (see Appendix A)

- Site visits/liaison with six innovative services that use diet and nutrition to promote mental health or to manage mental health problems

- Peer review of the report through a reference group of nutrition and mental health specialists

Food consumption

- What we are eating now is very different from that of our recent ancestors. Food production and manufacturing techniques, coupled with changing lifestyles and increasing access to processed foods, mean that our intake of fresh, nutritious, local produce is much lower, at the same time as our intake of fat, sugar, alcohol and additives is much higher.

- Up to 40% of food we produce is wasted directly because we buy it and then throw it away, or indirectly, because supermarkets reject produce that is the 'wrong' size or shape or past its 'sell-by' date.

- Over the last 60 years there has been a 34% decline in UK vegetable consumption with currently only 13% of men and 15% of women now eating at least five portions of fruit and vegetables per day.

- People in the UK eat 59% less fish than they did 60 years ago.

Mental health

- Some nutrients trick the brain by triggering an over-release of neurotransmitters and some foods damage the brain by releasing toxins or oxidants that harm healthy brain cells. There are many more nutrients that serve the brain without deception or damage, which can improve mood and mental well being.

- A balanced mood and feelings of well being can be protected by ensuring that our diet provides adequate amounts of complex carbohydrates, essential fats, amino acids, vitamins and minerals and water.

- There is a plethora of anecdotal, clinical and controlled studies that point to the importance of diet as one part of the jigsaw in the prevention of poor mental health and the promotion of good mental health.

- Research indicates that good nutritional intake may be linked to academic success. A number of studies report that providing children with breakfast improves their daily and long-term academic performance.

- Among some young offenders, diets supplemented with vitamins, minerals and essential fatty acids have resulted in significant and remarkable reductions in anti-social behaviour.

Mental health problems

- There is growing evidence that diet plays an important contributory role in specific mental health problems including Attention Deficit Hyperactivity Disorder (ADHD), depression, schizophrenia and Alzheimer's disease.

- The presentation of depression in the UK population has increased dramatically over recent decades and this has been accompanied by a decrease in the age of onset, with more cases being reported in children, adolescents and young adults.

- A correlation between low intakes of fish by a country and high levels of depression amongst its citizens, as well as the reverse, has been shown for major depression, post-natal depression, seasonal affective disorder and bipolar affective disorder.

- The incidence of schizophrenia is similar across the globe, although there are differences in outcomes between countries. This implies that environmental factors have some role in determining the duration and severity of symptoms, and the role that diet has to play is attracting increasing scientific interest.

- Alzheimer's disease has become more common in the past fifty years and is believed to be the result of a combination of factors, including the aging population, genetics and environmental factors.

- Growing epidemiological evidence suggests that diet may be one of those environmental factors with associations being reported between the occurrence of Alzheimer's and the amount of saturated fats, vitamins and minerals consumed.

- Complementary mental health care services that focus on diet and nutrition report promising results, particularly among those who experience ADHD and depression. On the whole however, they are poorly resourced and have received insufficient research attention to draw firm conclusions.

National opinion poll findings (NOP)

- Women report eating healthy foods, including fresh vegetables, fruit or fruit juice and meals made from scratch, more often than men, who tend to eat more takeaways and ready meals.

- Younger people report eating less healthy foods (fresh fruit and vegetables, organic foods and meals made from scratch) and more unhealthy foods (chips and crisps, chocolate, ready meals and takeaways) than older people.

- 29% of 15-24 year olds report eating a meal made from scratch every day, compared with 50% of those aged over 65.

- Younger people are more likely than older people to report daily mental health problems, as are those in social class DE, those on a lower income, those who are not in paid employment and those who are not married.

- Nearly two thirds of those who do not report daily mental health problems eat fresh fruit or fruit juice every day, compared with less than half of those who do report daily mental health problems. This pattern is similar for fresh vegetables and salad.

- Those who report some level of mental health problem also eat fewer healthy foods (fresh fruit and vegetables, organic foods and meals made from scratch) and more unhealthy foods (chips and crisps, chocolate, ready meals and takeaways).

RECOMMENDATIONS

The Government as a whole, and all relevant departments and agencies, should officially recognise the links between diet and mental health and incorporate this recognition into all food and mental health related policy and practice. For instance, general healthy eating campaigns such as five-a-day should always include a mental health component.

Because the diet that is good for the brain is also the same diet that is good for the body, Government should increase financial and political support for measures to ensure that sustainable* supplies of a wide variety of nutrient-rich foods are available, affordable and attractive for people to obtain both now and in the future.

Specifically:

1.

The UK population and particular groups who are at increased risk of mental health problems should be provided with information about foods that promote their mental, emotional and physical well-being

Stakeholders:
Department of Health
NHS Health Scotland
Health and Social Care Department
Department of Health, Social Services and Public Safety
Food Standards Agency

2.

United Kingdom Health Departments should review and improve food and nutrition standards for the mental health and social care sectors in light of the evidence that a range of nutrients contribute to mental health and well being

Stakeholders:
Department of Health
NHS Health Scotland
Health and Social Care Department
Department of Health, Social Services and Public Safety

3.

Organisations that commission mental health services should include within commissioning criteria and service specifications food and nutrition standards for any services that provide food

Stakeholders:
Primary Care Trusts
Local Authorities
NHS Health Boards
Local Health Boards
Health and Social Services Boards/Trusts

4.

Annual monitoring of food and nutrition standards across the health and social care sector should be incorporated into current performance assessment mechanisms

Stakeholders:
Healthcare Commission
Commission for Social Care Inspection
Care Commission
NHS Quality Improvement Scotland
Mental Welfare Commission
Health Inspectorate Wales
Care Standards Inspectorate
Northern Health and Social Services Council
Department of Health, Social Services and Public Safety

5.

Primary care should have ready access to information on the link between diet and mental health as well as a working knowledge of the information and expertise available to support people through dietary change

Stakeholders:
Primary Care Trusts
NHS Health Boards
Local Health Boards
Health and Social Services Boards/Trusts

6.

Secondary mental health service staff should have ready access to nutritional specialists for liaison and consultation

Stakeholders:
Mental Health Trusts
NHS Health Boards
Local Health Boards
Health and Social Services Boards/Trusts

7.

All existing NHS and social care facilities that provide meals to service users, including the independent and not for profit sector, should instigate sustainable food policies and practices, so that all service users and staff are encouraged to choose, or be provided with if unable to choose, diverse and culturally appropriate meals, snacks and drinks that promote their mental, emotional and physical well-being

Stakeholders:
Strategic Health Authorities (or their successor)
Local Health Boards
NHS Health Boards
Health and Social Services Boards/Trusts
Local Authorities

8.

All prison facilities should instigate sustainable food policies and practices so that all residents and staff are encouraged to choose culturally diverse and appropriate meals, snacks and drinks that promote their mental, emotional and physical well-being

Stakeholders:
Home Office
Scottish Executive
Northern Ireland Office

9.

Research funding bodies should co-ordinate their strategies and increase the grants available to investigate the relationship between diet and mental health, particularly the effectiveness of interventions

Stakeholders:
Department of Health through its Research Funders Group
Scottish Executive Health Department and National Programme for Improving Mental Health and Well-being
Health and Social Care Department
Department of Health, Social Services and Public Safety
Food Standards Agency

10.

Regulations should be introduced to support the promotion of healthy food to children, and to protect them from all forms of broadcast and non-broadcast marketing of unhealthy food

Stakeholders:
Department for Culture Media and Sport
Ofcom
The Department of Health's Advertising Forum
Department of Health
NHS Health Scotland
Scottish Executive
Health and Social Care Department
Department of Health, Social Services and Public Safety

11.

Practical food skills, including cooking and growing, should be reintroduced as a compulsory part of the national curriculum

Stakeholders:
Department for Education and Skills
Health Promoting Schools
Scottish Executive Education Department
Department of Education

12.

The progressive approach to ensuring better food in school meals should be continued and in addition access to free water dispensers should be available to all children by 2007

Stakeholders:
The School Food Trust
Department for Education and Skills
Health Promoting Schools
Scottish Executive Education Department
Department of Education

13.

Targets should be introduced to reduce unhealthy levels of fat, sugar and salt in processed food, and to remove damaging trans-fats from food ingredients and food products. As an interim measure, manufacturers should be encouraged to label clearly the nutritional quality of and ingredients in their products

Stakeholders:
Food Standards Agency

14.

Agricultural policy development should be informed by what is known of its nutritional impact and its subsequent effect upon our mental as well as physical health. Specifically, support must be increased for organic farming, the production and promotion of fruit and vegetables, other micro-nutrient rich food and for alternative sources to oily fish of omega-3 fats. Moreover, Government policy on promoting fish consumption needs to change to promoting only sustainable sources of oily fish, with low levels of toxicity

Stakeholders:
Department for the Environment, Food and Rural Affairs
Food Standards Agency
Department of Environment and Rural Affairs
Department of Agriculture and Rural Development

1. INTRODUCTION

1.1 The Mental Health of the Nation

In September 1999, the Department of Health set out their blueprint for tackling mental health problems in England, giving priority to mental health alongside coronary heart disease (CHD) and cancer. Five years later, mental health problems are now the number one reason for people to claim Incapacity Benefit, with around one million people unable to work and millions of others affected in their roles as carers, friends or colleagues[1]. Many more suffer away from the limelight of statistics, with one in four people likely to experience a mental illness at some point in their lifetime, and there appears to be no respite in the pace and impact of the growing burden of mental ill-health on us as individuals and as a nation. Latest figures estimate that the economic burden of this is now approaching £100 billion a year in the UK[2]. There are many explanations for this increase in mental health problems – from globalisation and changes in economic stability to changing social trends and diminishing interpersonal networks. An holistic approach to mental health recognises the complexity of factors that contribute to a person's sense of wellbeing and acknowledges the real but partial answer offered by any one approach to treatment.

1.2 An holistic approach to mental health

For decades, the prevailing treatment for those with mental health problems was medication, prescribed largely by primary care practitioners and – on occasions – in consultation with other professionals. In the 1990s, this was often given in conjunction with some psychotherapeutic intervention (e.g. counselling, cognitive behavioural therapy), although for many in an overstretched system of care, this often was too little, too late. The NHS Improvement Plan (2004) signalled a shift in the Government's approach to treatment for mental health problems by emphasizing what many had already discovered for themselves: that effective and sustainable care involves a focus on the whole of health and well-being. With this in mind, an integrative approach, which embraces complementary therapies and recognises the interplay between the physical, emotional and mental aspects of a person's life, can often be more effective than any one single route of treatment.

In-depth qualitative research shows that many factors are important in promoting wellbeing and preventing mental ill-health, including medication, relationships with friends, family members and professionals, complementary therapies, religious and spiritual beliefs, self-help strategies, sport and physical exercise, and creative expression[3]. It is not surprising, therefore, that publications describing and endorsing non-conventional approaches in mental health have increased in the last few years. Both anecdotal and clinical evidence have supported the links between exercise[4], acupuncture[5], and spirituality[6] with mental health, to name but a few. For some individuals, complementary or alternative therapies work in tandem with conventional methods, helping medication (for example) to work more effectively and with fewer side effects. For others, alternative therapies really are just that – an alternative to prescribed or conventional treatments that are sufficient in themselves. One area that is receiving increasing attention from a range of communities is the role of diet in mental health.

1.3 The role of diet in mental health

Most people in the UK are aware of the well-established association between diet and physical health[7]. For example, a diet high in saturated fats, salt and sugar and low in fibre, fresh fruit and vegetables is heavily implicated in coronary heart disease (CHD) and some cancers - the leading causes of mortality in industrialised countries. Diet is also implicated in obesity and Type 2 diabetes, amongst many other physical health problems in the UK and beyond (see Figure 1).

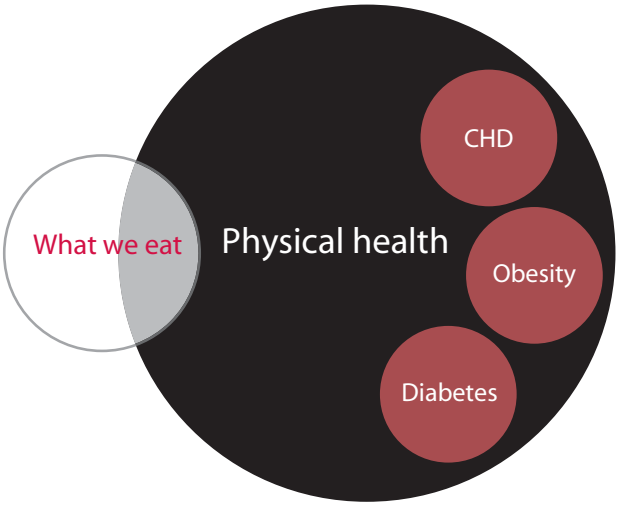

Figure 1: The association between diet and physical health

Less common in the UK is an awareness of a similar association between diet and mental health. Although the contribution made by diet to our mental health is complex and unquestioningly affected by other issues, there is a simple principle recognised by those who adopt an integrative understanding of human life. We know that diet affects physical health and we know that physical health affects mental health (for example, there is an increased incidence of depression in those who have heart disease), therefore even if there was no direct link between diet and mental health, we can understand that there is an indirect link. However, as this report explains, there is also an increasing understanding in the research community of the direct association between what we eat and how we feel and behave (see Figure 2).

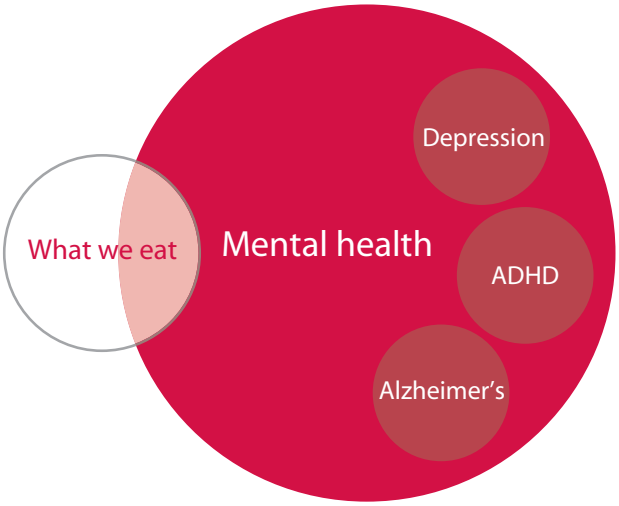

Figure 2: The association between diet and mental health

Although implicated in a number of mental health problems, including depression, Attention Deficit Hyperactivity Disorder (ADHD) and Alzheimer's, the role of diet in the nation's mental health has yet to be fully embraced. Potential reasons for this include being unaware of the evidence, scepticism of its quality and/or vested interest in other treatments. Added to this is the complex interplay of factors that can affect our mental health.

Even restricting ourselves to the growing body of research that illustrates the relationship between our diet and our feelings and behaviours, it becomes obvious that what we eat is affected by why and how we eat, both of which may also have an impact on our mental health. For example, if we see food purely as a means of 're-fuelling', our meal times will affect us differently than if we see food as a vital source of nourishment for our body and mind. Similarly, if we eat alone, the psychosocial benefits of food may be different than if we eat with others. This is reflected by the importance that food is given across a diverse range of cultural and religious traditions. Many faith communities observe traditions involving food, such as fasting and subsequent breaking of fasts with others or regular communal mealtimes. For others, many foods have spiritual significance and are consumed or avoided as an expression of faith.

The multitude of psychosocial factors that influence why and how we eat, contribute to – and are affected by – the choices concerning what we eat. A key factor that is associated with both mental health and diet is poverty (see Rogers and Pilgrim 2003[8]). This is closely tied to employment and levels of earnings and these issues also relate to what, why and how people eat. Add to this the reciprocal nature of many of these relationships and the picture becomes increasingly complex (see Figure 3).

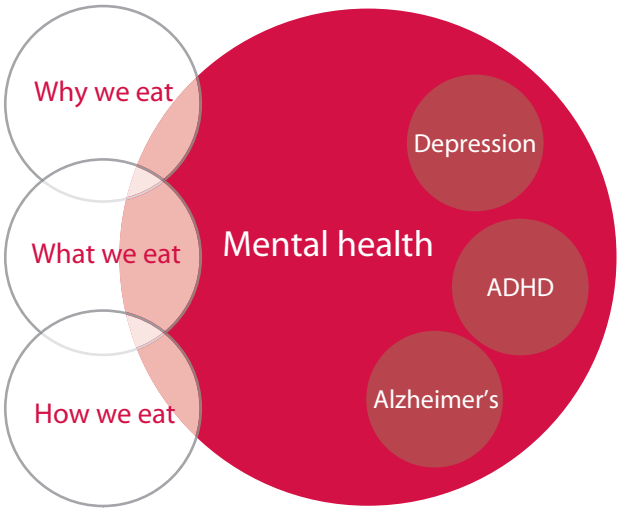

Figure 3: What, how and why we eat all affect, and are all affected by, mental health

In addition to the association diet has with specific mental health problems, there are generalised anxieties amongst the UK population concerning the impact of certain food production techniques on our mental health. For example, in recent years, hundreds of thousands of cows were incinerated in response to the threat of Bovine Spongiform Encephalopathy (BSE). When cows infected with BSE are consumed, people eating them are at risk of contracting a variant of Creutzfeldt-Jakob disease (CJD), which causes psychiatric and behavioural symptoms and, eventually, leads to death. Other recent anxieties have arisen in response to the impact of school dinners on children's health and wellbeing, the threat of E. coli and Salmonella poisoning.

With one in four people in the UK likely to experience a mental illness in their lifetime, the need for effective approaches to understanding and improving mental health has never been greater. Identifying and evaluating different pieces of the jigsaw enables individuals, practitioners and policymakers to make informed choices about promoting and maintaining good mental health. It is in this context that the evidence linking diet with mental health is explored.

