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Genetically modified (GM) or genetically engineered (GE) crops is a controversial topic that is underpinned by important questions of whether they are safe to eat and safe for the environment. This article will give an overview of how these crops are genetically modified, the potential benefits and risks of these crops, considerations for assessing their safety, and how GM foods are currently regulated and labelled.

**Genes and the technology of genetic engineering**

Each human, animal and plant is made up of trillions of cells. Each of those cells has a nucleus that contains deoxyribonucleic acid (DNA). Genes, which are made of DNA, provide instructions for organisms to make proteins and enzymes to carry out biological processes that are essential for the structure and function of that organism.

To breed new plant varieties, traditional plant breeders take a plant with a desired characteristic (e.g. a high yield) and cross-pollinate it with another plant with another desired characteristic (e.g. disease resistance) to try to develop a plant with both characteristics in it. Genes are then passed down through generations in an organised manner that is consistent with the laws of nature. However, plants won’t cross-breed like this if the plants are sufficiently different to each other. For example, you can’t cross a rose plant with a wheat plant. And you certainly can’t cross a fish with a tomato.

Plant breeders who want to do that kind of plant breeding use genetic engineering, where specific pieces of DNA are directly transferred from one organism into another in a laboratory. This allows you to transfer genes between completely different species.

For the GM crops that we are currently eating, the aim is for the plant to produce one or more new proteins. There are two main types of proteins usually produced. The first type makes the plant resistant to a herbicide, usually glyphosate. Glyphosate is the active ingredient in herbicides like Roundup. The aim is that when you spray the crop, the crop will live while the weeds around it die. Because so much glyphosate has now been applied to farmland, some weeds have become resistant to it and now don’t die when they are sprayed with this herbicide. In order to try to solve this problem, the GM industry is now engineering crops to be resistant to two or more herbicides at once. These crops are currently being grown in the US.

The other main type of protein produced kills insects that try to eat the plant. These are usually Bt proteins, so-called because they originally came from a bacterium called Bacillus thuringiensis (Bt). Whole Bt bacteria have been sometimes sprayed onto organic crops to get rid of caterpillars or grubs when other methods have failed. The natural form is very quickly degraded in sunlight, so that by the time the food gets to the consumer, there is usually none of the bacteria left, and any remnants can be washed off. In contrast, GM plants are engineered to make synthetic versions of Bt proteins within every cell of the plant, so the Bt proteins cannot be washed off. When a grub tries to eat one of these GM plants, it eats the synthetic Bt protein, which causes its stomach to rupture so that the grub dies.

Many GM plants have both pesticide and insecticide genes inserted.
New methods for altering genes or the expression of genes are now being developed. The aim of some of these new methods is not to insert new DNA into the plant as such, but to silence a gene within the plant itself. For example an apple has been developed with a silenced gene so that the apple doesn’t go brown quite as quickly when it is cut. Non-GM apples are also available with that ability.

**What is known about the risks and benefits?**

Proponents of this GM technology argue that a GM plant has not changed significantly and that the rest of the plant will continue to behave as it did before (i.e. that the plant is ‘substantially equivalent’ to the parent plant), and therefore does not need safety testing. They also claim that GM crops are safe to eat, increase crop yields, reduce pesticide use, benefit farmers, have economic benefits, are good for the environment, can help solve problems created by climate change, reduce energy use and are needed to feed the world.

Critics argue that many of these statements are untested hypotheses, or have been proven to be untrue and there may be many unknown or unintended consequences from these crops. They argue that the precautionary principle should be applied, thorough safety testing should occur before GM crops are commercially planted or eaten, current safety testing methods are inadequate, and that government regulation should be improved to better determine the effects of these crops on health and the environment.

**Concerns about the technology**

a. The function of genes is now known to be much more complex than previously thought

An assumption underpinning genetic engineering is that each gene codes for only one protein with only one function. However, we now know that this is not the case, and that most genes code for more than one protein, proteins perform multiple functions, and many cellular functions are achieved by groups of genes working together. As a result, a single alteration in the DNA of the plant could cause many non-intended effects, with potentially serious consequences for cellular function and health.

