ASPECTS OF OBESITY

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1. FIVE WAYS OF MEASURING BODY FAT, OVERWEIGHT AND OBESITY

1. Weight and height

These are the most simple measures of body size. The relative weight or weight for height expresses the weight as a percentage of the average weight of people of the same height (Al-Sindi 2000). This is compared to tables of expected weight.

Among 111 Chinese men, Wu et al (2009) reported that waist to height ratio (WHtR) was a better measure than waist circumference, waist-to-hip ratio, and body mass index.

Advantages

- Easy to measure and use.
- Direct measure of overweight.

Disadvantages

- Requires data about expected weight
- Not a measure of regional body fat

2. Body Mass Index (BMI)

The BMI is a complex version of weight and height, but it is the most commonly used measure. It is calculated as weight in kilograms divided by height in metres squared (kg/m^2).

Based on future risks for diseases like heart disease and diabetes, cut-off points are set for overweight and obese. For example, the World Health Organisation set 25-29.9 as overweight (grade 1 overweight), and >30 as obese (grade 2 overweight) with >40 as severely obese (grade 3 overweight) [1].

Advantages

- Generally there is a good correlation between BMI and percentage of body fat in a large population (Seidell and Flegal 1997).
- Easy to calculate, particularly with large populations.
- Most commonly used in studies.

[1] A BMI between 18.5 and 24.9 is viewed as normal with <18.5 as underweight.

Disadvantages

- Does not take account of body frame or proportion of lean mass - eg: a young male body builder can have same BMI as a middle aged obese woman (Seidell and Flegal 1997).

- Does not take into account gender differences - excess body fat in women is distributed peripherally, usually in the thighs, buttocks, and breasts, but stored abdominally in men. In terms of health risks, this suggests that women can tolerate body fat better than men (Seidell and Flegal 1997).

- Does not take account of age differences - older people seem to "tolerate" an excess body fat better than younger people, but not good for using with very old (Seidell and Flegal 1997).

- Weak for accurately measuring intra-abdominal fat accumulation (Chan et al 2003).

- Not useful with ethnic groups (or individuals) with relatively short leg length compared to sitting height (Seidell and Flegal 1997).

- "Because differences in weight between individuals are only partly due to variations in body fat, many people object to the use of weight or indices based on height and weight (such as the body mass index, BMI) to discriminate between overweight and normal weight people" (Seidell and Flegal 1997 p238).

- Mulligan (2000) questioned its usefulness with children as their BMI is not constant across childhood as well as a critical period for excess weight gain in adolescence and early adulthood. Lawlor and Chaturvedi (2010) disagreed. They saw BMI as better with children because intra-abdominal fat is limited in children, and thus measures of it like waist-to-hip ratio are of limited use.

- "What conceivable interest can inhere in a statement of the number of units of body weight associated with a unit part of a theoretical plane got by squaring the stature - a plane that corresponds to no conceivable biological reality" (Pearl 1940 quoted in Lawlor and Chaturvedi 2010 p1134).

- Different cut-off points lead to different amounts of obesity in the population. For example, the International Obesity Task Force (IOTF) (Cole et al 2000) define overweight as a BMI ≥25 at 18 years old,

while the WHO Expert Committee (1995) use a BMI greater or equal to the age-specific 85th centile derived from USA data 1971-4. Wang and Wang (2000) applied the two definitions to 6-9 year-olds in China, Russia and the USA. The IOTF definition produced rates of overweight of 10.5%, 26.6% and 23.4% respectively compared to 11.9%, 29.4% and 27.0% with the WHO definition.

Kinra (2000) compared the two definitions for obesity [2] with data from 20 802 5-14 year-olds in Plymouth, England. The WHO definition produced a rate of 5% and 3% with the IOTF definition.

3. Skinfold thickness

Total body fat can be calculated from skinfold thickness at different points on the body. The subscapular skinfold [3] is used for trunk body fat and triceps skinfold on arms shows fat on the limbs. From these measurements equations are used to give total body fat.

Advantages

- Simple method.
- Inexpensive method.
- Measures regional body fat.