1.4 Exploring the evidence

Anecdotal evidence of the connection between diet and brain functioning has been present and growing for many years. Beyond grandmotherly advice on 'brain food', a number of health professionals, parents, teachers and patient organisations have repeatedly asserted that changes to diet are mirrored in both positive and negative changes in feelings, behaviour and cognitive function. Increasingly, however, these personal experiences have gathered support from the academic and clinical research community. Studies have varied in their methodological approach, ranging from the examination of individuals' responses to dietary changes in randomised controlled trials to population-based, cross-cultural comparisons of mental health and food intake.

This report provides an overview of the impact of food on mental health. It recognises that some mental health problems, such as anorexia nervosa and bulimia, are associated specifically with issues around food consumption. It also acknowledges the cross-cutting impact of poverty on mental health and also upon what and how people eat. Whilst an exploration of these issues is beyond the scope of this report, further research is warranted to address their complexity and importance.

To place the evidence in context, historical patterns of food production and consumption and corresponding trends in mental health are presented in Section 2. Section 3 discusses the impact of diet on general wellbeing and daily mood, with particular emphasis on the physiological impact of diet on the brain. Section 4 examines the evidence linking diet with four specific mental health problems: ADHD, depression, schizophrenia and Alzheimer's. Finally, Section 5 recommends steps that need to be taken by policy-makers, practitioners and the broader research community to ensure that the role of diet in mental health is given the attention it deserves. Throughout the report, case studies of services or user groups and National Opinion Poll (NOP) survey data are presented. These are designed to illustrate and support the academic research data presented in the text.

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2.1 Changing patterns of food consumption

Although we depend on food like we always have, our relationship with it has undergone a transformation of remarkable magnitude. Whilst our hunter-gatherer ancestors would have been entirely dependent upon small amounts of local wild foods, many people (although not all) in the UK now have the luxury of eating more calories than the body physically requires, sourced from many countries around the globe.

Recent statistics[1] show that up to 40% of food we produce is wasted directly (because we buy it and then throw it away) or indirectly (because supermarkets reject produce that is the 'wrong' size or shape or past its 'sell-by' date). As shown in Figure 7, this trend is more pervasive amongst younger age groups, perhaps indicating a change in recent decades in the way we relate to food and consumption.

Box 1: Food – why we eat and what we throw away

Respondents to the NOP survey were asked to identify the main influences on their food consumption from the following list: time, habit, diet, cost, health, social reasons or convenience. The most commonly cited reason identified was health (40% of the sample), followed by time (30%), diet (29%) and convenience (23%). However, some of these responses varied according to the age, socio-economic status, income or marital status of the person being asked*.

For example, health became an increasingly important consideration with age, with nearly half of people aged over 65 reporting that health was a main influence on what they ate, compared with around one fifth of people aged 15-24* (see Figure 4).

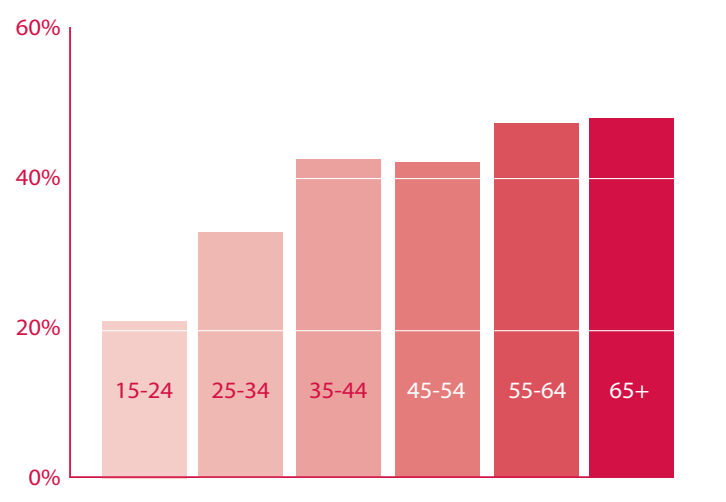

Figure 4: Those reporting that health was a main influence on what they eat, across age groups

Conversely, nearly half of people aged under 24 reported that time was an important influence on their choice of diet, compared with less than one tenth of people aged over 65*. This corresponds to the notion that eating for convenience is increasingly common in younger age groups (see Figure 5).

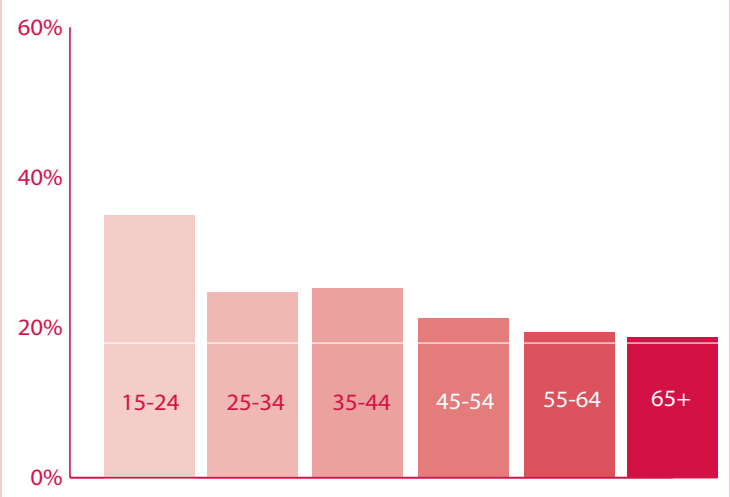

Figure 5: Those reporting that convenience was a main influence on what they eat, across age groups

Age is not the only factor that influences our decisions about what to eat. Household income and Socio-economic Status (SES) have a significant impact too. Cost is an important consideration in choices around food consumption, and becomes increasingly so as household income decreases. Approximately one third of people with a household income under £7,500 report that cost is an important influence on what they buy, compared to one tenth of people with a household income of over £50,000. The pattern is similar for SES (see Figure 6) and for those who are not in paid employment*.

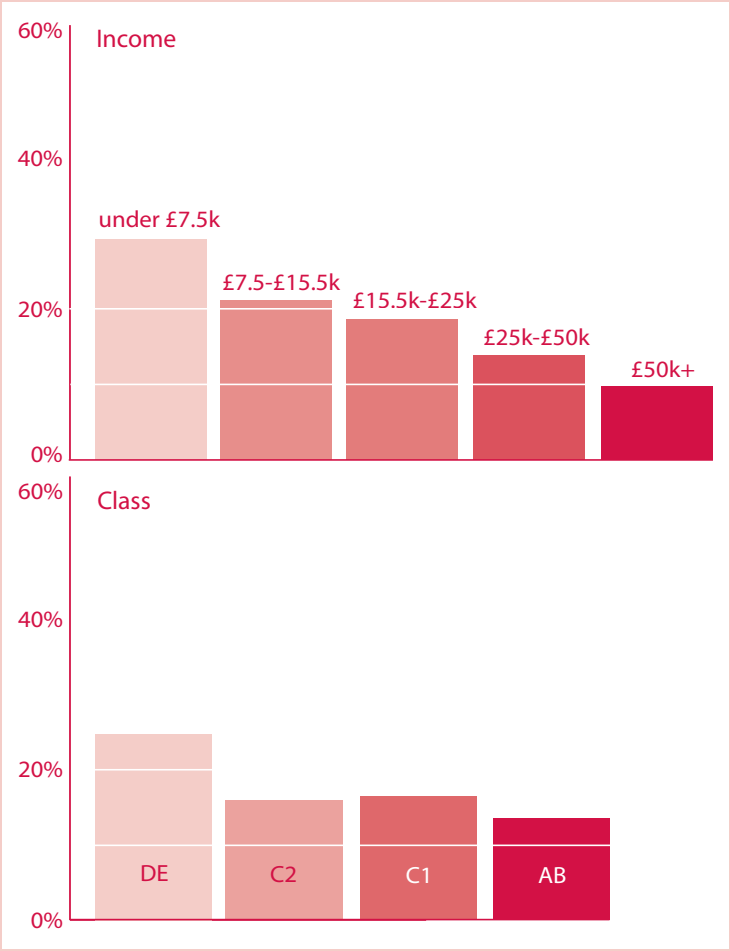

Figure 6: Those reporting that cost was a main influence on what they eat, according to income and class

People often buy food that they do not consume. For example, nearly a quarter of the sample report that they throw away 10% or more of all the food they buy each week.
However, some groups in the sample reported that they threw nothing away at all. Those with the lowest household income (under £7,500 p.a.), and those in class DE, fall into that group (21% and 19% respectively), compared to only 6% of people with a household income of greater than £50,000 or 12% of people in class AB. Similarly, 22% of those who are not in paid employment throw no food away, compared to 9% of people in full-time employment and 6% of those working part-time.
Those least likely to throw any food away are people aged over 65, as shown in Figure 7*.

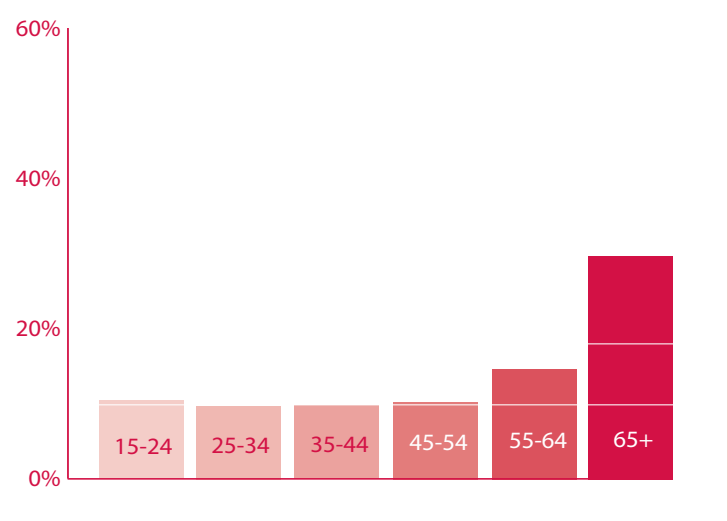

Figure 7: Those reporting that they throw no food away, across age groups

*All differences p<.05

The apparent shift in our attitude towards food – seemingly from one of respect to one of convenient necessity– has its roots in changes to food production that have occurred in western society. As humans evolved and developed new techniques for gathering food, the human diet changed from being hunter-gatherer based to being dependent on agriculture. As people shifted from nomadic groups to farming-based communities, the previous diet of wild meat, fruits and vegetables was replaced with a diet highly dependent on cereal grains. Archaeological evidence shows that these changes were accompanied by a marked decline in health[2,3].

The onset of the industrial revolution led to more dramatic dietary changes. The arrival of large numbers of workers into towns and cities required reliable quantities of cheap food to sustain them. This necessity led, in part, to a variety of changes both to the way food was prepared and where it came from. These changes included the advent of canning and freezing, more efficient and cheaper grinding of flour (which had the unintended consequence of removing most of the nutrients), the refining of sugar and improved methods of extracting vegetable oils. Moreover, developments in transport allowed foods to be transported vast distances, both quickly and cheaply. The twentieth century saw the pace of change quicken. After the experience of rationing during the world wars, British agricultural policy was driven by the need to increase the amount of food produced. Farming was industrialised and processed food became more and more commonplace.

The result of all these changes, alongside increasing wealth and shifting lifestyles, is that we are now consuming a diet different in both quantity and quality to that of our ancestors[4], with further variation in food consumption that has arisen in response to the changing ethnic and cultural diversity in the UK.

2.2 What we are eating now

According to the Food and Agriculture Organisation of the United Nations, production of food within the last thirty years has grown faster than the global population. Counting only the food available to humans, the world now produces the equivalent of 2,700 calories per person per day, whereas only thirty years ago the amount available was 2,300 calories[5]. What this means is that the existing food production system provides enough food to theoretically meet everyone on earth's calorie requirements every single day (although this is clearly not happening).

This increase in quantity is not the only change to our nation's food. The last fifty years have also witnessed remarkable alterations to the types of food we eat, the way we produce it, the way food is prepared and the way it is consumed. Since 1942, the UK Government has collected data on the weekly consumption of food in British households, which is then compiled in the annual National Food Survey (now the Expenditure and Food Survey)[6]. From these records and other surveys, it is possible to describe the types of food eaten by the British population in the last fifty years. Figure 8 shows the changes in the type and quantity of some popular foods consumed, on average, by an adult in the UK over that fifty year period. Whilst the consumption of two staple foods – bread and potatoes – has decreased, consumption of fruit juice, frozen vegetables and chicken have increased in the past fifty years. This probably reflects changes in income and lifestyle in addition to the increased availability of such products. Although it is initially appealing to assume that consumption of 'healthy' products has risen, what these statistics disguise is the impact of food production techniques on the quality – and nutritional benefit – of food (see below).

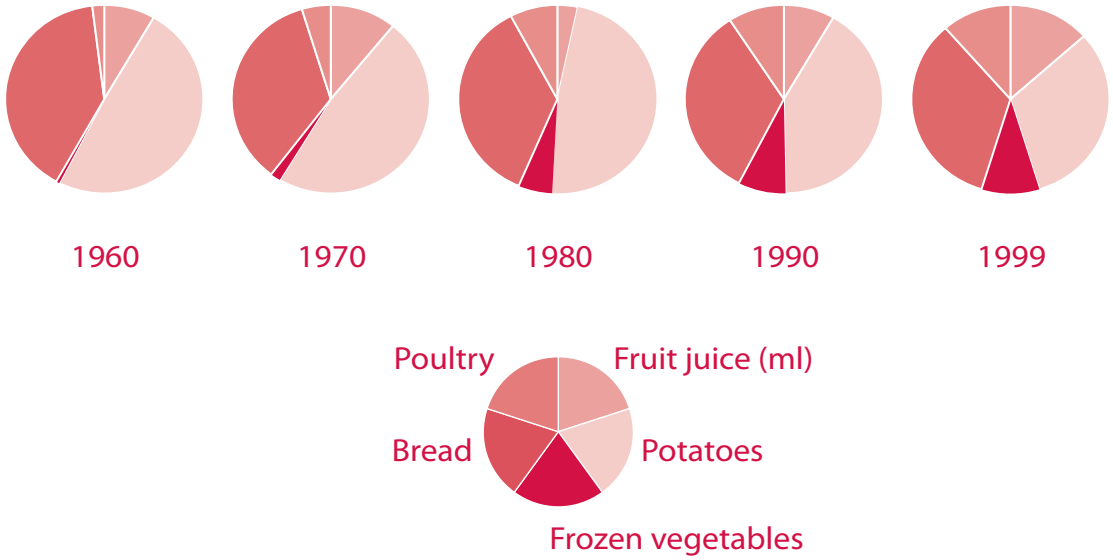

Figure 8: Changing patterns of food consumption in the UK over the past fifty years

The Expenditure and Food Survey also reveals some changes in the intake of other food products (see Box 2) as well as extensive data on two other contributions to our national diet: sugar and alcohol. The average consumption of sugar in the UK is 44 kg of sugar per person per year, consumed directly (added to drinks or meals) or indirectly (through sweets, chocolate and soft drinks). In addition, 60% of men and 44% of women exceed the (then) recommended alcohol intake of 21 and 14 units per week, respectively[7].

Box 2: Patterns of Food Consumption

Cereals

In the UK, the average calorie intake of cereals per person per day is 849 – or 25% of the total daily diet. The vast majority of this comes from wheat, which provides nearly 90% of those calories[8].

Meat

Once rationing was withdrawn in the early 1950s, the consumption of meat in the UK began to rise, a pattern repeated in the rest of the world. In 1961, the world ate 71 million metric tonnes of meat, but by 2002 this had risen to over 245 million - more than a three-fold increase[8]. The average consumption in the UK is approximately 81kg per person per year, or about 13% of the total daily diet[6].

Fruit and Vegetables

Since the first National Food Survey, there has been a 34% decline in UK vegetable consumption. Although the current recommendation is to eat at least five portions of fruit and vegetables per day, the most recent National Diet and Nutrition Survey found that only 13% of men and 15% of women did so, with most eating barely half of that amount[7].

Fish

People in the UK eat 59% less fish than when National Food Survey first began[6]. Nutritional advice is to eat at least 140g of oily fish per week, but much of the UK population fails to do so. On average, seafood contributes only about one per cent of the nation's daily calories[8].

Differences in consumption between men and women are not limited to alcohol. In the most recent National Diet and Nutrition Survey (NDNS, 2004), adults aged 19 to 64 years living in private households were selected at random to describe their food and nutrient intake, physical measurements, nutritional status and physical activity. The NDNS shows that women tend to eat more fruit, yoghurts and low-calorie drinks then men – who consume more alcohol, fats & oils, meat, sugars and full sugar soft drinks. Age also has an impact on the type and quantity of food consumed. For example, people aged 19 to 24 years consume fewer portions of fruit and vegetables than those aged 50 to 64 years. Those in the younger age group consume an average of 1.5 portions of fruit and vegetables per day, compared with 3.7 portions for men and women in the oldest group. Poverty creates another division. Men and women living in households in receipt of statutory benefits consume fewer portions of fruit and vegetables (about 2 per day) than those in non-benefit households (about 3 per day). Similar differences between groups were found in the NOP survey conducted for this report (see Box 3).

Box 3: Differences In Food Consumption in the General Population

Respondents in the NOP survey were asked how often they ate the following: breakfast; chips or crisps; chocolate; a meal made from scratch; organic foods; vegetables or salad; takeaway meals; fruit or fruit juice and ready meals.

Women reported eating healthy foods, including fresh vegetables, fruit or fruit juice and meals made from scratch, more often than men, who ate more takeaways and ready meals. This pattern was replicated for older people, half of whom reported eating a meal made from scratch every day (compared with less than a third of people under the age of 24) and 87% of whom reported eating breakfast every day (compared to 39% of people under the age of 24). Older people were also less likely to eat unhealthier (or 'junk') foods like takeaway or ready meals, chocolate and chips or crisps (see Figure 9) *.