An added concern is that the insert may become unstable over generations, resulting in it degrading, changing, or moving elsewhere in the genome.

b. GM plants may unexpectedly produce new, toxic substances

Of particular concern is the potential production of new toxic proteins in GM plants. Because GM inserts are placed randomly into the plant’s DNA, some inserts may influence the expression of the plant’s genes in unintended and unpredictable ways. The insert may cause the plant to increase or decrease the production of substances normally made in the plant, or to now produce a new and toxic substance, or cause the plant to produce a wild characteristic from a wild ancestor. This is a concern if partial copies of the insert are inserted, as they sometimes are in these crops.

c. New DNA or proteins from GM food could be taken up by the bacteria in our gut or tissues in the body

Advocates of the technology state that this is unlikely as any DNA would be quickly degraded, and that if any novel proteins were made, they would be broken down in the gut and not enter bodily tissues. However, it is well known that some proteins are not easily broken down, can cross the gut wall and create a range of health problems, such as food allergies.

In addition, researchers have found GM DNA in animals and people who have eaten GM food, particularly in the gut. GM DNA has also been found in cows’ milk on supermarket shelves. GM crops are common ingredients in cow feed. GM DNA can also be taken up by bacteria in the gut. This is of concern because gut bacteria have many important roles in human health and disease.

d. Antibiotic resistance

Many GM plants have been engineered to contain DNA that makes them resistant to antibiotics. This is done to make it easier to pick out the plants that have successfully taken up the GM DNA. One GM potato was made resistant to five antibiotics. If these antibiotic-resistant DNA sequences are taken up by bacteria in the gut of animals and people, it could make those bacteria resistant to antibiotics, which could considerably worsen our current medical problems with antibiotic-resistant bacteria.
e. Proteins that GM plants have been engineered to produce are not normally found in the human diet. Neither the protein that makes plants resistant to being sprayed with a herbicide nor the synthetic Bt proteins have been found in our diet before. In addition, Bt proteins, whether naturally occurring or synthetic, have not previously been found in the diet in the amounts found in GM crops. While some claim that Bt proteins are safe to eat, others have found adverse effects in animals eating them. For example, potatoes containing a Bt toxin that had been approved for human consumption were found to cause damage to the microscopic structure of the small intestine in mice.

f. There are concerns about increased levels of herbicides and insecticides in food. Most of the GM crops currently being grown have been engineered to be resistant to herbicides containing glyphosate. The use of these herbicides has gone up dramatically in the US (which grows a lot of GM crops) compared to Europe (which grows almost no GM crops). Higher concentrations of this herbicide are therefore likely to be present in the food that we eat, and recent studies have found glyphosate in the urine of a substantial proportion of the population.

Advocates of the technology argue that GM crops require fewer insecticides. However, they tend not to include insecticides (such as Bt proteins) that are produced by the GM plant in their calculations.

**How is GM food regulated and assessed for safety?**

In Australia, a government body called Food Standards Australia New Zealand (FSANZ) is responsible for assessing and approving food and food products. This body does not do any GM food safety testing itself but instead relies on data given to it from companies that develop GM crops. FSANZ only requires a test of “substantial equivalence” to see if a GM crop is safe to eat. FSANZ does not require any animal or human studies to make this decision, and its guidelines essentially enable GM foods or crops to be considered safe until proven harmful. This is the opposite of the precautionary principle.

For the test of substantial equivalence, some samples of the GM crop are chemically broken-down and compared with some non-GM crops of the same species. For example, proteins are broken down into amino acids, which are the building blocks of proteins, and then the amino acids are compared. However, this process has the effect of destroying important safety information about the proteins. It is rather like comparing the fire safety of two buildings, not by comparing fire evacuation procedures or the placement of fire extinguishers, but by knocking-down the two buildings and counting the bricks. You have destroyed important safety information in order to measure unimportant safety information. Also, other important composition information, like the levels of key fats, vitamins and minerals are rarely measured. Furthermore, there is no determination as to how different a GM plant needs to be to fail the test for substantial equivalence. So, everything passes the test, unless the GM crop has been designed to have a different composition. I saw one GM corn variety where 44% of the amino acids were found to be significantly different to non-GM corn, and FSANZ still assessed the corn to be substantially equivalent to non-GM corn.