Disadvantages

- Problems with reliability (ie: different areas of the body measured by different measurers).
- Need to partially undress.
- Low accuracy (Al-Sindi 2000).

4. Waist measurement

Waist-hip circumference ratio (WHR) shows the regional fat distribution in the body. Waist circumference is measured at the point midway between the costal margin (bottom edge of rib cage) and iliac crest (top of pelvis) in the mid-axillary line while standing and breathing normally, and the hip circumference is the widest point around the greater trochanter (prominent

[2] Obesity is BMI >98th centile (WHO) or ≥30 at 18 years old (IOTF).
[3] Areas on back by shoulder blade.

part of hips) (Chan et al 2003) [4]. The WHR is then calculated as waist measurement divided by hip measurement.

Variations include the girth to height ratio (waist circumference divided by height) and waist/thigh circumference.

Advantages

- Shows regional fat distribution.
- Best predictor of abdominal fat.

Disadvantages

- Does not account for large variations in level of total fat.
- Requires two measurements, and thus an increased risk of error.
- Can prove misleading if both waist and hip measurements increase as WHR remains the same. For example, a waist of 80 cm and hips of 100 cm gives a WHR of 0.80. if this individual puts on weight and the waist becomes 100 cm and hips 125 cm, the WHR remains 0.80 (Despres et al 2001).
- Questions about accuracy with women, different body types, and different ages (Chan et al 2003).

5. Measurement of body composition

Methods based on modern technology have been developed to assess body composition, like dual energy absorptiometry (DEXA) and computerised tomography (CT).

Advantages

- High accuracy.
- Best measures for details of total body fat (ie: direct measures).

Disadvantages

- Expensive to use.
- Impractical for large numbers of people.

[4] A cut-off point for waist circumference is 102 cm/40 in for men and 88 cm/35 in for women (Seidell and Flegal 1997).

2. OBESITY PANDEMIC IN THE WEST

Canada

In the "obesity pandemic" today, Canada is one of the leaders with adult obese BMI at 25% in 2008 (up from 14% in 1979-80), and youth obesity based on BMI up from 3% to 8% for the same period (Janssen et al 2011).

Janssen et al (2011) questioned the use of BMI as it gives no information about distribution of fat within the body. For them, waist circumference (WC) is a better predictor of obesity-related health problems (morbidity and mortality risks). Janssen et al reported an increase in mean WC values between 1981 and 2007-9.

They used data from various sources to map the changes over these nearly thirty years:

1. 1981 Canadian Fitness Survey (CFS) - a nationally representative sample measured between February and July 1981 (n = 13 994 12-69 year-olds).

2. 1988 Campbell's Survey on the Well-Being of Canadians (CSWB) - a sub-sample of the CFS measured in March-April 1988 (n = 2602).

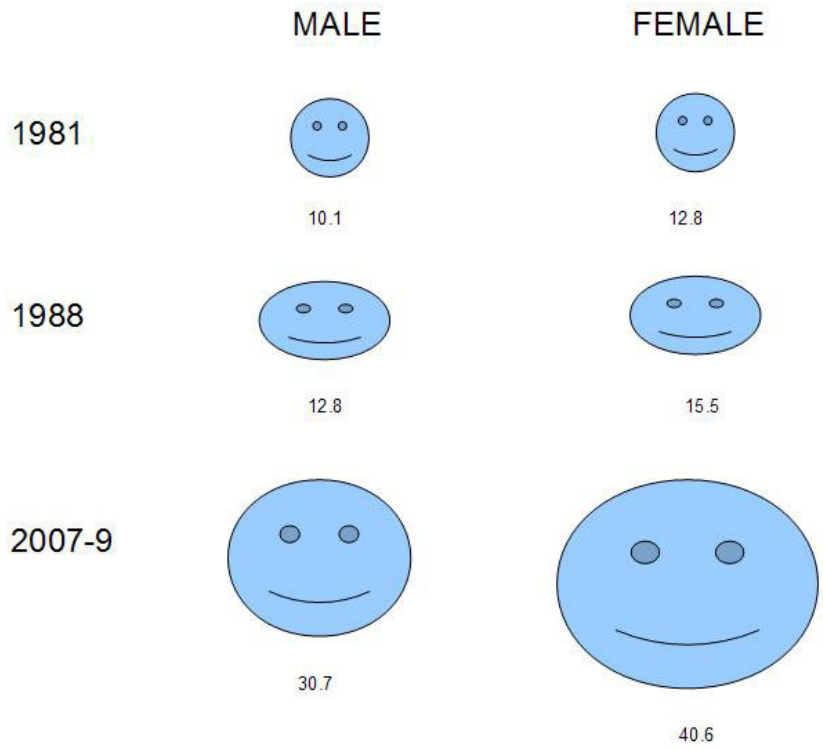
3. Canadian Health Measures Survey (CHMS) 2007-9 - a nationally representative sample of 6-79 year olds living in private households [5]. Data were collected between March 2007 and February 2009 at fifteen sites across Canada. Janssen et al used the 4530 respondents aged 12-79 years old.