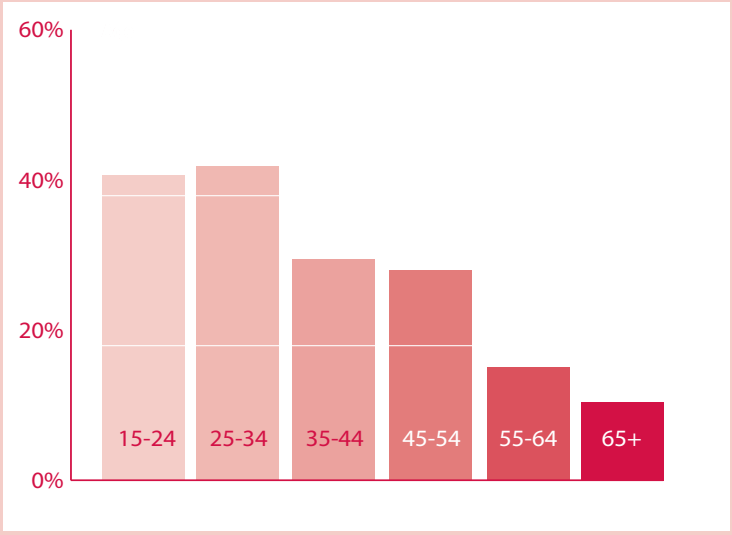

Figure 9: Those eating 'junk' foods 1-2 times per week, across age groups

The data shows that older women are those most likely to be eating healthy foods (e.g. organic food and meals made from scratch) more often and unhealthy or 'junk' foods less often. This pattern is also true for those who have higher household incomes, those who are married and those in full-time employment (for example, see Figure 10 and Figure 11) *.

*all differences p< .05

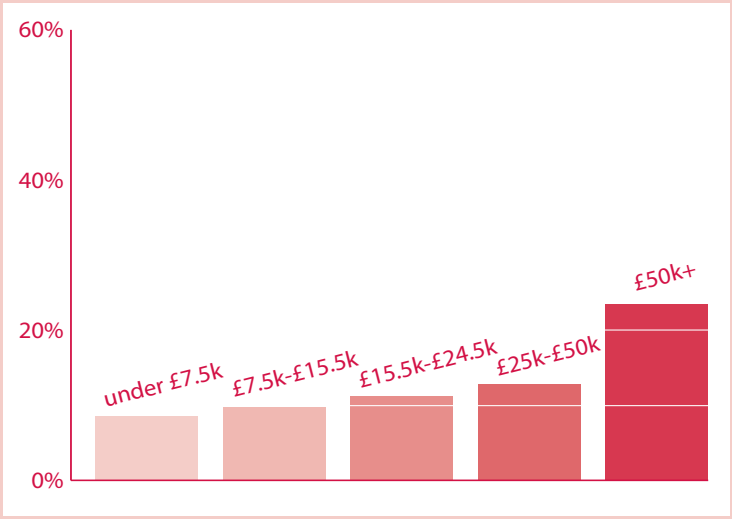

Figure 10: Those eating organic food 3-5 times per week, according to household income

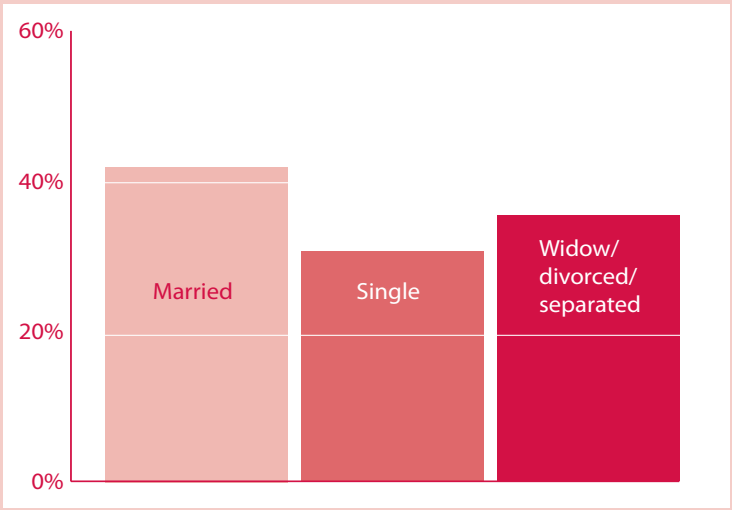

Figure 11: Those eating a meal made from scratch every day, according to marital status

Disguised amongst the statistics are the contributions made to our diet by differences in food manufacturing techniques, including the way it is processed and refined; food additives; use of pesticides and the alteration of animal fats through intensive farming. Table 1 summarises the effect of these common food production techniques on our dietary consumption.

Table 1: The impact of food production techniques on the diet

Technique	Impact
Processing	• Many packaged and processed foods are high in calories, fat, salt and sugar. For example, soft drinks contain an average of 160 calories and 1.5 ounces of sugar per can[9]. In the UK, in the year 2000, the average person drank 186 litres of soft drinks. In addition, 75% of salt in the diet comes from processed foods, with white bread often the single largest source of salt in an individual's diet[10]. • Processed foods are commonly devoid of nutritional elements, such as vitamins, minerals and essential fats (see Section 3). • Processed foods have also led to a damaging type of fat to be introduced more widely into the diet. Trans- or hydrogenated fat has no nutritional benefit, but mounting evidence suggests that it is much less healthy than even standard saturated fat. Although it exists naturally in small quantities in some animal products, its availability has increased due to the growth of processed foods. The impact of these fats on brain function will be examined in more depth in Sections 3 and 4.
Additives	There is a long history of adding substances to food to improve tastes or prevent spoilage, including smoke, salt, alcohol, spices and vinegar. However, the 1950s saw an explosion in the use of chemical additions to food and, by the beginning of the 1960s, there were 2,500 different chemicals being used in food production[11].

	The widespread use of food additives means that anyone who eats any amount of processed food will ingest them. It has been estimated that the average person in the UK and other industrialised countries will eat over 4kg of additives every year[12]. The impact of this situation is still controversial. Some Governments have appeared reluctant to fund, conduct or publish rigorously controlled studies examining the effects of additives and this is particularly the case regarding the 'cocktail effect' when different additives are combined.
Industrialised Farming	Since the drive to increase agricultural output began in earnest after the Second World War, there have been a number of changes in crop production that are influencing both the quantity and quality of the food consumed in the 21st century. These changes affect the composition of the food we consume and decrease the range of foods from which we can obtain the nutrients vital to our physical and mental health. For example: • The genetic diversity of crops is declining. Only nine crops are now responsible for over three-quarters of the plants eaten and 97% of the varieties of fruits and vegetables found in North America in 1900 are now extinct[13], along with 83% of the varieties of wheat developed in the Middle East[14]. • Also affecting the micro-nutrient composition of the food we eat is the distance it travels to get to our plate. "Food miles" is the term often used to describe how far a food travels from the place it is grown to the place it is eaten. It is difficult to estimate accurately, but one study calculated that the food purchased in an average UK shopping trip will have travelled over 3,000 kilometres[15]. Vitamins A, C, E, riboflavin, folate and thiamine can easily be lost through long storage, exposure to light, oxygen and heat[15]. • Several studies have suggested that the continuous replanting and then inadequate re-fertilisation of the soil is leading to poor soil quality. If this is the case, the result would be a loss of minerals, which are then absent from food grown in that soil.
Intensively reared animals	Changing methods of farming have also introduced higher levels and different types of fat into our diet. For example: • The worldwide production of chicken in 1961 was below 9 million metric tonnes – in 2002, that figure had risen to over 73 million[3]. This dramatic rise in production has only been possible due to considerably intensified production techniques. Chickens now reach their slaughter weight twice as fast as they did thirty years ago, which has changed the nutritional profile of chicken meat. Whereas a chicken carcass used to be 2% fat, it is now 22%. In addition, the diet fed to chickens is no longer based on insects, seeds and plants, but commercially grown cereals and soya-based foods. This has reduced levels of omega-3 fatty acids and increased omega-6 fatty acids in chicken meat[16] (see Section 3). • The same issue was reported in cattle over thirty years ago. A comparison of domestic, intensively reared cattle and wild bovids found that the carcass of the domestic animal contained 30% fat, whereas the wild species contained 5%[17]. • A similar pattern has been shown with fish. Due in part to concerns about falling levels of wild fish stocks, modern fish farming was developed in the 1960s. It is now the fastest growing form of food production in the world[18] and, because of the diet that farmed fish are fed, is leading to changes in the ratio of essential fatty acids in farmed fish, similar to that of chicken (more about this in Section 3).

Pesticides	About 350 different pesticides are presently used in conventional farming, with 31,000 tonnes sprayed every year in the UK alone[19]. Although there are concerns about the health effects of pesticides, we regularly consume them in the food we eat. Testing for residues by the Pesticide Residues Committee (PRC) in 2002 found that nearly 43% of all the fruits and vegetables tested contained residues, with some exceeding the approved limit[20]. This included 78% of apples and 50% of lettuces tested[21] and similar patterns have been found in cereals and bread[21]. The potential impact of pesticides on the very young and as a possible factor in the onset of Alzheimer's Disease will be explored further in Sections 3 and 4, respectively.

It is clear that what we are eating now is very different to that of even our very recent ancestors. Food production and manufacturing techniques, coupled with changing lifestyles and increasing access to processed foods, mean that our intake of fresh, nutritious, local produce is too low, at the same time as our intake of fat, sugar, alcohol and additives is too high. The question this brings to mind, therefore, is what impact this dietary shift has upon our nation's health?

2.3 Trends in the Health of the Nation

One result of the changes outlined above is a rise in serious physical health problems directly attributed to the modern diet, including obesity, coronary heart disease, diabetes, some cancers, osteoporosis and dental diseases[22]. Rising blood pressure with age is now so common it is considered normal, yet humans are the only animals to experience it and it does not occur in modern hunter-gatherer societies[23].

Our physical health has not been the only aspect of our health to suffer over recent years. Problems in mental health have also been increasing, with depression predicted to become the second highest cause of the global disease burden within the next 20 years[24]. Latest figures also show that, worldwide, 450 million people suffer from mental health problems, including depressive disorders, bipolar affective disorder ("manic depression"), schizophrenia, Alzheimer's and other dementias, obsessive compulsive disorder and panic disorder.
Mental illnesses represent four of the ten leading causes of disability worldwide and affect more than 25% of people at some point in their lives. At any one time, about 10% of the adult population is suffering from a mental or behavioural problem. In practical terms, one in four families is affected by a member with a psychological or behavioural problem[25]. These figures are reflected in the NOP survey conducted for this report (see Box 4).

Box 4: Mental Health and Diet

Respondents to the NOP survey were asked to identify the number of times they had experienced problems with depressing thoughts or ideas, anxiety or worry or problems with concentration and forgetfulness in the past month. The responses could range from "not at all" to "at least once a day".

Overall, half of the sample reported that they had experienced problems to some extent, with over a quarter of the sample (28%) indicating that they had experienced problems in one of these areas at least once a week.

These figures vary between groups*. For example, younger people are more likely than older people to report daily mental health problems, as are those in class DE, those on a lower income, those who are not in paid employment and those who are not married (for example, see Figure 12).

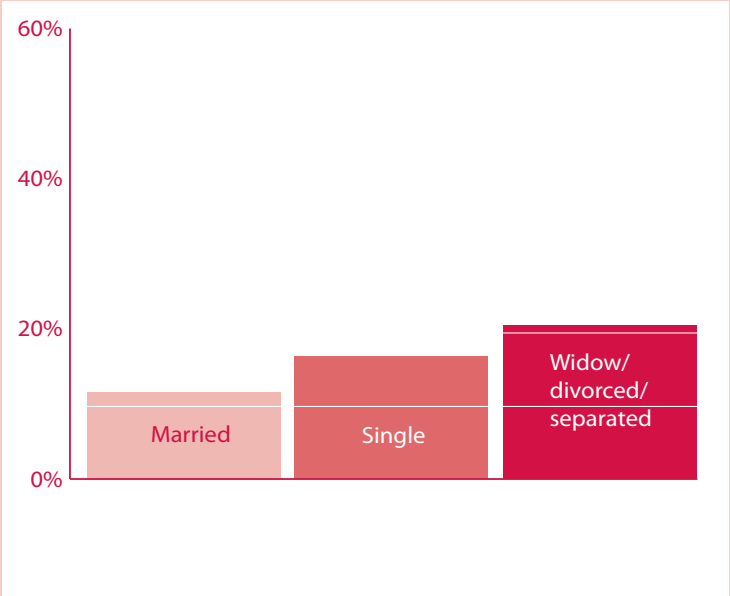

Figure 12: Those reporting daily mental health problems, according to marital status

This is consistent with the evidence showing the association between material, psychological and social deprivation and mental health problems. We know that different aspects of social structure affect mental health and those who are economically or socially disadvantaged are also at greater risk of experiencing a range of mental health problems, creating a cycle of inequality (for a comprehensive review of mental health and inequality, see Rogers and Pilgrim, 2003[26]).

There are also some associations between mental health and patterns of food consumption*. For example, nearly two thirds of those not experiencing mental health problems eat fresh fruit or fruit juice every day, compared to under half of people who report daily mental health problems and the pattern is similar for fresh vegetables and salad (for example, see Figure 13).

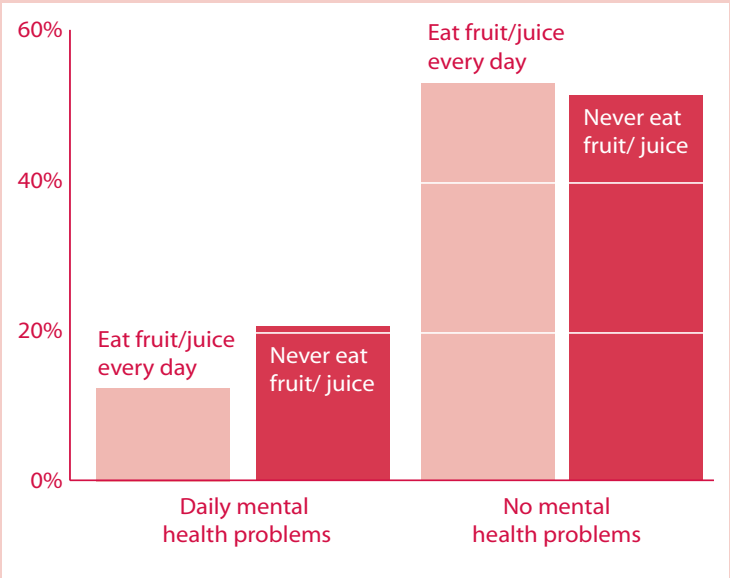

Figure 13: Difference in consumption of fresh fruit or fruit juice according to mental health status

Similarly, 65% of people in the group that have not experienced any mental health problems over the past month eat breakfast every day, compared to 59% of those who experience mental health problems at least once a day.

Although the direction of causation is difficult to establish in a survey of this nature and the interplay of other factors (such as income and age) draws a complex picture, two elements of the survey are reasonably clear. Firstly, just over a quarter of the population indicate some level of mental health problem and this is most pronounced in the younger age groups. Secondly, those with mental health problems are also those who are eating less healthy foods (fresh fruit and vegetables, organic foods and meals made from scratch) and more unhealthy foods (chips and crisps, chocolate, ready meals and takeaways). Further research is required to explore the nature and interaction of these patterns and to develop strategies to empower and encourage vulnerable people groups (especially the young and those on low incomes) to make choices that will benefit their mental health.

all differences $p<.05$

The impact of these changes in the mental health of the nation is not isolated to the individual experiencing mental health problems, devastating as they can be for those affected. One study in the UK showed that expenditure on inpatient mental health services was 22% of the total inpatient health care spending[24], and in 2000/1, the total cost of mental health problems was over £77 billion in England alone (this was twice the projected cost)[25]. Of this, £23.1 billion was due to lost employment, as 39% of adults with mental health problems are not in paid employment, and nearly £400 million was spent directly on antidepressant medication, as prescriptions continue to rise every year (see Figure 14). Latest figures estimate that the cost is continuing to rise, with the economic burden for the UK approaching £100 billion a year[27].

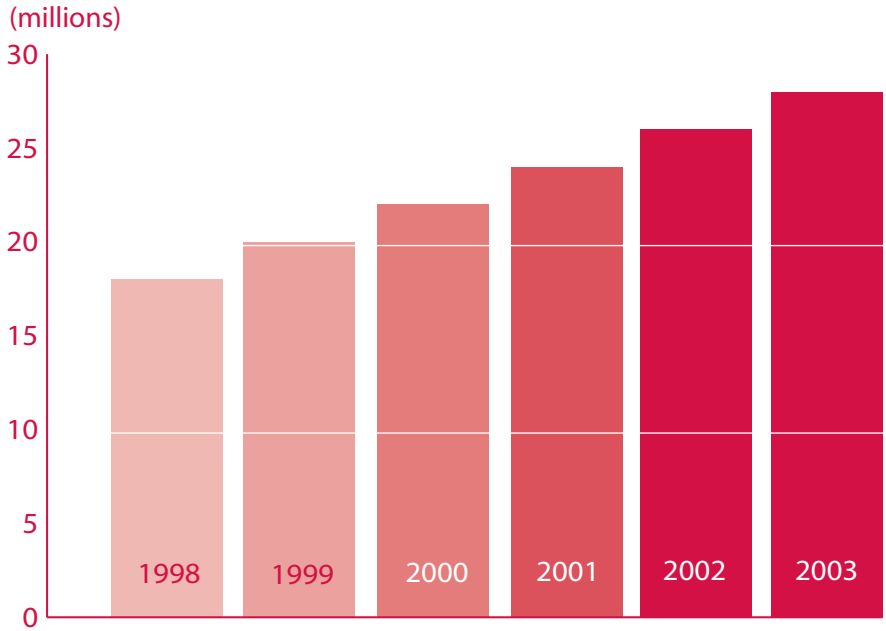

Figure 14: Number of prescriptions for antidepressants in England and Wales from 1998 to 2003 (millions)

2.4 Conclusion

The increasing burden of mental health problems is mirroring changes in food production and consumption in the UK. The evidence suggests that this is a contributory part of the picture. As farming becomes more intensive and the nutritional composition of some of the nation's best-loved foods deteriorates, stress-related illnesses are becoming more common and the general mood of the nation appears to be declining. Although some nutritionists and many in the mental health field have long been aware of the importance of diet within an holistic approach to improving mental health, shifts in policy and practice have been slower to materialise. In light of the gloomy picture painted of the state of the nation's health, what hope is there for reversing the trend and exploring alternative methods for improving general wellbeing and turning the tide of growing mental health problems? It is to this question that we now turn.