In addition, FSANZ does not require any studies at all to be done on a GM crop containing several “stacked” genes if all the genes have previously been individually approved in the same kind of plant. FSANZ therefore does not consider any additive or synergistic effects of several GM genes interacting with each other.

a. How does this approach compare to best practice?

There are four main areas where people have expressed concerns about GM crops and where they want to see thorough safety testing. These are allergies, reproductive health, cancer and toxicology. In a review I did of FSANZ safety assessments covering 28 GM crops, I didn’t see a single animal study investigating allergic reactions or reproductive health or cancer. I only saw some animal studies measuring toxicology.

The gold standard for testing a new substance for toxicology is for the substance to first go through thorough animal testing before then being tested on people by going through four phases of a clinical trial. If the results are good enough, and the drug is approved for sale, it is monitored to see if it causes any adverse effects in the community. In contrast, GM crops are approved for people to eat without any human studies, there is no monitoring in the community, and it has been argued that even the animal studies used are inadequate.

For example, to determine if there may be harm to people, the animals that the crop is tested-on should be similar to humans. Yet many of the studies that “show” that GM crops are safe for people to eat use animals such as chickens, cows or trout that have a very different physiology to humans. For example, chickens have two “stomachs”, swallow grit to help grind their food in one of their stomachs, lay eggs to reproduce, fly, and have kidneys that do not produce urine. This does not describe a human being. Furthermore, most of these studies only measure things that are not good measures of human health, such as death rates and body weights. Anyone who is ill with heart disease, diabetes, cancer, etc., would be regarded as healthy using that measure, as long as
the person wasn’t dead (yet). If other measures of health are taken in these studies, they are often things such as breast meat yield or milk production, which are not measures of human health. In fact, these sorts of studies are animal production studies, designed to reassure farmers that if they feed these GM crops to their farm animals, the animals will provide a suitable income to the farmer in the form of a suitable milk yield (from a cow) or breast meat yield (from a chicken). Yet these types of studies are regularly quoted by FSANZ and the GM industry as evidence that GM crops are safe for people to eat.

If the GM industry does actual toxicology studies, they are usually very short-term studies where a few lab rats are given a single oral dose of the protein that has been genetically engineered to appear in the plant, not the whole food, and then rats are watched for a few days to see if they get sick or die. Amongst other things, this assumes that the only new substance that will appear in the GM plant will be the one that is expected, and that nothing unintended will happen in the plant.

Longer-term toxicology studies are sometimes done on some GM crops using suitable animals such as lab rats where they feed the part of the plant that people eat, e.g. maize seeds or soy beans. Of the studies I looked at, it was clear that animals were not fed for long enough for most adverse effects to develop; there were too few rats to be able to find statistical significance for anything other than the majority of rats getting serious health problems; not enough measurements were taken to measure health; and any adverse effects were not investigated further.

In another example, we reviewed published studies containing one or more of three commonly used GM genes (Zdziarski et al., 2014). We reviewed histopathology studies where gut tissues were looked at under a microscope because this is the best quality of evidence. We found that 47 crop varieties had been approved by government regulators for animal or human consumption with one or more of these GM genes. However we could not find any published histopathology studies for 81% of them. Of the studies that were done, 76% were done after the crop had been approved for human or animal consumption, with half of these being published at least nine years after they had been approved. Furthermore, we found that not one study was properly conducted or reported and that therefore, the findings could not be relied upon. We concluded that there was a lack of evidence that these crop varieties were safe to eat.

b. Industry studies vs. independent studies

As per other areas of medical research such as smoking and pharmaceutical drugs, there tends to be a difference in the findings from studies done by industry-associated researchers compared to the findings from independent researchers. The latter are more likely to find harm. For example, in a study that my colleagues and I did, we found that pigs (which have a similar digestive system to humans) had far higher rates of severe stomach inflammation than pigs fed an equivalent non-GM diet (Figure 1). The weight of the uterus of female pigs fed the GM diet was also significantly heavier (Carman et al., 2013). A detailed plain English review of some of the other independent studies is given in GMO Myths and Truths (Fagan et al., 2014).