The WC was measured in each survey at the mid-point between the last rib and iliac crest, and individuals were rated as low-risk (men ≤93.9 cm/women ≤79.9 cm), increased-risk (men 94.0 - 101.9 cm/women 80.0 - 87.9 cm), or high-risk (men ≥102.0 cm/women ≥88.0 cm).

From the CHMS 2007-9 data, just over one-third (36.7%) of adults (20-79 years) and 12.8% of adolescents were categorised as high-risk WC. These are significantly more than 1981 (11.4% of adults and 1.8% of adolescents) and 1988 (14.2% and 2.4% respectively). This is a sevenfold increase for adolescents over the thirty years studied and a threefold increase for adults (figure 2.1).

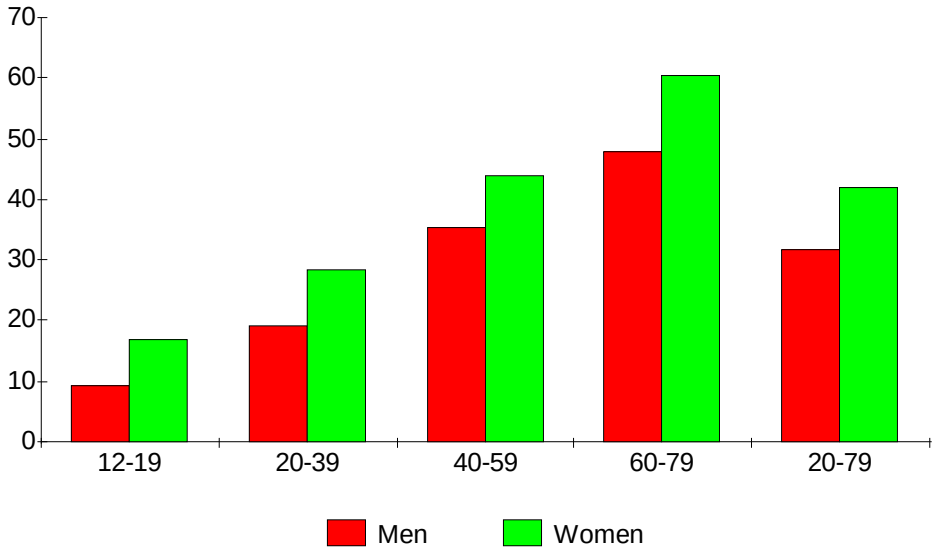
In terms of gender differences, there were more women than men in the high-risk category in the CHMS 2007-9 (figure 2.2).

[5] It included older adults than 79, all adults living in institutions, full-time members of Canadian Forces, certain remote regions, and residents of Indian/Aboriginal Reserves and Crown lands, and pregnant women (Janssen et al 2011).