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3. THE ROLE OF DIET IN RELATION TO MOOD AND GENERAL WELLBEING

3.1 A healthy brain

At some point in our lives, most of us have experienced that nauseous feeling that leaves us asking ***"…maybe it was something I ate…?"***. We suspect that our stomach might recoil after badly-cooked chicken, or our liver will protest after too much alcohol, but, for some reason, we don't always apply this intuition to another physical organ of the human body – the brain.

Maybe one of the reasons that the health of our brain is rarely an important factor in our dietary considerations is because it has an aura of complexity unlike many of our other vital organs. It doesn't cause immediate distress in the way that our stomach might when we get food poisoning, so we rarely learn to connect what we eat with how our brain reacts. Yet, like the heart or the stomach or the liver, the brain is acutely sensitive to what we consume in our daily lives. To remain healthy, it needs different amounts of the following essential nutrients:

1. **Complex carbohydrates**
2. **Essential fatty acids (EFAs)**
3. **Amino acids**
4. **Vitamins and Minerals**
5. **Water**

In order to understand how these nutrients contribute to the health of the brain, it is helpful to summarise what the brain does, what it is made from and the mechanisms it uses to work effectively.

The brain is partly composed of billions of nerve cells, known as neurons. Neurons use their unique physical structure to allow the brain to communicate within itself and throughout the rest of the nervous system. Each neuron is connected to thousands of other neurons by branches called axons and dendrites. Each neuron, axon and dendrite is predominantly composed of fat, or 'lipid' and these are derived from the diet. Specifically, they are made from highly unsaturated fats, which ensures that they are highly flexible and can work rapidly. Between each branch, there is a gap where messages (called neurotransmitters) are passed back and forth. These messages allow neurons to communicate information amongst themselves (see Figure 15). Neurotransmitters are made from amino acids, which often must be derived directly from the diet. For example, the neurotransmitter serotonin, which is involved in feelings of contentment, is made from the amino acid trytophan. Adrenaline and dopamine, neurotransmitters that are involved in helping us feel motivated, are made from phenylalanine.

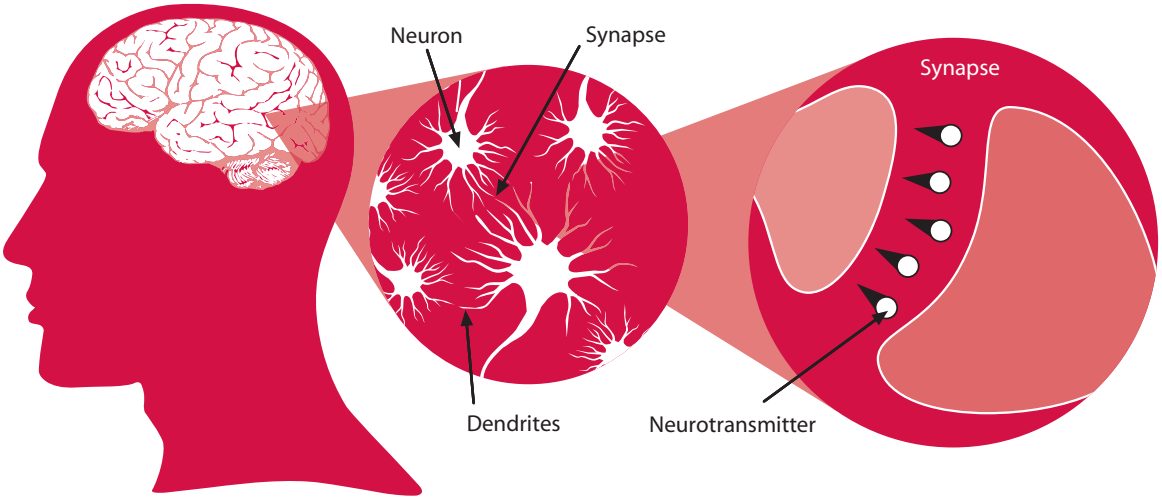

Figure 15: How the brain communicates information between neurons

In addition to the combined roles of genes and environment in brain development (especially critical during fetal development and infancy), diet is another factor that influences the health of the brain. This is partly because much of the brain's structure is derived directly from food. Therefore it is easy to see that what we eat will have a dramatic effect on our thoughts and feelings. Just as the products that we put into a car affect its performance, so the engine of our thoughts and feelings is designed to work most effectively when certain nutritional requirements are met. These requirements persist throughout the lifetime and, as evidence increasingly demonstrates, are important even from before we are conceived.

3.2 A healthy brain for life

The food we eat has the potential to affect our mental health and wellbeing at every stage of life.
The development of the brain at conception, during pregnancy and throughout the first three years of life are critical stages in this process[1]. Babies born at full term and at a healthy weight (i.e. those whose brains are fully and healthily developed) have physical and cognitive advantages over other pre-term or low-weight babies[2], with differences recorded in IQ, language and reading ability[3 4 5]. Studies have also shown that infants with low birth weights are less co-operative, less active, less alert and less happy than normal-weight infants[6].

Low birth weight can arise for many reasons, including the diet of the mother during pregnancy or a baby being delivered pre-term. Exposure to some pesticides while pregnant can increase the likelihood of a pre-term birth[7]. A link has also been found between pesticide exposure during pregnancy and a smaller infant head. Because head size has been linked to later cognitive ability, there may be a link between pesticide exposure and subsequent cognitive development[8].

The trend continues throughout infancy. The nutritional intake of an infant affects its neurodevelopment, which affects cognitive outcomes both in the short and long term[9 4]. Many studies have found that babies who are breastfed have a neurophysiological advantage in comparison to babies fed with formula milk and explanations for these findings point to the increased levels of essential fatty acids (EFAs) in breastmilk. EFAs are crucial elements of the brain's structure and are vital for good brain function (see page 42). One trial conducted to test this theory found that infants fed on formula milk supplemented with one particular EFA called docosahexaeonic acid (DHA) in the first weeks of their lives, performed better on cognitive, language and motor ability tests when they had reached eighteen months than those fed on standard formula milk[10]. Another study, which followed infants on supplemented formula milk until they had reached one year, found cognitive and language benefits at over three years of age[11].

As the child continues to grow, diet and nutrition continue to have a contributory influence on mental health. Many researchers (along with parents, teachers and campaigners) have suggested that the changes in nutrition provided in school and at home over the past 20 years may be a contributing factor to the rise of mental health problems in childhood and adolescence over that time[12]. Much of the research exploring the connection between diet and mental health in these age groups focuses on Attention Deficit Hyperactivity Disorder (ADHD) and there is also growing concern about the rising levels of depression in the young. Both of these specific mental health issues are explored in Section 4. However, diet is also implicated in other aspects of mental health, well-being and behaviour in young people.

One aspect that has received much attention has been academic attainment, with many studies linking children's nutritional status to achievement in the classroom. Research has shown that good nutritional intake is linked to academic success. In particular, several studies have shown that providing children with breakfast improves their daily and long-term academic performance[13 14 15]. Schools that have breakfast clubs also report improved behaviour in the classroom (see Box 5).

Box 5: Magic Breakfast - Fuel For Learning

Aims

Magic Breakfast aims to ensure that no child starts a school day feeling hungry and therefore unable to concentrate or learn.

Target group

Magic Breakfast delivers breakfast items to thirteen inner-city primary schools in London, UK. Approximately forty children per school receive the service.

History of organisation

Magic Breakfast was created when its founder, Carmel McConnell, discovered that a significant number of young children in the UK arrive at school hungry. Her first reaction was to personally deliver breakfast foods to five schools. When teachers subsequently reported that they had seen a positive difference to the school as a result of the donated food, Carmel created the Magic Breakfast to formalise the service. It became a registered charity in 2003.

Key Activities

- Distribution of protein-enriched bagels and healthy cereals to children in need via breakfast clubs (although some schools distribute throughout the morning if required).
- Provision of freezers to store bagels between deliveries.
- Delivery of healthy eating events to pupils, their teachers and parents. These include: trying new foods, learning new recipes and fun quizzes on nutritional knowledge.
- Offering companies a range of development opportunities (e.g. leadership skills, team-building, mentoring projects, website development, financial structuring) for employees who wish to assist inner-city school communities. This happens through Magic Breakfast's sister organisation Magic Outcomes.

Achievements

As well as the benefit of ending immediate child hunger, teachers have reported that children concentrate better and are more able to settle down in the classroom. In addition, their ability to socialise with other children has also improved (see 'Testimonies' below). Recently, Magic Breakfast was awarded an UnLtd Millennium Commission Level Three award. These are awarded to social enterprise organisations that UnLtd recognises as having the potential to have an impact at a national level.

Testimonies

"It is noticeable that the children who are eating bagels before school or at playtime are more focused during the following lesson and find it easier to follow school rules."

Headteacher, Kingsmead Primary School, Hackney, East London

"[An improvement in the children's capacity to concentrate and learn has been] particularly noticeable in individual children who are known for unsettled behaviour and limited concentration spans."

SHINE Academy co-ordinator, Millfields Community School, Clapton London E5

Barriers

- Funding. Magic Breakfast does not charge for any of its services to schools. Although it does have a small income from Magic Outcomes, it derives much of its funding from grants and charitable giving.
- Time. Due to the breadth and depth of the school curriculum, finding time to improve nutritional education can prove difficult, regardless of a school's enthusiasm.
- Lack of awareness. Many parents, organisations and members of the general public are unaware of the importance of nutrition or the extent of the problem in schools. Therefore, support for the organisation can be limited.

A number of published studies have shown that hungry children behave worse in school, with reports that fighting and absence are lower and attention increases when nutritious meals are provided[16 17 18]. Several studies have also looked at the impact of nutrition on younger people with anti-social behaviour problems. One study, conducted in a young offenders' unit, found that supplementing diets with vitamins, minerals and essential fatty acids resulted in significant and remarkable reductions in anti-social behaviour[19] (see Box 6).

Box 6: Natural Justice

Aims

Natural Justice is a registered charity that works to determine the causes of antisocial and criminal behaviour. It develops and promotes techniques for care and rehabilitation that address the social, biological and environmental influences on criminal behaviour.

Target groups

Those involved in criminal or anti-social behaviour and those working in the criminal justice system.

History of organisation

Natural Justice began (under a different name) in Cumbria where its director, Bernard Gesch, provided supervision to young offenders in the community who would have otherwise been sent into custody. During this time, Mr. Gesch noted the poor diets of those in his charge and in 1988, he convinced magistrates in Cumbria to let him test the effects of diet on a juvenile offender who had failed at all other attempts of rehabilitation. The result was a swift improvement in the young man's behaviour and the programme rapidly attracted academic and medical support. Individual dietary and supplementation programmes were then devised and around 20 young people went through the nutrition program with the approval of the courts. Some cases resulted in dramatic improvements in behaviour.

Activities

- Natural Justice brings experts from different scientific disciplines together to test empirically whether diet can change anti-social and criminal behaviour.
- Examination of the evidence that links offending behaviour with poor nutrition and exposure to toxic pollutants.

Achievements

The charity has extensive research collaborations and is now based at Oxford University. In 2001, Natural Justice conducted a double-blind randomised controlled trial to examine potential benefits of improved nutrition in a young offenders prison. 231 young adults were either provided with the daily recommended amount of vitamins, minerals and essential fatty acids or placebos and then evaluated for anti-social behaviour. Offending rates of those receiving the nutrients were reduced by an average of 35 percent.

In May 2004 the Dutch Ministry of Justice evaluated the research linking diet and antisocial behaviour. It concluded that the dietary approach was sufficiently cost-effective that it would allow them to improve services whilst achieving an 18% cost saving. Natural Justice has since been asked to assist the World Health Organisation in preliminary estimates of how much global violence could be attributed to poor diet.

Barriers

Funding. Natural Justice gets by on scarce resources. The funding for its initial controlled research came from the charitable sector, but it believes that a more costly in-depth study will require public funds.

It is not only childhood and adolescence during which food consumption influences our mental health and wellbeing. The protective effect that diet has on the ageing brain is also growing in evidence and recognition. Several dementia-related organisations promote healthy diets as a preventative measure against age-related cognitive decline (for example, the Alzheimer's Society's "Mind Your Head" campaign and the Alzheimer's Association's "Maintain Your Brain" Campaign) and an increasing number of studies show that a diet high in essential fatty acids and low in saturated fats slows the progression of memory loss and other cognitive problems.

Many studies have also examined the impact of pesticide exposure on the onset of Parkinson's Disease (PD). Following a review of over forty studies that showed an increased risk of the disease following exposure to a number of different pesticides, the UK Government's Advisory Committee on Pesticides has recently called for more research into this association and to clarify which pesticides create the highest risk[20]. A previous meta-analysis of many of these studies had also confirmed a relationship between PD and pesticide exposure[21]. Exposure has ranged from those who work in agriculture[22], those who live in the vicinity of sprayed areas[23], and even those who have eaten large amounts of sprayed fruit[24].

One mechanism through which diet protects against cognitive decline is the process of methylation, the process our brain depends on to create, maintain and repair brain cells and the neurotransmitters that pass between those cells. Technically, the methylation process involves methyl groups – made of one carbon atom and three hydrogen atoms – being added to or subtracted from other molecules. In this way, the body is able to make the substances it requires (or break down those it doesn't) and keep a well-balanced and healthy collection of cells. Metaphorically, methylation is like the brain's mechanic – monitoring, fixing and keeping everything working as it should. The better the mechanic works, the better the brain works. The impact of poor methylation will be examined in more detail in Section 4.

3.3 Food and mood in the general population

The majority of the UK population are aware of the connection between diet and obesity or diet and coronary heart disease. Similarly, anyone who has ever smoked, drank alcohol, tea or coffee, or eaten chocolate knows that such products can improve one's mood, at least a little and at least temporarily. However, what seems to be less common is an understanding that some foods can have a long-lasting influence on general mood and mental wellbeing because of the impact they have on the structure and function of the brain.

What we eat (and drink) affects how we think and feel every day of our lives, regardless of our age, gender or family background. This is reflected in the statistics: not only is the UK a nation of tea-drinkers – in an average week we drink 1 billion cups – we are a nation addicted to many 'feel-good' fares, including coffee, soft drinks, alcoholic drinks, cigarettes and chocolate[25]. Although it's tempting to assume that we all know what's bad for our health and that the problem is with the translation from that knowledge to behaviour, the picture is less straightforward than that. Not only is much of the population unaware of the connection between unhealthy food products and mental health, even more are unaware of the impact of healthy foods on our mood and feelings (see Box 7).

Box 7: The Association Between Food And Mood

Respondents to the NOP survey were asked to indicate the extent to which they thought a number of foods and drinks affected their mood or feelings. All of the foods are known to influence mood and feelings to some extent, although it was hypothesised that people would be more aware of the link between unhealthy foods and mood than between healthier alternatives. As shown in Figure 16, a majority of respondents reported that brown rice or pasta, fish and fruit & vegetables did not affect their mood at all.

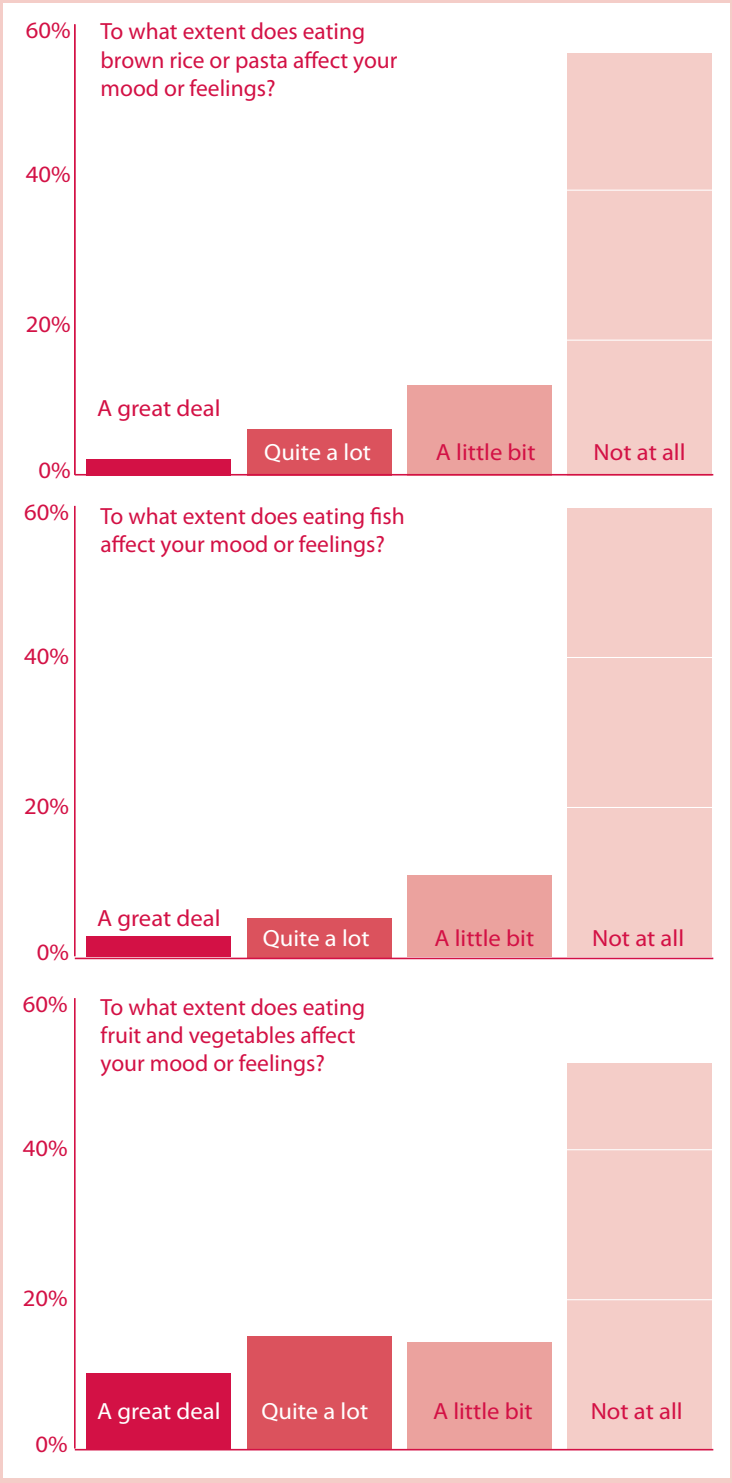

Figure 16: The extent to which different healthy foods are perceived to affect mood and feelings in the general population

However, similar patterns were also demonstrated for food products that, when consumed in large amounts, are unhealthy in terms of our mental (as well as physical) health, including alcohol, fast food meals and some carbonated, caffeinated drinks (see Figure 17).