It can be difficult for independent researchers to do any studies at all. GM crops are protected by patents, and buying GM seeds to test from a seed merchant often requires the buyer to sign a legal agreement that prevents you from doing any research on the crop or giving the seeds to anyone else to do research on, either. These agreements can also contain ‘gag clauses’ so that a farmer can’t tell anyone if the GM crop did poorly in the field. While farmers have spoken about their experiences with GM crops, they are generally those who have been given permission to speak by the GM industry.
Foods that are currently genetically modified and labelling laws

There are currently well over 100 GM crops in the world – mostly varieties of cotton, canola, corn (maize) and soy.

They are common ingredients in breads, pastries, snack foods, baked products, oils (e.g. canola oil), fried foods, confectionary, soft drinks, and sausage skins. There have been instances of unapproved GM crop varieties from trial sites, or GM varieties only allowed into animal feed, that have entered the human food supply, creating chaos. Different countries have different labelling laws. Europe has some of the most stringent laws in the world, while the US does not require any labelling and does not even require a GM crop company to inform its food regulator before introducing a new GM crop into the US food supply. Australia has something in between. In Australia, highly processed products of GM food such as cooking oils, sugars and starches do not need to be labelled because FSANZ considers that these do not contain DNA or protein. However, we know this assumption is incorrect. In addition, none of the following need to be labelled in Australia: products from animals fed with GM feed (e.g. meat, milk, eggs, honey), food prepared at bakeries, restaurants and take-aways, and foods that are ‘unintentionally’ contaminated by up to 1% per ingredient, are made with processing aids or food additives using GM microbes, or that contain GM flavours at less than 1%.

Therefore, if you wish to avoid GM foods in Australia, you cannot fully rely on Australia’s labelling laws. More reliable methods are to buy food that is certified to be organic or to use the True Food Guide (see the references). Alternatively, you can phone the free call number on the label of most foods and ask the manufacturer if the food contains any GM ingredients.

Student activities:

1. Look up the document written by Fagan and others in the reference list. Look at the description about how plants are genetically modified. How precise do you think these processes are?

2. Look up the document written by Fagan and others in the reference list. Describe the difference between vertical gene transfer and horizontal gene transfer.

3. Do you think that GM crops should be assessed in animals to see if they increase the risk of cancer or reproductive problems or allergies in people? Why/why not?

4. Do you think that GM crops should undergo safety assessments on people before they come into the human food supply? Why/why not?

5. Read Steven Druker’s article about documents he obtained from the Food and Drug Administration (FDA) of the USA (https://allianceforbiointegrity.wordpress.com/about/). Describe how these events produced the USA’s current process for regulating GM food.
6. How a study is done can influence the quality of the study and the results obtained. What are some aspects of an experiment’s study design that need to be considered when evaluating the findings of scientific studies?

7. How do the current labelling laws for GM food (e.g. soy milk, canola oil) and for products from animals fed GM feed (e.g. milk, eggs) differ between the US, Australia and Europe?

8. Look up Australia’s Food Standards Code (given in the reference list) and look at Standard 1.5.2, Food Produced Using Gene Technology. What sorts of crops have been approved for human consumption in Australia? What sort of foods could contain ingredients from these crops?

9. A GM corn variety called LY038 was assessed to be safe by Australia’s food regulator (FSANZ) but not by Europe’s (EFSA). Why? This document may assist you: https://independentsciencenews.org/#article/116.

10. How can consumers influence the food that is sold in food outlets?

References and further reading

http://GMOJudyCarman.org has various papers and short, clear-English summaries of work conducted by Dr. Judy Carman. This site is not run by Dr. Carman; it is a fan site.


Druker, S. M. 2015. Altered genes, twisted truth: how the venture to genetically engineer our food has subverted science, corrupted government, and systematically deceived the public. Clear River Press: Salt Lake City UT.


http://gmomythsandtruths.earthopensource.org/

Food Standards Code in Australia can be found at: http://www.foodstandards.gov.au/thecode/foodstandardscode.cfm (GM food regulations are given as Standard 1.5.2, Food Produced Using Gene Technology)

Public Health Association of Australia (PHAA) policy on GM foods can be found at: https://www.phaa.net.au/advocacy-policy/policies-position-statements.


Australian dietary guidelines tell us that we should eat a diet comprised predominantly of fresh whole foods, and mostly plant foods, and limit our intake of processed foods, fast food, and unhealthy snack food high in sugar, salt and fat (NHMRC 2013). Yet most Australians do not eat a diet that is consistent with these guidelines. To understand why people do not eat a healthy diet, we need to understand which groups of the population have the poorer diets and why they make these food choices.

One factor that is an important determinant of both health and health behaviours (i.e. food intake, physical activity and smoking) is ‘socioeconomic status’ (also called socioeconomic position or social class). In affluent countries such as Australia, individuals of low socioeconomic status are more likely to have poorer health, engage in poorer health behaviours and have an increased risk of dying prematurely.

Conversely, individuals of high socioeconomic status are less likely to have poorer health, less likely to engage in poor health behaviours and have a reduced risk of dying prematurely. These differences do not just occur at the low and high ends of the socioeconomic spectrum, but rather there is a socioeconomic ‘gradient’ such that people in the middle of the socioeconomic ladder have better health than those at the bottom and poorer health than those at the top.

Socioeconomic status (SES) is an individual’s or family’s social and economic standing in relation to others in society. SES is determined by a combination of indicators including education level, income, occupation status and affluence of the neighbourhood in which we live [Box 1].

**Box 1: Definitions of the indicators of socioeconomic status**

**Education level**: the highest level of schooling or further education that a person has completed. At the primary and secondary school level, it is the number of grades completed. At the postsecondary level, it refers to institutions attended (i.e. University or TAFE) and certificates, degrees or diplomas obtained.

**Income**: the money an individual, family or household receives on a regular basis from all sources including but not limited to wages from employment, welfare and investments.

**Occupation**: Is a person’s job or profession. In Australian, occupations are categorised on a social gradient as lower or higher status using the Australian and New Zealand Standard Classification of Occupations (ANZSCO) which groups occupations into eight tiers according to level of skills, education, responsibility and experience required to perform the occupation.

**Neighbourhood SES (Postcode)**: Neighbourhood SES is most commonly defined using the postcode of a neighbourhood. In Australia, the Socioeconomic Index for Areas (SEIFA) is used to rank postcodes according to the social and economic characteristics of the residents of the neighbourhood. SEIFA combines data on factors such as income, education, unemployment and occupation of the residents within an area to give a rank for the area on a scale of relative disadvantage.
Socioeconomic disparities in food consumption

One of the contributing factors to social gradients in health are socioeconomic disparities in food intake. These socioeconomic disparities have been observed from childhood to adulthood and they follow similar patterns across all age groups. Studies evaluating socioeconomic differences in dietary patterns show that individuals of low SES consume diets of poorer quality than individuals of high SES.

Compared to those of higher affluence, individuals who are socioeconomically disadvantaged tend to consume less fruit, vegetables, and whole-grain foods, and more snack foods, fast foods and sweetened drinks (soft drinks and energy drinks). Studies in children and adolescents of low SES have also shown that they are less likely to follow eating behaviours that promote healthy food intake, such as eating breakfast every day and eating dinner at the table with their family. This can translate to a diet that is lower in key nutrients such as fibre and healthy fats (monounsaturated and polyunsaturated fats), and too high in energy, sugar, salt and fat (in particular saturated fat and trans fat).

The ‘Longitudinal Study of Australian Children’ (Daraganova and Thornton 2014) showed that at age 2-3 years 33% of children from low SES were eating too much energy-dense food and not enough fruit and vegetables, compared to 17% and 10% of children middle and high SES families respectively (Figure 1). This socioeconomic gradient in diet quality persisted as children grew up, even though the proportion of children not eating according to dietary guidelines increased in all SES groups. At age 10-11 years 48% of children of low SES were not meeting dietary guidelines, compared with 28% of children from high SES families.