Statistical tests on the data collected by the survey reveal that a higher percentage of those reporting that these food products do not affect their mood and feelings at all are male and are in the younger age groups*. There are a number of explanations for this finding, including the possibility that their perception is accurate or their reporting is biased in some way. An alternative explanation is that a generation of young people is becoming increasingly unaware of the connection between what they consume and how they feel and perhaps that there are underlying reasons why males are particularly vulnerable to not accessing that knowledge.

*p<.05

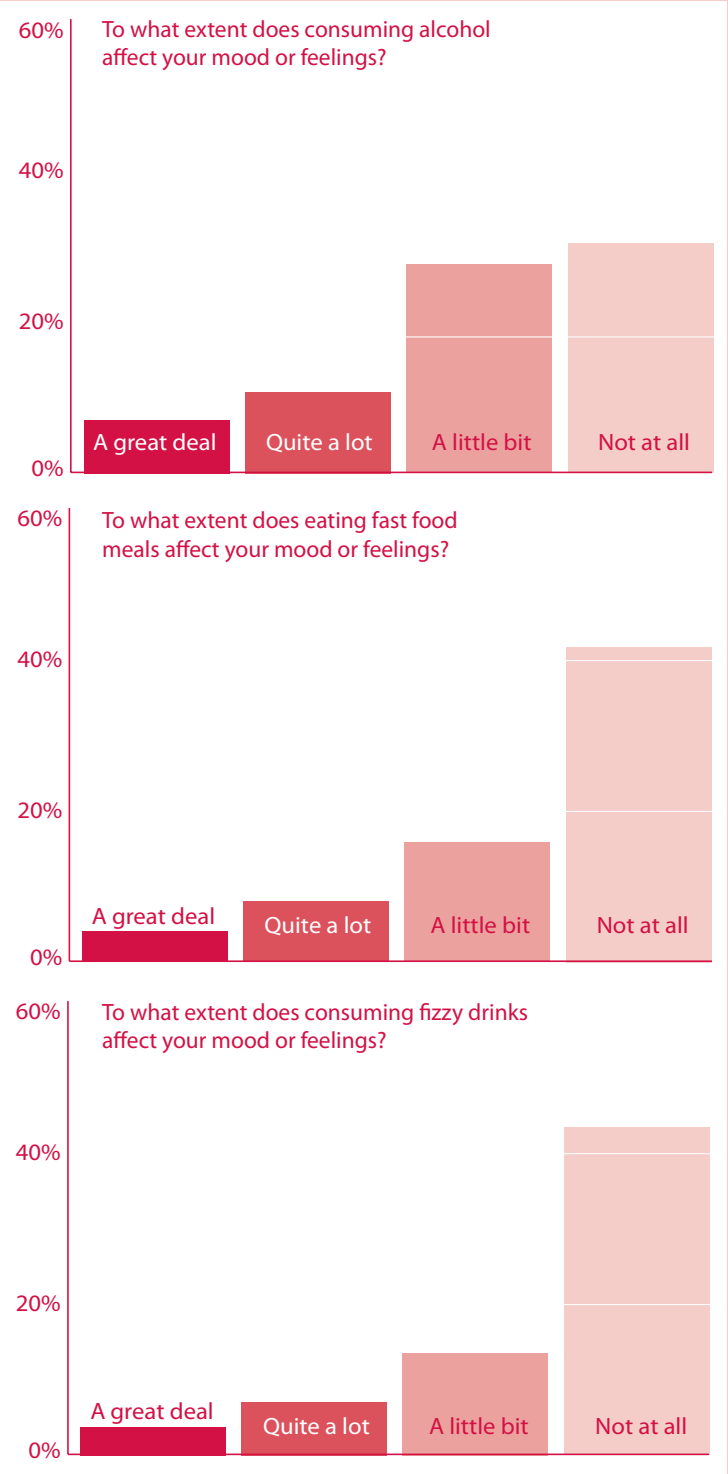

Figure 17: The extent to which different unhealthy food products are perceived to affect mood and feelings in the general population

Before we look at foods that serve the brain – and, therefore, our mental health – it's important to understand how some products in our diet have a detrimental effect on our thoughts and feelings, including those that we think 'boost' our mood from time to time. Broadly speaking, there are two groups of foods that can have a negative effect on mood in the short and/or long term. One group trick the brain into releasing neurotransmitters that we may be lacking, thereby creating a temporary fix to the deficiency, and one group damage the brain by preventing the necessary conversion of other foods into nutrients the brain requires. The third group are those that nourish and replenish the brain and, when eaten regularly and in sufficient quantities, are associated with improvements in mood and feelings of wellbeing.

3.4 Foods that trick the brain

There are four neurotransmitters that are particularly important when it comes to our thoughts and general mood: acetylcholine, serotonin, dopamine/adrenaline/noradrenaline and 4-aminobutyrate (GABA). A sufficient balance of these neurotransmitters is essential for good mental health, as they are influential in feelings of contentment and anxiety, memory function and cognitive function. This becomes apparent when people have neurotransmitter imbalances or deficiencies, which can create many symptoms, ranging from difficulties in sleeping to feeling unmotivated or anxious.

Some substances are good at temporarily promoting the neurotransmitter that we lack and, as we crave and then consume them, they 'trick' us into feeling better, for a while. For example, if an individual is low in levels of adrenaline, they may find themselves craving caffeine, which gives a short-term boost to levels of adrenaline. Similarly, products containing nicotine trigger the release of GABA and dopamine, responsible for reducing feelings of stress. Chocolate is another classic example of this 'trick' effect: it contains substances that boost levels of noradrenaline, which subsequently boost our feelings of wellbeing and enthusiasm for life. Whilst we can all probably testify to the perceived immediate psychological benefit of these products, the process is – by and large – one of deception over the long term.

By making the brain less sensitive to its own transmitters and less able to produce healthy patterns of brain activity, these substances encourage the brain to down-regulate[26]. Down-regulation is the brain's instinctive mechanism for achieving homeostasis: when the brain is 'flooded' by an artificial influx of a neurotransmitter (for example, adrenaline triggered by a strong coffee), the brain's receptors respond by 'closing down' until the excess is metabolised away. This can create a vicious circle, where the brain down-regulates in response to certain substances, which in turn prompt the individual to increase their intake of those substances to get the release of the neurotransmitter that their brain is lacking (see Figure 18). This is one reason why people sometimes crave certain products. The section on foods that nourish the brain will look at ways of promoting the release of the brain's own neurotransmitters through foods that do not trick the brain in this way.

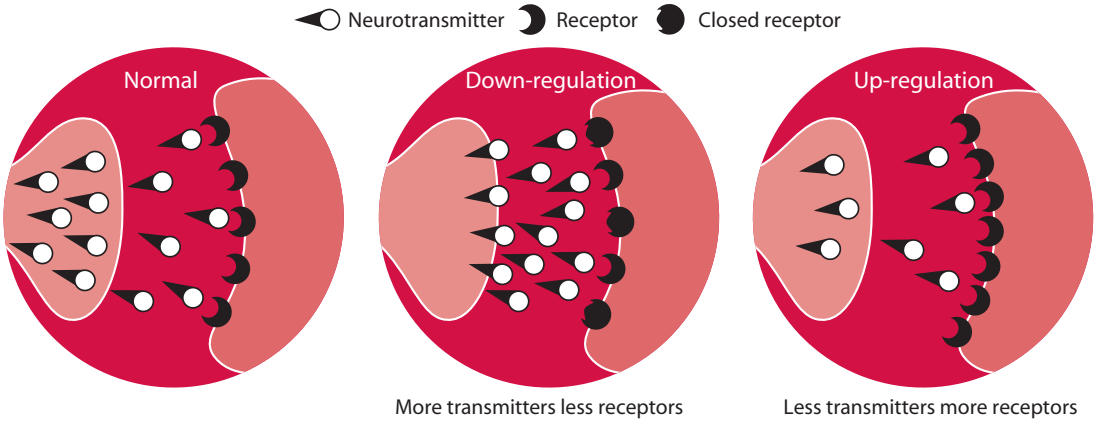

Figure 18: How foods affect the regulation of the brain

3.5 Foods that damage the brain

As well as foods that trick the brain into releasing (or suppressing) vital neurotransmitters, certain foods (and drinks) do their damage by increasing the amount of toxic 'free-radicals' or oxidants in the body. Oxidants are unstable molecules that are missing a critical atom. In order to stabilise themselves, they search to find and steal that missing atom from another molecule. Unfortunately, in acquiring these missing atoms, oxidants injure healthy cells, damaging their DNA and creating the potential for disease by damaging the tissue that is built from essential fats, proteins, and vitamins that are required for optimum brain function. Although normal cell functions produce a small percentage of oxidants, some foods can increase their emission to a level that the body cannot cope with alone. Saturated fats (e.g. butter, lard, whole milk, coconut and palm oils) and hydrogenated- or trans-fats (unsaturated vegetable oils that have been refined and hardened) are two of the worst culprits in this category.

Because the brain is composed of about 60% fat (when water is removed), the fats we eat directly affect the structure and substance of the brain cell membranes. Saturated fats – those that are hard at room temperature, like lard – make the cell membranes in our brain and body tissue less flexible. If we eat large quantities of saturated fats, their rigidity is reflected in the rigidity of the brain cells. Although most authorities now agree that no more than 11% of our total calorific intake should be derived from saturated fats, the average adult population intake of saturated fat is approximately13.3% of food energy and that is before we add the calories we consume through trans-fats[27].

The recent and widespread appearance of trans-fat in the diet raises great concern, particularly because of its impact on the brain, where it assumes the same position as essential fatty acids (EFAs) in the brain. This blocks the brain's conversion of EFAs into docosahexaeonic acid (DHA) and eicosapentaenoic acid (EPA) so that those vital nutrients are not able to assume the position they need to for the brain to function effectively (see Figure 19). Trans-fats are prevalent and pervasive, found in processed foods like commercially-made cakes, crisps and ready meals.

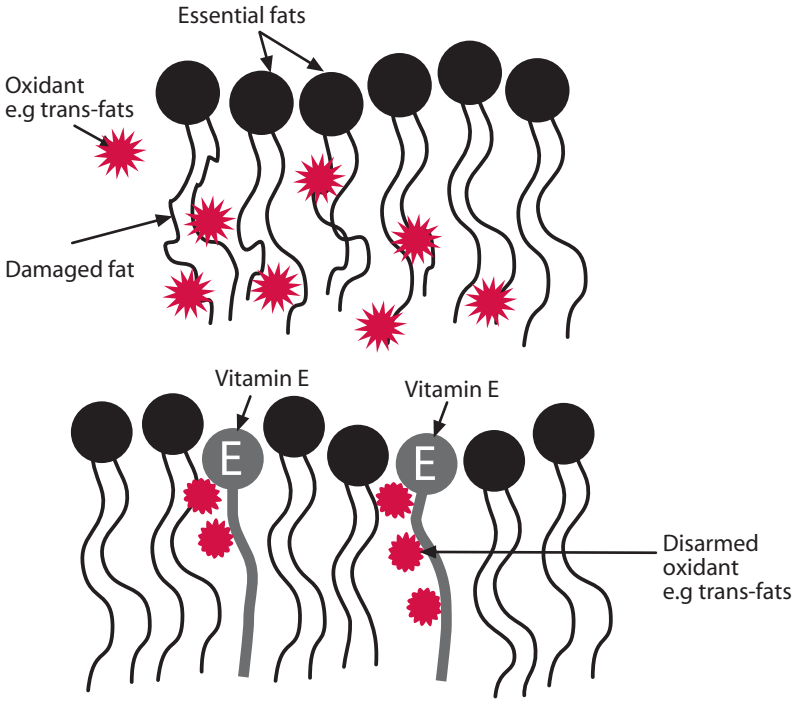

Figure 19: How oxidants (e.g. trans-fats) affect the structure of the brain

Fried food, smoking, alcohol and stress also introduce oxidants into the body. Ways of increasing the body's natural ability to fight these toxins are explored below.

3.6 Foods that nourish the brain

We have seen that some nutrients trick the brain by triggering an over-release of neurotransmitters and some foods damage the brain by releasing toxins or oxidants that damage healthy brain cells. Both of these processes are implicated in long term mental health issues. Fortunately, there are many more nutrients that serve the brain without deception or damage, and can improve mood and mental well-being.

Firstly, there are some foods that can help the brain to release an efficient balance of neurotransmitters that won't lead to down-regulation. As mentioned earlier, there are four neurotransmitters that are particularly important when it comes to our thoughts and general mood: acetylcholine, serotonin, dopamine/adrenaline/noradrenaline and GABA. Table 2 summarises the effects of deficiency in each of these neurotransmitters, the foods that will make the deficiency worse and those that will improve it.

Table 2: Neurotransmitters and their effects (from Holford, 2003[28])

Neurotransmitter	Effects of deficiency	Foods to avoid	Foods to consume
Acetylcholine	Deterioration of memory and imagination Fewer dreams Increased confusion, forgetfulness and disorganisation	Sugar Deep-fried food Junk foods Refined and processed foods Cigarettes Alcohol	Organic/free-range eggs Organic or wild fish – especially salmon, mackerel, sardines and fresh tuna*
Serotonin	Low mood Difficulty sleeping Feeling 'disconnected' Lacking joy	Alcohol	Fish Fruit Eggs Avocado Wheatgerm Low-fat cheese Lean, organic poultry
Dopamine	Lacking drive, motivation and/or enthusiasm Crave stimulants	Tea & coffee Caffeinated drinks & pills	Regular, balanced meals Fruits and vegetables high in Vitamin C Wheatgerm Yeast spread
GABA	Hard to relax Can't switch off Anxious about things Irritable Self-critical	Sugar Alcohol Tea & coffee Caffeinated drinks	Dark green vegetables Seeds & nuts Potatoes Bananas Eggs

* Recent and current trends in the fishing industry have led to significant concerns about social, economic and environmental sustainability of fish stocks. If you do eat wild fish, choose only those sources that are certified with the MSC-Label, which ensures your fish came from a sustainably managed source. If you choose to purchase farmed fish, make it organically farmed fish[29].

Secondly, aside from avoiding pollutants like cigarette and exhaust fumes and learning to manage stress effectively, it is possible to combat the effects of oxidants by ensuring that our diet is full of anti-oxidants, that is, foods containing the nutrients that disarm toxins and decrease brain pollution. The main sources are fruit and vegetables, which are rich in the antioxidants vitamins A, C and E.

According to studies using human and animal blood, certain foods – those high in an antioxidant assay called ORAC (oxygen radical absorbance capacity) – may protect cells and their components from damage by oxidants[30]. Figure 20 demonstrates the value of 14 top sources of antioxidants. Other antioxidants include selenium (found in oysters, brazil nuts, seeds, tuna and mushrooms); glutathione (tuna, pulses, nuts, seeds, garlic and onions); lipoic acid (red meat, potatoes, carrots, yams, beets and spinach) and co-enzyme Q (sardines, mackerel, nuts, seeds and soya oil).

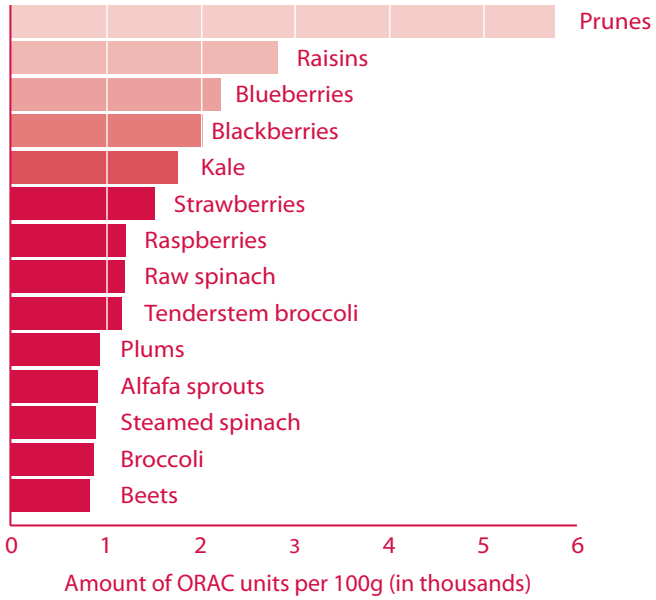

Figure 20: the ORAC value of 14 antioxidant foods[30]

In addition to feeding the brain with foods that will regulate neurotransmitter activity and protecting the brain from the effects of oxidants, mood and feelings of wellbeing will be improved by ensuring that one's diet provides adequate amounts of complex carbohydrates, essential fats, amino acids, vitamins and minerals and water.