How does socioeconomic status affect food consumption?

Each of the SES indicators can affect food intake in a different way. For children and adolescents, it is their parents’ education, income and occupation that can influence their food intake. However, mother’s rather than father’s education and occupation can be a more important influence for children’s food intake because mothers are still most likely to be the gatekeepers of food provision in the household.

Education level: Higher education attainment may better enable individuals to understand and make use of health and nutrition information. Individuals of low SES may have poorer nutrition knowledge, place less importance on healthy eating and consider health and nutrition knowledge less when making food choices. All of these factors can influence the types of food an individual chooses to eat and a parent chooses to provide for their children.

Occupation: Type of occupation determines working conditions such work hours, flexibility of working arrangements and exposure to work place stress. Low status occupations can have long work hours which are inflexible, work conditions can be challenging and stressful, and work resources and benefits are often low. These factors can impact on how much time a person has to shop for and prepare meals, as well as how much money they have available to purchase food. However, individuals who work in high status occupations may...
also be required to work longer hours and may sustain more work stress which could also negatively impact on time available for food shopping and preparation. The workplace environment may also influence food intake through the types of food available, culture and social networks.

**Income:** Income determines the amount of money an individual or family can spend on food. For those on a lower income, a greater proportion of their income is spent on food. For example, to provide a healthy weekly meal plan a middle-income family would need to spend 20% of their income, but a welfare-dependant family would spend double that and a large family in the lowest income category would need to spend 56% of their income on food (The Cancer Council NSW 2007). Therefore, financial barriers can pose a considerable challenge to achieving a healthy diet. Although it is commonly perceived that it is more expensive to eat a healthy diet, this is not always the case. For example, consider the difference in price between an apple which is a much cheaper (and more nutritious) snack than a chocolate bar. But people who perceive healthy foods to be more expensive are less likely to purchase these foods.

**Neighbourhood SES:** There is some evidence suggesting that there are differences in the composition of stores and restaurants in neighbourhoods according to their affluence. This is discussed in more detail in the sections below.

**What other factors influence food consumption, and how does socioeconomic status fit in?**

We know that both individual factors (related to the person) and environmental factors influence the food choices people make. Importantly the individual and environmental factors interact, that is individual factors determine how a person responds to their environment to make food choices. Vice versa, the environment may promote certain types of food choices and may contribute to the development of individual factors that lead to food choices.

This framework for understanding how individuals make food choices is called the ‘Social ecological model of health behaviours’ (Sallis et al 2008) [Figure 2].

**Figure 2: Social ecological model of health behaviours**

Individual factors include personal attitudes and beliefs about healthy eating (e.g. whether someone thinks it is important to eat healthy foods), food preferences, nutrition knowledge and self-efficacy.

Environmental factors arise from all the different ‘micro’ and ‘macro’ environments in which a person subsists – including the home environment, social environment (family and friends), school environment, local neighbourhood and community, and the political/policy environment (e.g. food-related laws and government policies). Environments can enable healthy eating by providing easy access to healthy food, but conversely ‘obesogenic’ environments may restrict healthy eating and encourage intake of ‘junk’ foods through providing more opportunities for making unhealthy food choices.

**So where does socioeconomic status fit in?**

Socioeconomic factors can affect the factors that influence food consumption. We know that individual factors such as nutrition knowledge and attitudes to healthy eating can differ between individuals of different SES. For example, nutrition knowledge and attitudes to healthy eating can be poorer among adults of low education.

Occupation determines work environment, and therefore the food and culture individuals are exposed to at work. Occupation and employment can also influence the time that individuals have to shop for and cook healthy foods, as well as where they can buy food. Socioeconomically disadvantaged women have reported a lack of time due to work commitments as a barrier to healthy eating and less confidence to cook healthy meals.
Socioeconomic disparities in home food availability

The types of foods available at home can influence food intake, particularly in children and adolescents. In homes where fruits and vegetables are readily available, children and adolescents eat more fruits and vegetables. Whereas if ‘junk foods’, high in fat, sugar and salt, and soft drinks are more readily available then these are more readily consumed, and their intake can displace fruit and vegetables from the diet.