3.6.1 Complex Carbohydrates

The brain runs on the fuel of glucose, using more of this nutrient than any other organ in the body. It is derived from carbohydrates, which are turned into glucose upon digestion and delivered to the brain and cells in other parts of the body. However, some carbohydrates are better at fuelling the brain than others, because they are less refined and therefore release the glucose more slowly. Slow-releasing – or complex – carbohydrates, in foods like wholegrains, vegetables and beans, take longer to digest than refined equivalents such as white bread, processed cereals and sugar, that have, in a sense, been 'pre-digested' by the processing techniques. Choosing foods that take longer to be converted from their raw state to glucose means that your brain receives a more stable and consistent flow of fuel with which to function.

3.6.2 Fats: Essential Fatty Acids (EFAs)

Although some fat is often considered unhealthy, it is vital for proper brain functioning. The 'dry weight' of the brain is composed of about 60% fat, including saturated fat and cholesterol, with approximately 20% of that made from the essential fatty acids, omega-3 and omega-6. Omega-3 and omega-6 are groups of essential fatty acids, of which there are a number of different types. For example, reference is often made to arachidonic acid (AA), docosahexaeonic acid (DHA) and eicosapentaenoic acid (EPA).

Omega-3 and omega-6 are termed 'essential' because they cannot be made within the body, so must be derived directly from the diet. Each fatty acid performs vital functions in the structuring of brain cells (or neurons), therefore ensuring that smooth communication is possible within the brain. One of the richest sources of omega-3 fatty acids are oily fish. Fish consumption has been reported to have an association with better moods and a higher self-reported mental health[31], even after adjustment for factors such as income, age and other eating patterns. A recent study has also found fish consumption to be associated with a reduced risk of cognitive impairment (including memory) in middle age[32]. The study also found a increased risk of impairment associated with the consumption of cholesterol and saturated fat, which impairs the efficient conversion of fatty acids into brain cell membranes. Omega-6 fats are found in a range of seeds, vegetables and vegetable oils.
Although scientists are still uncertain of the reasons why, evidence shows that unequal intakes of omega-6 and omega-3 fats are implicated in a number of mental health problems, including depressive and affective problems and concentration/memory difficulties. This evidence is examined in more detail in Section 4.

3.6.3. Amino acids

Neurotransmitters (the 'messengers' in the brain) are made from amino acids, some of which can be made in the body and some of which need to be derived from protein in the diet (therefore called essential amino acids). Some amino acids convert directly into neurotransmitters meaning that if the diet does not provide adequate amounts of these amino acids, sufficient neurotransmitters may not be produced, potentially creating problematic communication between neurons.

A deficiency in certain amino acids may leave someone feeling depressed, apathetic, unmotivated and unable to relax[33]. Perhaps the most widely studied in diet-behaviour research has been the connection between tryptophan (an amino acid) and serotonin (a neurotransmitter). Tryptophan is found in eggs, lean meat, free-range poultry (especially turkey) and beans and is first converted to 5-hydroxytryptomine (5-HTP) before being converted to serotonin. Stable and sufficient levels of serotonin are implicated in mood, wellbeing and sleep patterns. As well as increasing one's intake of foods rich in tryptophan, carbohydrates (even though they contain no tryptophan) also increase its availability, because the insulin released on digestion puts the competing amino acids to a different use, easing tryptophan's entry into the brain. Other amino acids have also been the focus of academic research, with promising results. For example, tyrosine (which converts to dopamine, noradrenaline and adrenaline) improves mental and physical performance under stress better than coffee[34] and GABA has been shown to be highly effective against anxiety[35]. For foods that will supply your brain with sufficient amounts of these amino acids, please refer to Table 2 on p40.

3.6.4. Vitamins and Minerals

Vitamins and minerals (called micronutrients) perform a number of essential functions in support of all the processes described above, including assisting essential fatty acids to be incorporated into the brain and helping amino acids convert into neurotransmitters. Large amounts of some minerals are needed within the body, while some are only required in very small amounts (called 'trace elements'). All vitamins, with the exception of vitamin E (which the body is able to synthesise), must be derived from the diet.

Deficiencies in vitamins and minerals are sometimes implicated in a number of mental health problems. On occasions, the first symptom that a body is deficient in a certain micronutrient is psychological[36] (see section 4). In addition, some vitamins work as anti-oxidants, which protect the brain from the damaging process of oxidation (see above). Vitamins and minerals also play a crucial part in the conversion of carbohydrates into glucose, fatty acids into healthy brain cells and amino acids into neurotransmitters. As such, they are vital in promoting and maintaining positive mental health. This has been observed for vitamins C[37], B12[38] and B2[39] and has led to research on the mood effects of depleting or supplementing various micronutrients.

One double blind, placebo study supplemented participants' diets with nine separate vitamins, at over ten times the recommended daily level, for one year. At the end of the year, both men and women in the supplemented group reported better mental well being than the control group[40]. The same study also found better performance on a range of cognitive tests amongst the females taking the supplement[41]. Thiamine, or vitamin B1, has also been the subject of a number of studies. Several controlled trials have demonstrated that participants experience low mood, irritability and fatigue when they have a low thiamine status – and that their mood improves when their status is increased[42 43 44 45]. A low selenium status has also been associated with poor mood[46] and that supplementing the diet with selenium leads to improvements in mental health and feelings of wellbeing[47]. Another study, which depleted selenium from some of the study participants' diets, recorded increased levels of hostility and depressed moods when status was low[48]. Similar results have been found in studies looking at iron deficiency[49].

These results – a handful amongst hundreds – indicate the importance of ensuring regular and sufficient amounts of these vitamins and minerals are consumed in the diet. Table 3 lists the major nutrients that the body needs and where best to find them.

Table 3: Table of essential vitamins and minerals and where to find them (from Holford, 2003[28])

Nutrient	Effect of deficiency	Food sources
Vitamin B1	poor concentration and attention	wholegrains vegetables
Vitamin B3	depression	wholegrains vegetables
Vitamin B5	poor memory stress	wholegrains vegetables
Vitamin B6	irritability poor memory stress depression	wholegrains bananas
Vitamin B12	confusion poor memory psychosis	meat fish* dairy products eggs
Vitamin C	depression	vegetables fresh fruit
Folic acid	anxiety depression psychosis	green leafy vegetables

Magnesium	irritability insomnia depression	green vegetables nuts seeds
Selenium	irritability depression	wheat germ brewer's yeast liver fish* garlic sunflower seeds Brazil nuts wholegrains
Zinc	confusion blank mind depression loss of appetite lack of motivation	oysters nuts seeds fish*

* Recent and current trends in the fishing industry have led to significant concerns about social, economic and environmental sustainability of fish stocks. If you do eat wild fish, choose only those sources that are certified with the MSC-Label, which ensures your fish came from a sustainably managed source. If you choose to purchase farmed fish, make it organically farmed fish[29].

3.6.5 Water

Water makes up about 80% of the brain and is an essential element in its functioning. Inadequate hydration – either because of insufficient water intake or as a consequence of taking some psychiatric medicines – has significant implications for mental health. The early effects of even mild dehydration affect feelings of wellbeing, performance and learning and in the long term carry a higher risk of a number of health problems. For example, initial symptoms of dehydration include restless or irritable behaviour, weakness and feeling unwell. More severe symptoms include low blood pressure, fainting, severe muscle contractions in the arms, legs, stomach and back, convulsions and, on occasions, heart failure. During an average day in the UK, an adult's body loses approximately 2.5 litres of water. This can be through the lungs as water vapour, through the skin as perspiration, or through the kidneys as urine. If sufficient fluids are not consumed to replace this water, symptoms of inadequate hydration – including increased irritability, loss of concentration and reduced efficiency in mental tasks – can appear.

Poor hydration also adversely affects a child's ability to concentrate, pay attention and remain alert. Water consumption can have an immediate alerting and revitalising effect on children, a fact not ignored by the Government, whose Guidance for Caterers for School Lunch Standards[50] expects that "drinking water should be available to all pupils every day free of charge". However, these are guidelines only, not requirements - and there are no guidelines for provision of water during the rest of the school day. Although the Welsh Assembly has provided free mains-fed water coolers and personal water bottles to 384 schools in Communities First areas and The Scottish Executive has funded mains-fed water coolers, modern water fountains with swan necks and personal water bottles for all primary and secondary schools, schools in England are still awaiting such developments.

3.7 Conclusion

The contribution of what we eat to how we feel is gaining ever more public recognition. This is due, in part, to the increasing body of academic research demonstrating the association between food and brain function. It is also due to high-profile campaigns on the television and amongst mental health organisations. One project that explored in depth the association between food and mood is described in Box 8.

Box 8: The Food And Mood Project

Aims

The Food and Mood Project (www.foodandmood.org) is a web-based, user-led, self-help service that aims to help individuals explore the relationship between diet, nutrition and emotional and mental health. It also facilitates the sharing of experience by enabling people to run workshops, and through email discussion groups.

Target groups

The Food and Mood Project targets the general adult population, although much of their information is appropriate for children. Individuals, voluntary and statutory sector organisations, nutritional therapists, dieticians and mental health professionals all use the Project's resources.

History of project

The Project was founded in 1998 with a Mind Millennium Award by former registered nutritional therapist Amanda Geary after her own experience of recovery from ill-health using dietary self-help. The Food and Mood Project continued beyond the Millennium Award-funded period, workshops were delivered throughout the UK and a quarterly newsletter produced. In 2000 a 'Mind Meal' was launched in conjunction with Mind, and the Mind Guide to Food and Mood was also published. The Project's approach was then developed into a self-help book, The Food and Mood Handbook (Thorsons, 2001). In 2002, a Food and Mood Survey was conducted and the survey report, The Food and Mood Self-Help Report, was presented at a national Food and Mood conference, with the findings publicised by Mind in the national media.

Key Activities

Since 2003 the Project has been an internet-based service providing Food and Mood self-help resources such as the Guide for Workshop Leaders designed for non-nutritionists to facilitate their own DIY Food and Mood Workshops. More resources are currently in production.

Achievements

The Food and Mood Project has generated increased awareness of an accessible and affordable self-help strategy. The Food and Mood Handbook has remained in print with steady sales continuing. With the help of the Mind press office, the Project has received wide media coverage in the national print and broadcast media.

The 2002 Food and Mood Self-help Survey asked a sample of 200 women and men questions about their experience of using this form of self-help. 80% said the changes were beneficial, with a quarter of respondents each specifically reporting large improvements to, or even the disappearance of mood swings (26%), depression (24%) and panic attacks/anxiety (26%).

Testimonies

"There is a definite link with food and mood , but I do lapse and when I do I feel noticeably different. Once you find out your triggers you can feel so much better."

"I have been mentally ill for a number of years...since working with my support worker I began to look at what I was eating and drinking. I started feeling the benefits of reducing caffeine, alcohol and sugar and eating meals on a regular basis...my paranoia decreased, my anxiety reduced, my depression almost disappeared and my sleep pattern went back to normal. I have not been working for the past ten years due to my mental health problems and I am now feeling well enough to return to some form of paid or voluntary work."

Barriers

Funding. The work has been led by and undertaken mainly on a voluntary or low-cost basis by the Project's founder, with some additional assistance. Since initial funding from the Mind Millennium Award scheme, the Project has been largely self-sustaining, but lack of funding for development has limited growth.

We have seen that food and mental health are intrinsically linked, both at specific times in the lifecycle and amongst the general adult population. Just as the association between diet and physical health took some time to understand and embrace, so has been the pattern for diet and mental health. However, the plethora of anecdotal, clinical and controlled studies all point to the importance of diet as one part of the jigsaw in the prevention of poor mental health and the promotion of good mental health and wellbeing. Also increasing in quantity and pace is the collection of evidence that highlights the important role diet plays in specific mental health problems, such as depression, ADHD, Alzheimer's and schizophrenia. It is to this evidence that we now turn.

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4. THE ROLE OF DIET IN RELATION TO SPECIFIC MENTAL HEALTH PROBLEMS

The previous section showed that there is good evidence of an association between the food we eat, our brain development and our general mood and well-being. There is also growing evidence that diet plays an important contributory role in specific mental health problems and diagnosed mental illnesses. This section presents the evidence for the links between diet and Attention Deficit Hyperactivity Disorder (ADHD), depression, schizophrenia and Alzheimer's disease.

4.1 ADHD

ADHD is prevalent in approximately 4% of the population, most commonly in childhood or adolescence, and more often in boys than girls. It is a collection of symptoms characterised by overactivity, impulsiveness and an inability to sustain attention. Low self-esteem, underachievement and difficulties in socialising are also often experienced, along with a high overlap with other learning disabilities, such as dyslexia, dyspraxia and autistic spectrum disorders. It can persist into adulthood, resulting in continued problems of underachievement and social difficulty.

Alongside behavioural management strategies, one widely-used treatment for ADHD is medication, usually in the form of methylphenidate (commonly known as Ritalin). However, concerns about the long-term impact of this and other drugs have encouraged support groups to look at alternative approaches, including dietary changes. Many parents, teachers and others have reported great improvements when dietary changes are introduced to children with ADHD. Two food groups that have subsequently been implicated through clinical research are essential fatty acids and minerals.

4.1.1 Essential Fatty Acids (EFAs)

The idea of a link between hyperactivity and essential fatty acids (EFAs) was first proposed by the founders of the Hyperactive Children's Support Group (HACSG) over twenty years ago[1] (see Box 9). Through surveying the children known to the group, similarities were found between the children's physical symptoms and the symptoms of EFA deficiency. These included abnormal thirst, eczema and asthma. Further studies confirmed that children diagnosed with ADHD commonly share characteristics of EFA deficiency, which include dry, rough skin, dull hair and frequent urination[2]. Following this, a number of controlled trials have compared the levels of EFAs in children with ADHD to those without.

One of the earlier trials compared the blood of 48 hyperactive children with 49 non-hyperactive children, finding that the levels of some EFAs were significantly lower in the hyperactive children[3]. This finding has been replicated several times in trials of children diagnosed with ADHD, as well as in adults. Some trials also noted an inverse linear relationship between levels of EFAs in the body and the degree of the disorder (i.e. the lower the level, the worse the symptoms). One found this particularly associated with deficiencies of total omega-3 fatty acids[4]. A recent trial, which was testing children diagnosed with developmental dyspraxia, also found that the often-accompanying ADHD symptoms decreased significantly when the children were given an omega-3 supplement[5].

4.1.2 Minerals

A similar inverse relationship has been found with levels of iron in children and symptoms of ADHD[6] and deficiencies in magnesium and zinc have also been noted[7 8]. One study found that a third of those with ADHD showed a marked zinc deficiency, which could not be accounted for by dietary intake[9], and this has led to several trials testing the efficacy of zinc supplementation. Findings have consistently shown significant improvements with zinc when compared with placebo, alongside normal medication[10] or as a stand-alone treatment[11]. Similar results have been recorded with magnesium supplementation[12].

Two issues with research in this area are the difficulty in establishing cause and effect and the lack of studies examining the collective contribution of combined nutritional supplementation (individual nutrients are usually examined in isolation). Further research is required to disentangle the complex interplay of factors that are described above.

Box 9: The Hyperactive Children's Support Group (HACSG)

Aims

The HACSG aims to raise awareness and disseminate information about the connection between a child's diet and his or her behaviour.

Target groups

The HACSG targets parents and carers of children and young people who are hyperactive or diagnosed with ADHD. It also targets the professionals charged with diagnosing or providing care for children suffering behavioural problems.

History of organisation

The HACSG was set up in 1977 by Sally Bunday, whose son's hyperactivity greatly improved in response to the dietary changes recommended by the Feingold Diet*. The family's health visitor began to pass the information onto other interested parents, at which point a more formal organisation was created.

Activities

- Promoting awareness. The HACSG employs a number of activities to increase awareness of the link between diet and behaviour. These include running a website, writing articles for publication, arranging presentations (to schools and other interested groups) and networking with a number of related organisations and researchers.
- Publications. Approximately 1,000 newsletters are sent out three times a year. Other publications include Hyperactivity in the Classroom, which was aimed at teachers and school administrators, a summary of the related research and a collection of case histories
- Support. The HACSG provides an information service, via email and telephone, where parents and carers can get individual information and support on beneficial dietary changes. It can also refer parents or carers to laboratories where a child can be tested for nutritional deficiencies or food allergies. Regular workshops are held in London, normally four per term, where a nutritionist can offer help on dietary changes and strategies for coping with hyperactivity.

Achievements

Since records started being kept, the HACSG has had approximately 250,000 members. It estimates that every person who joins is multiplied by ten more who receive its information. The HACSG regularly receives letters from parents who have seen remarkable changes in their children's behaviour once dietary changes have been instituted. Parents have credited the HACSG for everything from a child's ability to gain entrance to university to stopping proceedings to take a child into care. Most recently, founder Sally Bunday was awarded an MBE for her work for parents and children over the past 27 years.

Testimonies

*"After following the diet changes you sent us and daily Zinc drops, Charlie** is a different child. After just a few weeks at the diet and drops, the change in him was noticeable...the difference was truly staggering..."*

"Lapses in diet result in such lapses in behaviour that sceptical relatives and friends have been convinced. Have successfully recommended the diet to other parents."

"For years, Peter was a real Jekyll and Hyde character. Sometimes he was lovely and charming and other angry and argumentative...I constantly asked myself 'What am I doing wrong?' worried it was down to poor parenting...Then, three years ago, I started to realise that Peter's moods were affected by things he ate. So I began to keep a record of everything that he ate and the effect it had on his mood. Seeing a link between the additives in these foods and his bad behaviour I contacted [the HACSG] and they sent me information about e-numbers and the effect they can have on some children. I cut them out of Peter's diet and the change in him was incredible. He was so much more relaxed, no longer hyper...his concentration both at home and school is so much improved and he's a real pleasure to be around."

"The response was almost immediate (three days) and the improvement sustained. When zinc was taken out, the symptoms reappeared, when zinc was reintroduced, the symptoms reduced again."