‘Accessibility’ of foods can be just as important as ‘availability’. Availability relates to whether the foods are present in the home environment, whereas accessibility is ensuring the food is in a form and location that makes it easy to consume. For fruit and vegetables, ‘accessibility’ may be as important as availability to encourage their intake. Fruit, and particularly vegetables, often require some sort of preparation (for instance, chopping carrots into carrot sticks), before they can be consumed. Therefore, even if they are present, fruits and vegetables may not be consumed if they are not easy to access. In comparison, unhealthy snacks and drinks are mostly packaged in a ready to eat form. So, in an environment where they are readily available, unhealthy snack foods may be consumed in place of fruit and vegetables if these are not easily accessible.

Home food availability and accessibility are influenced by a range of factors including nutrition knowledge, attitudes and beliefs about healthy eating and food preferences. Socioeconomic factors also influence home food availability and accessibility, and like dietary patterns, there are socioeconomic gradients for home food availability and accessibility.

Differences in home food availability between disadvantaged and more advantaged households may explain some of the reasons why socioeconomic disparities in food intake occur. The availability of and accessibility to fruit and vegetables may be lower in socioeconomically disadvantaged households, and the availability of unhealthy snack foods, convenience foods and sweetened drinks may be higher, compared to more affluent households. Some research suggests that in an environment where fruit and vegetable availability is high (i.e. high SES), accessibility may be less important than in environments where fruit and vegetable availability is low (i.e. low SES).

Furthermore, research has found that children living in socioeconomically disadvantaged households may be more susceptible to differences in food availability than children living in more affluent households. Lower availability of fruits and vegetables and higher availability of unhealthy foods and fast foods have been detrimentally related with food intake in children of low SES but not high SES.

Socioeconomic disparities in neighbourhood food availability

‘Obesogenic’ neighbourhood food environments are those that are less supportive of healthy eating by making it harder to purchase healthy nutritious foods such as fruit and vegetables, and provide more opportunities to purchase unhealthy snack foods and drinks, fast foods and takeaway. The types of foods which can be purchased close to a person’s home, school or work can influence the types of foods an individual consumes. For example, more fast food restaurants close to home may lead to higher intake of fast food, replacing the intake of home cooked meals.

Some evidence suggests that disadvantaged neighbourhoods may be more obesogenic than more affluent neighbourhoods because of the type of food stores and vendors in the neighbourhood. Other factors that may vary according to neighbourhood SES are the cost, quality and variety of foods available, and the store opening hours. Most of the evidence supporting socioeconomic disparities in neighbourhood food environments comes from the USA, and evidence from Australia does not consistently support this.

Evidence from the USA shows that in disadvantaged neighbourhoods there are fewer supermarkets, fruit and vegetable stores, bakeries and speciality stores (e.g. butchers), but more fast food restaurants, grocery stores and convenience stores, which affects the types for foods that are available for individuals to purchase. Convenience and grocery stores sell less fresh foods such as fruit and vegetables and fewer ‘healthy alternatives’ such as wholegrain bread or skim milk. Convenience foods and grocery stores also have a lower variety of foods and higher prices compared with supermarkets. In some disadvantaged areas of the USA the availability of fresh foods is so low, that these areas have been called ‘food deserts’.

Furthermore, research has found that children living in socioeconomically disadvantaged households may be more susceptible to differences in food availability than children living in more affluent households. Lower availability of fruits and vegetables and higher availability of unhealthy foods and fast foods have been detrimentally related with food intake in children of low SES but not high SES.
In Australia however, the evidence for disparities in neighbourhood food environments related to neighbourhood disadvantage and affluence is very inconsistent. Some research has shown there more supermarkets and fruit and vegetable stores in more advantaged neighbourhoods, but other studies have shown no differences in the types of food stores in low and high SES neighbourhoods. Likewise, the evidence for neighbourhood variation in the density of takeaway and fast-food outlets in Australia is mixed, with research studies showing no differences; more fast-food outlets in disadvantaged neighbourhoods; and conversely more fast-food outlets in more affluent neighbourhoods.