Barriers

- Funding. The HACSG relies on membership fees and small grants and donations to survive. Grants are typically from trusts and foundations, with very little funding from Government sources. With the popularity of funding bodies preferring to fund project (as opposed to normal running) costs and the growth of free information on the internet, the HACSG struggles to continue to operate.
- Integration into mainstream medical practice. The HACSG reports that when parents take hyperactive and problematic children to their GP, little mention is made of the link between diet and behaviour.

*The Feingold diet focuses on the influence of food additives (preservatives and colourings) on children's behaviour.

**Names have been changed throughout to protect identity.

4.2 Depression

Depression is the most common mental health problem in the UK, characterised by the presence of one or more of the following symptoms: feelings of worthlessness or guilt; poor concentration; loss of energy and feeling fatigued; thoughts of suicide or preoccupation with death; loss or increase of appetite and weight; disturbed sleep; physical and mental slowing down and restlessness or anxiety. The presentation of depression in the population has increased dramatically over recent decades[13] and this has been accompanied by a decrease in the age of onset, with more cases reported in children, adolescents and young adults[14], and mirrored by the increasing prescriptions for antidepressant medication over the past decade (see Section 2). Antidepressants still remain the first choice of treatment in primary care, despite non-chemical interventions such as exercise and acupuncture being as effective for mild to moderate depression[15 16]. A third non-chemical therapeutic approach focuses on the diet (see Box 10).

Box 10: Diet And Depression

Complex carbohydrates, as well as certain food components such as folate (folic acid), omega-3 fatty acids, selenium, and tryptophan may decrease symptoms of depression.

complex carbohydrates

Consuming foods that are high in tryptophan along with foods high in complex carbohydrates will help enhance the proper absorption of typtophan more effectively. Carbohydrates may also boost serotonin activity in the brain.

Leading food sources of complex carbohydrates: broccoli, brown rice, potatoes, pasta, whole wheat and grains.

folic acid

Because folic acid is often deficient in people with depressive symptoms, getting more of this vitamin through foods may help. The vitamin appears to have the ability to reduce the high levels of homocysteine associated with depression.

Leading food sources of folic acid: asparagus, spinach, avocados, Brussels sprouts, Savoy cabbage, beans, chick-peas, soybeans, lentils, oranges, peas, turkey, broccoli.

omega-3 fatty acids

Certain omega-3 fatty acids may be beneficial for depression.

Leading food sources of omega-3 fatty acids: salmon*, trout*, tuna*, flax oil, rapeseed oil, pumpkin seeds, soya beans, almonds.

tryptophan

Lean protein, containing tryptophan and L-phenylalanine, encourages the brain to produce the endorphins serotonin and noradrenaline.

Leading food sources of tryptophan: organic lean meat, organic poultry (especially turkey), game and free-range eggs.

* Recent and current trends in the fishing industry have led to significant concerns about social, economic and environmental sustainability of fish stocks. If you do eat wild fish, choose only those sources that are certified with the MSC-Label, which ensures your fish came from a sustainably managed source. If you choose to purchase farmed fish, make it organically farmed fish[17].

There are three key nutrient groups implicated in depression: EFAs, vitamins & minerals and amino acids.

4.2.1 Essential Fatty Acids (EFAs)

A number of cross-country and population-based studies have linked the intake of certain foods or nutrients with the reported prevalence of different types of depression. Several studies have looked at the intake of essential fatty acids, measuring intake by the amount of fish or seafood consumed. Correlations between low intakes of fish by a country and high levels of depression amongst its citizens – and the reverse – has been shown for major depression[18], post-natal depression (PND – see Figure 21)[19], seasonal affective disorder[20] and bipolar affective disorder[21]. Epidemiological research has also been conducted with specific populations. A study looking at the changing diets of peoples living in the Arctic and Subarctic regions found that levels of depression were rising at the same time that traditional diets, which were high in EFAs, were being abandoned for more processed foods[22].

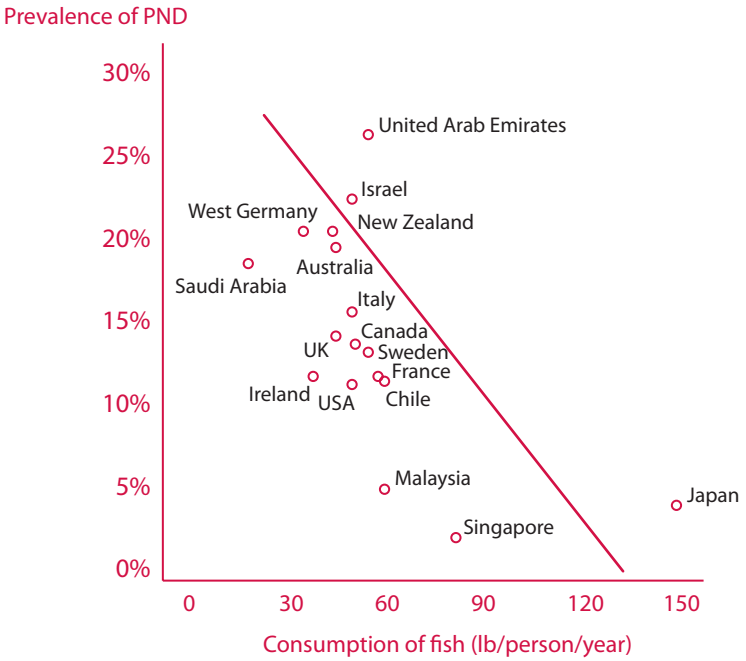

Figure 21: Fish consumption and prevalence of post-natal depression (PND) across countries (from Hibbeln, 2002[19])

These findings have prompted many studies investigating the effectiveness of EFAs in treating depression. A number of case studies have been published, some of which show dramatic effects of omega-3 supplementation on depressive symptoms. One of these supplied EPA, an omega-3 fat, as an additional treatment to an individual who had previously not shown improvement on antidepressants. Nine months after beginning treatment with EPA, all depressive symptoms had gone. The researchers also found that the EPA treatment was accompanied by significant structural changes in the individual's brain[23]. Similar results have been found in controlled trials of EPA for bipolar depression[24] and chronic clinical depression[25 26].

The proliferation of clinical research has been documented in an ever-increasing number of books aimed at informing the general public of the benefits of eating foods rich in EPA (namely, oily fish and flax-seed or their oils) in managing and beating depressive problems[27 28 29 16]. One issue that has been the focus of research in recent years is the need for balance between levels of omega-3 and omega-6 in our diet. Because there has been an

increase in the use of refined vegetable oils in the UK (and USA and Australia) and, because at the same time levels of fish consumption have been falling, experts suggest that most people consuming Western diets eat too much omega-6 and not enough omega-3. Some experts have linked this imbalance to physical health problems such as fluid retention, raised blood pressure and increased blood clotting[29]. In addition, some research has linked the imbalance to depressive and schizophrenic symptoms[30 31 32]. The precise mechanism through which this imbalance affects physical and mental health is still unclear. Although there is a general consensus that intake of omega-6 in the UK should be reduced (and intake of omega-3 increased), further research is required to establish the ways through which this process operates.

4.2.2 Vitamins and Minerals

Other research has focused on the role of vitamins and minerals and their association with depressive symptoms. One study of over 2,000 people found a correlation between dietary intake of folate, or folic acid, and depression. Those with low intakes of folate were significantly more likely to be diagnosed with depression than those with higher intakes[33], and this finding has been replicated in other populations[34 35].

Of course, establishing the direction of cause and effect has been a more difficult task. Nonetheless, trials looking at the efficacy of folate supplementation on depressive symptoms conclude that adding the micronutrient to existing treatment improved outcomes more significantly than standard treatment alone[36]. Similar conclusions have been drawn from studies looking at the association of depression with low levels of zinc and Vitamins B1, B2 and C. Supplementing standard treatment with these micronutrients results in greater relief of symptoms in people with depression and bipolar affective disorder, in some cases by as much as 50%[37 38 39]. One mechanism through which vitamins and minerals improve mental health and cognitive function is their supporting role in the brain's conversion of amino acids.

4.2.3 Amino acids

One of the characteristics of depression is a reduction in the amount of the neurotransmitter serotonin in the brain. Antidepressants like Prozac block the re-uptake of serotonin (hence their name - selective serotonin reuptake inhibitors or SSRIs). One impact of taking such medication is that more serotonin becomes available to the brain to help improve mood and feelings of well-being. Because of this, the precursor to serotonin - the amino acid tryptophan - has been the focus of much research.

There is evidence showing that consuming tryptophan leads to an increase of brain serotonin, and removing it from the diet reduces serotonin[40 34]. However, the results of trials using it to treat depression have been inconsistent. Of the studies comparing tryptophan to placebo, only a small number showed tryptophan to be superior – comparing it to antidepressants showed it only to be equivalent or inferior to the drug[41]. However, controlled studies that compared the combination of antidepressants and tryptophan to antidepressants and a placebo consistently found that the addition of the tryptophan gave better results[41]. Reasons for this may include the fact that the levels of tryptophan available for conversion to the serotonin transmitter is not only affected by the amount in the diet. Other dietary factors help determine its levels. For example, protein (even though it contains tryptophan) decreases its availability in the brain because it introduces amino acids that compete with tryptophan for transport to the brain. Carbohydrates (even though they contain no tryptophan) increase its availability, because the insulin released on digestion puts the competing amino acids to a different use, easing tryptophan's entry into the brain. In addition, a number of different enzymes, mineral and vitamins are essential to convert tryptophan to serotonin. Thus, if any are missing, serotonin will not be made, regardless of the level of tryptophan consumed[34].

4.3 Schizophrenia

Schizophrenia is a severe and enduring mental health problem characterised by hallucinations, delusions and disordered thinking. It occurs in approximately one in every hundred people and although incidence rates are similar around the globe, there are differences in outcomes between countries. Generally, people with schizophrenia in poorer countries fare better than those in richer, industrialised countries. In the WHO 10-country study at two-year follow-up, for example, the percentage of cases with full remission after a single episode ranged between 3% in the USA and 54% in India[42]. This implies that environmental factors have some role in determining the duration and severity of the symptoms. One avenue of research has focused on the role of diet in the outcome of schizophrenia (see Box 11).

Box 11: Rotherham Early Intervention Team: Doncaster and South Humber NHS Trust

Aims

The team exists to help those who are experiencing their first episode of psychosis. This includes improving their nutrition and activity level, with the aim of preventing the physical complications of schizophrenia and improving the mental state.

Target group:

Young people experiencing their first episode of psychosis.

History of project

This service is provided within the Doncaster and South Humber NHS Trust. All English mental health services are required under the National Service Framework to establish Early Intervention in Psychosis teams. These teams are required to follow guidance of the treatment of schizophrenia published by the National Institute for Health and Clinical Excellence, which focuses primarily on medication and psychosocial treatment for schizophrenia. In addition to these core treatments, the Rotherham team has established lifestyle interventions, incorporating nutrition and exercise, from the earliest stage of treatment. These have been in place since May 2005.

Activities

- Nutritional assessment. The project is supported by a nutritionist employed by Doncaster and South Humber Healthcare NHS Trust, and by the Trust's physiotherapy department. All new service users have a full nutritional assessment and analysis. Nutritional deficiencies in the diet are initially increased by using supplements (omega-3 fatty acids, multivitamin and mineral preparations) and service users who have an excess of poor nutrients are advised to reduce their intake of saturated fat and sugar. Continuing nutritional feedback is given with the aim of achieving optimum nutrition from a balanced diet, without the need for continuing supplements.
- Physical exercise. A physical activity assessment is also carried out by the physiotherapist and a programme of activities devised to suit the service user. This is supported by local facilities in the community (gym, swimming, etc.) as well as community sports staff taking exercise together with the individual.

Achievements

The Rotherham team has found this approach to be very well received by service users. Many people are reluctant to take anti-psychotic medication, but are willing to stay in contact with the service when they are offered lifestyle approaches. The team has found that modifying nutrition is much easier in this group than in service users with a longer history of mental health problems.

The service has not been established for sufficiently long to evaluate long-term effects upon physical and mental health, although short-term benefits have been recorded. One service user, seen for just over a month, has reported increased energy and a generally better sense of well being. The team will systematically evaluate the long-term benefits of the approach.

Barriers

- Staff. The main barrier to establishing this approach within the National Health Service is the lack of suitably qualified and experienced staff. Very few dieticians and nutritionists are also skilled in dealing with mental health issues.
- Lack of support within the profession. A second barrier is scepticism from some mental health professionals and managers, although the team does receive a sympathetic reception within its own organisation. The team suggests that scepticism be dealt with by highlighting that food considered to be good for the brain is known to be good for the body and therefore any lifestyle approaches used to help mental health problems can also help prevent physical illnesses.

The importance of diet in the onset and development of schizophrenia is well illustrated in the Dutch Famine Study[43]. Toward the end of World War II, the Nazi blockade of western Holland led to a severe famine in that area. Since the famine was both sudden and time-limited, and relatively complete health data on the population were available, it was subsequently possible to relate the degree and timing of nutritional deprivation to a variety of health conditions. Results showed that severe famine exposure in early pregnancy led to a two-fold increase in schizophrenia requiring hospitalisation in both male and female children. A recent study also replicates this finding in the context of the 1960s Chinese famine[44].

Other studies have looked at the impact of specific nutrients on the rates of schizophrenia in a population, focusing on fats and antioxidants.

4.3.1 Fats

One example of research on the role of fat and its association with schizophrenia is a Danish study that compared the amount of fat in the average national diet with rates of schizophrenia[45]. The researchers found significant correlations between low intakes of fat from birds and land animals (i.e. saturated fats) and lower rates of schizophrenia. Correspondingly, where there were higher percentages of fat from vegetables, fish and seafood, there were reduced rates of schizophrenia[45]. This epidemiological evidence is consistent with the observation that the people with this mental health problem have lower levels of polyunsaturated fatty acids (PUFAs) in their bodies than those without[46 47]. As with depression and ADHD, one of the primary suspects in the association is the omega-3 fatty acid EPA[48], with a number of studies showing reductions in symptoms with higher intakes of this fatty acid[49 50 51].

These observations have led to larger studies, including five double blind randomised control trials. The first of these attempted to distinguish between the effects of the two omega-3 fatty acids, EPA and DHA. Forty-five people with schizophrenia were divided into three groups and received either DHA, EPA or a placebo for three months, in addition to their normal medication. All those receiving EPA showed improvement in their symptoms that were statistically significant over any improvement on DHA or the placebo[50]. The second trial used only EPA or a placebo with people who were previously not taking medication, but given antipsychotics if deemed clinically necessary. Twelve were given the placebo, while fourteen were given EPA for three months. At the end of

the study, all twelve who had received the placebo needed antipsychotics, while only eight of the fourteen in the EPA group were medicated, and still showed improvement of symptoms. Further research is required to test the repertoire of EPA's therapeutic benefits amongst those with severe and enduring mental health problems.

4.3.2 Antioxidants

Further studies into the aetiology of schizophrenia has shown that antioxidant enzymes are also lower in brains of people with schizophrenia, suggesting that their cells are more vulnerable to oxidation[52]. In light of this, one study compared eighteen people with schizophrenia with fifteen others, measuring the levels of oxidants known as superoxides. Those with schizophrenia showed a significantly higher level of superoxides when compared to the control group and there was a linear relationship between the level of superoxides and the level of negative symptoms[53]. That said, trials testing the efficacy of treating schizophrenia with antioxidants and vitamins have proved inconclusive. One double blind, randomized controlled trial testing vitamin B6 showed no improvement in schizophrenic symptoms[54], while another controlled trial testing supplementation with vitamins showed no improvement in symptoms or behaviour over the five-month trial, in spite of raising vitamin levels in the body[55]. However, a controlled trial supplementing folate-deficient schizophrenic patients with folate did show improvement in symptoms over the six-month trial[56]. Additionally, a birth cohort study in Finland found an association with vitamin D supplementation during early life and a lower incidence of schizophrenia in males (there was no effect on females)[57].

Research over the past decade has established possible links between schizophrenia and Alzheimer's Disease[58], implicating the 5HTP receptor 2A as a priority in both of these mental illnesses. Further research is warranted to identify the specific mechanisms through which diet can work alongside other care options to alleviate the symptoms of schizophrenia in different populations. Any progress made in such research could also inform the evidence exploring the link between Alzheimer's and diet, to which we now turn.

4.4 Alzheimer's Disease

Research into vascular dementia – where the individual suffers a series of mini strokes – has demonstrated a strong association between diet and subsequent cognitive function. In particular, high blood pressure – associated with high salt intake – is known to increase the likelihood of vascular dementia[59]. To compound the issue, some medications prescribed to lower blood pressure are also linked to increased dementia in older adults[60]. This evidence suggests that one of the preventative measures a person can take against developing dementia, alongside regular exercise and intellectual stimulation, is to limit their salt intake and consume a healthy diet.

Alzheimer's Disease (AD) is the most common form of dementia. It is a progressive, physical disease of the brain, in which there is a gradual and continual death of brain cells. Symptoms include loss of memory, confusion, mood swings and withdrawal. It has become more common in the past fifty years and is believed to be the result of a combination of factors, including age, genetics and environmental factors[61]. Growing epidemiological evidence suggests that diet may be one of those environmental factors[62]. Specific connections have been found between the occurrence of AD and the amount of saturated fat[63] and vitamins & minerals in the diet. In addition, the process of methylation – affected by levels of the amino acid homocysteine in the body – has been the subject of some research in this field. Although there has not been a wealth of controlled clinical trials testing the efficacy of nutrients for the treatment of AD, the evidence that does exist points to a role in the prevention of AD (as opposed to its treatment).

4.4.1 Fats

Much of the evidence linking AD and diet is either epidemiological or the result of long-term cohort studies. Many of the studies have shown a positive association between saturated fat (SFA) intake and the incidence of dementia, whilst also showing an inverse relationship between its incidence and polyunsaturated fatty acid (PUFA) intake[64] (see Figure 22).