**How do we make sense of these inconsistent results?**

It is likely that the relationship between food intake, neighbourhood food environments and neighbourhood affluence are specific for different cultures and countries, and are also related to other factors such as the food policies and laws within a country.

One of the difficulties with research in this area is that there is no consensus about how to define an individual’s ‘neighbourhood food environment’. Therefore, different researchers use varying definitions for neighbourhood (i.e. a 500m, 1km or 2km radius from a person’s house, or simply their postcode) which could be contributing to the mixed findings.

Further still, using neighbourhood to represent the area within which individuals purchase foods may not adequately capture the food environments within which individuals purchase and consume foods. Individuals may purchase foods in areas other than their immediate local area. For instance, parents may go food shopping or purchase dinner from fast-food restaurants on their way home from work.

**Student activities:**

1. What socioeconomic factors influence food intake?
2. How do each of the socioeconomic factors influence food intake?
3. What are socioeconomic disparities in food intake?
4. How is food availability different to food accessibility? Explain using examples of home food availability and accessibility.
5. What is an obesogenic food environment? Explain using examples of the neighbourhood food environments.
   a. What characteristics of the types of food vendors and the foods sold in vendors can be used to determine if a neighbourhood food environment is obesogenic?
6. Are neighbourhood food environments more obesogenic in neighbourhoods of low SES compared to more affluent neighbourhoods? In your answer, consider the evidence from the USA and Australia. Why might some of the evidence be mixed?
7. What are some of the limitations of the research investigating socioeconomic disparities in neighbourhood food availability?

**Applied individual activity:**

8. Using the social ecological framework, discuss what factors influence your food choices? Are you influenced by environment or individual (or a combination of both)? Are there any socioeconomic factors that influence your food choices?
9. Design a health promotion strategy to increase fruit and vegetable intake in socioeconomically disadvantaged families.
Applied group activity:
(The following activity can be done individually, or in a small group)

10. Working in a small group, each group member should undertake an audit of their kitchen, fridge and pantry at home:

a) Record how many different types of fruit and vegetables are available at each group members’ house.

b) How many of the fruits and vegetables ‘accessible’? Explain why or why not the fruit and vegetables are accessible. (Hint: Consider how accessibility is different from availability)

c) Record how many different types of salty (i.e. chips, crackers) and sweet (i.e. chocolate, lollies, biscuits, cakes, ice cream & ice blocks) snack foods are available at each group members’ house.

d) How many of the snack foods are ‘accessible’? Explain why or why not the snack foods are accessible.

e) Record how many different types of sweetened drinks (including diet and regular soft drinks, fruit juice, fruit drinks, energy drinks, sports drinks and cordial) are available at each group members’ house.

f) How many of the sweetened drinks are ‘accessible’? Explain why or why not they are accessible.

g) Summarise the results of the food audit across the group. In the summary, use tables, graphs or figures to present the results.

h) Discuss the results. In the discussion consider what types of foods are more available and accessible. What factors could have influenced the types of foods available and accessible at home?

References


NHMRC (National Health and Medical Research Council) 2013 Eat for Health: Australian Dietary Guidelines: Proving the scientific evidence for healthier Australian diets. Commonwealth of Australia.


Further reading:


Winkler, E, Turrell, G and Patterson, C 2006a. Does living in a disadvantaged area entail limited opportunities to purchase fresh fruit and vegetables in terms of price, availability, and variety? Findings from the Brisbane Food Study. Health and Place, vol.12, no.4, pp.741-748.

Winkler, E, Turrell, G and Patterson, C. 2006b. Does living in a disadvantaged area mean fewer opportunities to purchase fresh fruit and vegetables in the area? Findings from the Brisbane food study, Health and Place, vol.12, no. 3, pp.306-319.

World Health Organization. 2006, Addressing the socioeconomic determinants of healthy eating habits and physical activity levels among adolescents. WHO Regional Office for Europe.