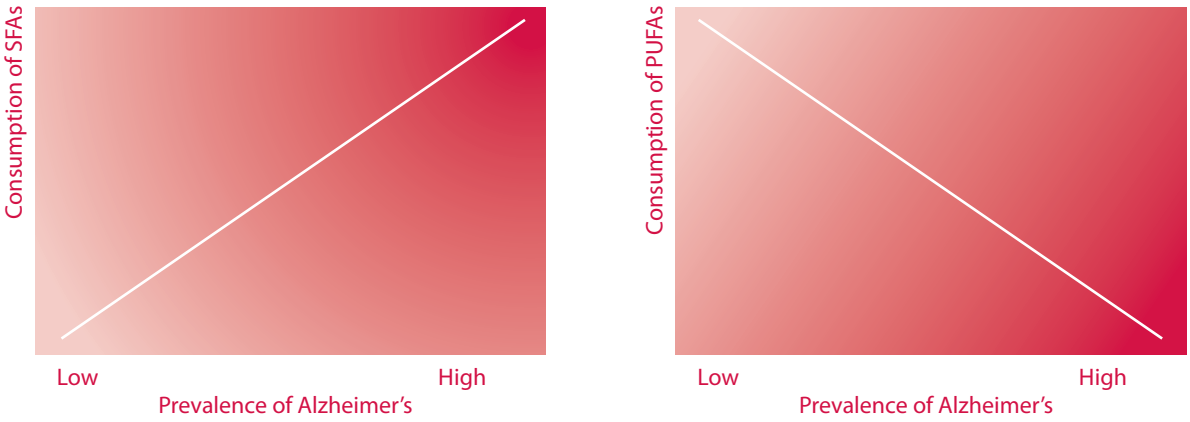

Figure 22: The relationship between saturated fats (SFAs) and polyunsaturated fats (PUFAs) and prevalence of Alzheimer's Disease

One study looking at the total fat intake of eleven countries found a correlation between higher levels of fat consumption and higher levels of AD amongst the over 65s[65]. It has also been observed that older Japanese people, known for their high fish consumption, have very low levels of AD[64] and this finding has been supported by cohort studies with other older populations[66 67]. Similarly, the "Mediterranean diet", characterised by high intakes of monounsaturated fatty acids, has been linked to low rates of dementia in Italy[68], while high intakes of cereals and fish appears to decrease risk in North American and northern European countries[69 70 71].

One controlled trial in this field looked at the effect of a mixed PUFA supplement on 100 older adults with AD, over a period of four weeks. Of the 60 that received the supplement, 49 reported improvement in mood, co-operation and short-term memory[72].

4.4.2 Vitamins and Minerals

A different field of research examines the association between high vegetable consumption and decreased incidence of AD. For example, one study compared groups of meat eaters and vegetarians, matched for age, sex and residence, finding that the meat- and fish-eaters were more than twice as likely to develop AD as their vegetarian counterparts. It is unclear whether this outcome was the result of higher fat consumption by the meat eaters or of higher vegetable consumption by the vegetarians[64]. However, the possible protection offered by vegetable consumption has also been explored in studies on antioxidants. One long-term population-based study found that high intakes of vitamins C and E were linked to a lower risk of AD, particularly amongst smokers[73], and this finding has been replicated in other long-term prospective studies[74].

4.4.3 Methylation & Homocysteine

Methylation is the process our brain depends on to create, maintain and repair brain cells and the neurotransmitters that pass between those cells (see Section 3). One amino acid – homocysteine – determines how effectively methylation occurs; that is, how effectively the methyl groups in the brain respond to the myriad demands placed upon them each second. If the level of homocysteine is low, the methyl groups are able to carry out repairs quickly and effectively, keeping our body healthy and balanced. Higher rates of homocysteine indicate that methylation is happening more slowly and ineffectively, leading to declining memory, mood and cognitive function[75].

Poor methylation and high levels of homocysteine are strongly associated with an increased risk of AD. Research in the US measured homocysteine levels in 3,766 males and 4,918 females and concluded that a diet low in folate, vitamin B12 or vitamin B6 can be a cause for homocysteine build-up[76]. As such, the United States Department for Agriculture (USDA) emphasise the need for older adults to consume nutrient-dense foods, fibre and water, recommending that they drink at least 8 250ml glasses of water a day[77]. The Alzheimer's Prevention Plan[28] also suggests a diet that improves methylation and reduces homocysteine, which includes essential fats and phospholipids, complex carbohydrates, vitamin- mineral- and antioxidant-rich foods and protein. Avoiding harmful fats, refined carbohydrates, sugar and excesses of caffeine and alcohol are also recommended. Examples of this approach in the prevention and treatment of AD are presented in Box 12.

Box 12: Brain Bio Centre

Aims

The Brain Bio Centre is an outpatient clinical treatment centre, specialising in the 'optimum nutrition' approach to mental health problems. The Centre works to improve mental health in individuals by performing comprehensive assessments of biochemical imbalances that may be contributing to their mental health problems. It then provides advice to correct these imbalances using diet and nutritional supplements.

Target group

The Centre works with any person who has a mental health concern, with a wide range of mental health problems and learning disabilities (e.g. depression, anxiety, bipolar disorder, schizophrenia, fatigue, learning difficulties, dyslexia, dyspraxia, autism, dementia, and Alzheimer's disease) amenable to improvement.

History of organisation

The Brain Bio Centre was set up in 2003 by nutritionist Patrick Holford. It is the clinical division of the Mental Health Project, which was created in 1994 by the Institute of Optimum Nutrition to highlight the role of nutrition in mental illness.

Activities

- Direct support. The Centre runs an outpatient clinic for anyone who would like to undergo a nutritional assessment to identify potential deficiencies that may be affecting their mental health.
- Raising awareness. The Brain Bio Centre also organises and presents lectures, seminars and conferences for national and local groups.
- Research. A recent study measured the effect of transforming diets at a residential school for autistic children.
- Website. Information and advice is available at www.brainbiocentre.co.uk

Achievements

Patrick Holford has published a number of books on nutrition and mental health, including *The Optimum Nutrition Bible* and *The Alzheimer's Prevention Plan*. Both of these document research conducted through the Mental Health Project, which concludes that the majority of people who seek treatment at the Brain Bio Centre gain significant improvement in many or all of their symptoms.

Testimony*

"Lilly began to suffer from deteriorating memory in her mid-sixties. At 70, she was finally diagnosed with Alzheimer's. She became progressively disorientated, forgetful, disturbed and unhappy. She realized something was wrong with her brain but refused any overt medical help. Within two years, Lilly required a level of care that could no longer be provided at home, so her husband reluctantly moved her to a nursing home. He meanwhile began researching available literature on Alzheimer's, and came across Patrick Holford's Optimum Nutrition for the Mind. He worked with a qualified nutritionist to devise a diet and supplement programme for Lilly along the lines of the Alzheimer's Prevention Plan, which was implemented with the approval of Lilly's consultant and the co-operation of the nursing home staff. Within ten weeks Lilly was showing small but encouraging improvements in her memory, so her husband decided to contact the Brain Bio Centre in London. After a series of blood tests and consultations, a supplement programme was devised for Lilly to take account of the test results, which revealed food allergies, neurotransmitter deficiencies and raised homocysteine levels. Within a few weeks, Lilly's husband, her sons and several friends noticed continuing significant improvements in her short and long-term memories, responsiveness, awareness and lucidity."

Barriers

- Access. At present, treatment at the Brain Bio Centre is not available on the NHS and, as such, is only available privately.

* This testimony is replicated verbatim from Patrick Holford's book 'The Alzheimer's Prevention Plan', p209[28], with permission.

4.5 Conclusion

The body of evidence linking diet with mental health is growing at a rapid pace. As well as its impact on feelings of mood and general wellbeing, the evidence demonstrates its important contributory role in the prevention and treatment of specific mental health problems such as ADHD, depression, schizophrenia and Alzheimer's. The implications are far-reaching, both in scope and depth, for a wide range of stakeholders. As policy-makers choose to incorporate the evidence into health and education guidelines, practitioners become more equipped to offer therapeutic treatments that take account of the complexities of mental health problems. Nutritional influences can be considered amongst a range of care options offered to those seeking to improve their mental health. Most importantly, perhaps, individuals can be resourced to become more aware of the association between their diet and their mental health, enabling them to incorporate dietary changes alongside their range of other care options.

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5. RECOMMENDATIONS

The Government as a whole, and all relevant departments and agencies, should officially recognise the links between diet and mental health and incorporate this recognition into all food and mental health related policy and practice. For instance, general healthy eating campaigns such as five-a-day should always include a mental health component.

Because the diet that is good for the brain is also the same diet that is good for the body, Government should increase financial and political support for measures to ensure that sustainable* supplies of a wide variety of nutrient-rich foods are available, affordable and attractive for people to obtain both now and in the future.

Specifically:

1.

The UK population and particular groups who are at increased risk of mental health problems should be provided with information about foods that promote their mental, emotional and physical well-being

Stakeholders:
Department of Health
NHS Health Scotland
Health and Social Care Department
Department of Health, Social Services and Public Safety
Food Standards Agency

2.

United Kingdom Health Departments should review and improve food and nutrition standards for the mental health and social care sectors in light of the evidence that a range of nutrients contribute to mental health and well being

Stakeholders:
Department of Health
NHS Health Scotland
Health and Social Care Department
Department of Health, Social Services and Public Safety

3.

Organisations that commission mental health services should include within commissioning criteria and service specifications food and nutrition standards for any services that provide food

Stakeholders:
Primary Care Trusts
Local Authorities
NHS Health Boards
Local Health Boards
Health and Social Services Boards/Trusts

4.

Annual monitoring of food and nutrition standards across the health and social care sector should be incorporated into current performance assessment mechanisms

Stakeholders:
Healthcare Commission
Commission for Social Care Inspection
Care Commission
NHS Quality Improvement Scotland
Mental Welfare Commission
Health Inspectorate Wales
Care Standards Inspectorate
Northern Health and Social Services Council
Department of Health, Social Services and Public Safety

5.

Primary care should have ready access to information on the link between diet and mental health as well as a working knowledge of the information and expertise available to support people through dietary change

Stakeholders:
Primary Care Trusts
NHS Health Boards
Local Health Boards
Health and Social Services Boards/Trusts

6.

Secondary mental health service staff should have ready access to nutritional specialists for liaison and consultation

Stakeholders:
Mental Health Trusts
NHS Health Boards
Local Health Boards
Health and Social Services Boards/Trusts

7.

All existing NHS and social care facilities that provide meals to service users, including the independent and not for profit sector, should instigate sustainable food policies and practices, so that all service users and staff are encouraged to choose, or be provided with if unable to choose, diverse and culturally appropriate meals, snacks and drinks that promote their mental, emotional and physical well-being

Stakeholders:
Strategic Health Authorities (or their successor)
Local Health Boards
NHS Health Boards
Health and Social Services Boards/Trusts
Local Authorities

8.

All prison facilities should instigate sustainable food policies and practices so that all residents and staff are encouraged to choose culturally diverse and appropriate meals, snacks and drinks that promote their mental, emotional and physical well-being

Stakeholders:
Home Office
Scottish Executive
Northern Ireland Office

9.

Research funding bodies should co-ordinate their strategies and increase the grants available to investigate the relationship between diet and mental health, particularly the effectiveness of interventions

Stakeholders:
Department of Health through its Research Funders Group
Scottish Executive Health Department and National Programme for Improving Mental Health and Well-being
Health and Social Care Department
Department of Health, Social Services and Public Safety
Food Standards Agency

10.

Regulations should be introduced to support the promotion of healthy food to children, and to protect them from all forms of broadcast and non-broadcast marketing of unhealthy food

Stakeholders:
Department for Culture Media and Sport
Ofcom
The Department of Health's Advertising Forum
Department of Health
NHS Health Scotland
Scottish Executive
Health and Social Care Department
Department of Health, Social Services and Public Safety

11.

Practical food skills, including cooking and growing, should be reintroduced as a compulsory part of the national curriculum

Stakeholders:
Department for Education and Skills
Health Promoting Schools
Scottish Executive Education Department
Department of Education

12.

The progressive approach to ensuring better food in school meals should be continued and in addition access to free water dispensers should be available to all children by 2007

Stakeholders:
The School Food Trust
Department for Education and Skills
Health Promoting Schools
Scottish Executive Education Department
Department of Education

13.

Targets should be introduced to reduce unhealthy levels of fat, sugar and salt in processed food, and to remove damaging trans-fats from food ingredients and food products. As an interim measure, manufacturers should be encouraged to label clearly the nutritional quality of and ingredients in their products

Stakeholders:
Food Standards Agency

14.

Agricultural policy development should be informed by what is known of its nutritional impact and its subsequent effect upon our mental as well as physical health. Specifically, support must be increased for organic farming, the production and promotion of fruit and vegetables, other micro-nutrient rich food and for alternative sources to oily fish of omega-3 fats. Moreover, Government policy on promoting fish consumption needs to change to promoting only sustainable sources of oily fish, with low levels of toxicity

Stakeholders:
Department for the Environment, Food and Rural Affairs
Food Standards Agency
Department of Environment and Rural Affairs
Department of Agriculture and Rural Development

6. FURTHER READING AND SUPPORT

Below is a selective list of organisations offering advice, information or guidance about food and mental health in the UK. Further organisations are easily accessible via an internet search using the relevant key words.

Food and Behaviour Research
Box 6066
Nairn
Scotland
IV12 4YN
www.fabresearch.org

The Food and Mood Project
Box 2737
Lewes, East Sussex
BN7 2GN
www.foodanmood.org

The Hyperactive Children's Support Group (HACSG)
71 Whyke Lane,
Chichester, West Sussex
PO19 7PD
www.hacsg.org.uk

Institute of Brain Chemistry and Human Nutrition
North Campus
London Metropolitan University
166-220 Holloway Rd.
London
N7 8DB
www.north.londonmet.ac.uk/ibchn

Institute of Optimum Nutrition – Brain Bio Centre
13 Blades Court
Deodar Road
Putney
London
SW15 2NU
www.brainbiocentre.com

Natural Justice
University Laboratory of Physiology,
Parks Road
Oxford
OX1 3PT
www.physiol.ox.ac.uk/natural.justice

The Schizophrenia Association of Great Britain
"Bryn Hyfryd", The Crescent,
Bangor. Gwynedd
LL57 2AG
www.sagb.co.uk

APPENDIX A – NOP SURVEY

NUTRITION

ALL ADULTS 15+ Section Answered------ 01 ASK Q1

SELF COMPLETION SECTION

I am now going to ask you some questions about food and your well being

Q.1 Firstly, thinking about food you buy each week, on average, how much if at all do you end up throwing away?

SINGLE CODE

More than 50%/half	01
30-50% (between a third and a half)	02
10-29% (between a tenth and a third)	03
Less than 10% (Less than a 10th)	04
None/Nothing	05
Not applicable/do not buy food	06
Don't know	07

Q.2 Thinking about an average week, how often, if at all would you say you eat any of the following? CODE ALL THAT APPLY.

	Less than once a week	Once or twice a week	three to five a week	Every day/ every meal	Never	
Breakfast	01	02	03	04	05	
Chips/Crisps	01	02	03	04	05	
Chocolate	01	02	03	04	05	
A meal made from scratch	01	02	03	04	05	
Organic food	01	02	03	04	05	
Fresh vegetables/salad	01	02	03	04	05	
A takeaway	01	02	03	04	05	
Fresh fruit/fruit juice	01	02	03	04	05	
Ready meals	01	02	03	04	05	

Q.3 What, if anything, do you think are the main influences on what you eat? PLEASE CHOOSE TWO MAIN INFLUENCES

Time	01
Habit	02
Diet	03
Cost	04
Health reasons	05
Sociability/whether other people are around or not	06
Convenience	07
Other (specify)	08
Don't Know	09

Q.4 Over the last month, have you had any problems with depressing thoughts or ideas, anxiety or worry, or problems with concentration and forgetfulness at all? **SINGLE CODE**

At least once a day	01
At least once a week	02
Less than once a week	03
Less than once a month	04
Not at all	05
Refused	06

Q.5 And how much, if at all, do you think the following things affect your mood or feelings?

	A great deal	Quite a lot	A little bit	Not at all	N/a drink	Do not eat/		Don't know
Alcohol (18+ Only)	01	02	03	04	05	06		07
Fish	01	02	03	04	05	06		07
Fizzy drinks	01	02	03	04	05	06		07
Brown rice or pasta	01	02	03	04	05	06		07
Fast food meals	01	02	03	04	05	06		07
Fruit and vegetables	01	02	03	04	05	06		07

Mental Health Foundation

About the Mental Health Foundation

Founded in 1949, the Mental Health Foundation is the leading UK charity working in mental health and learning disabilities.

We are unique in the way we work. We bring together teams that undertake research, develop services, design training, influence policy and raise public awareness within one organisation. We are keen to tackle difficult issues and try different approaches, many of them led by service users themselves. We use our findings to promote survival, recovery and prevention. We do this by working with statutory and voluntary organisations, from GP practices to primary schools. We enable them to provide better help for people with mental health problems or learning disabilities, and promote mental well-being.

We also work to influence policy, including Government at the highest levels. We use our knowledge to raise awareness and to help tackle stigma attached to mental illness and learning disabilities. We reach millions of people every year through our media work, information booklets and online services.

If you would like to find out more about our work, please contact us.

Mental Health Foundation
Sea Containers House
20 Upper Ground
London, SE1 9QB
020 7803 1100
www.mentalhealth.org.uk

Scotland Office
Merchants House
30 George Square
Glasgow, G2 1EG
0141 572 0125

Registered charity number 801130

Our partner in the Feeding Minds Campaign is

sustain
the alliance for better food and farming

About Sustain

Sustain: The alliance for better food and farming advocates food and agriculture policies and practices that enhance the health and welfare of people and animals, improve the working and living environment, enrich society and culture and promote equity. We represent over 100 national public interest organisations working at international, national, regional and local level.

If you would like to find out more about our work, please contact us.

Sustain: The alliance for better farming and food
94 White Lion Street
London, N1 9PF
www.sustainweb.org

Registered charity number 1018643

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