(Source: Janssen et al 2011)

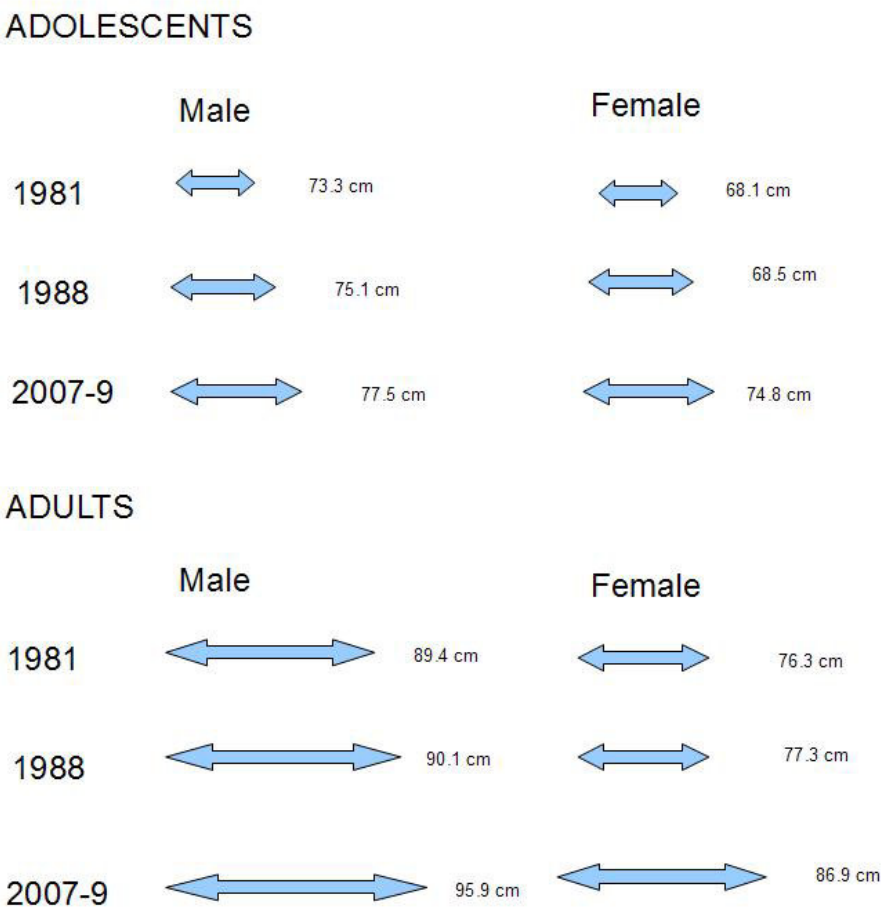
Figure 2.1 - Percentages of adult men and women categorised as high-risk WC in three Canadian surveys.



(Source: Janssen et al 2011 table 1 p400)

Figure 2.2 - Percentages of men and women rated as high-risk WC based on age group in the CHMS 2007-9.

The mean WC for adult men was 96.4 cm and 87.3 cm for women in 2007-9. These were significantly larger than 1981 (89.4 cm and 76.3 cm respectively) and 1988 (90.1 cm and 77.3 cm respectively) (figure 2.3).

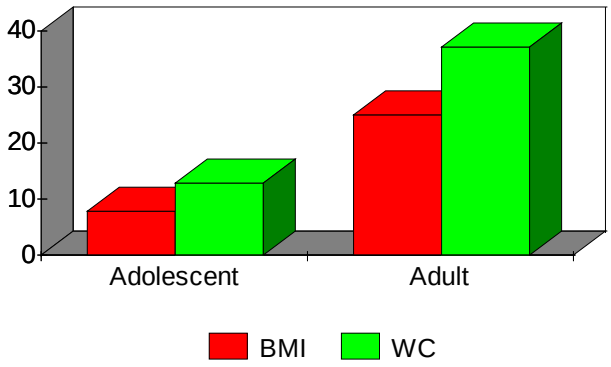


(Source: Janssen et al 2011)

Figure 2.3 - Mean WC in three Canadian surveys.

Janssen et al (2011) concluded that these WC data showed that previous studies using the BMI had underestimated the "obesity pandemic" in Canada (figure 2.4).

Foulds et al (2011) concentrated on a sub-group of the Canadian population, namely Aboriginal adults in British Columbia. Between January 2007 and February 2010, 759 adults from 22 locations (on and off Reserves) were



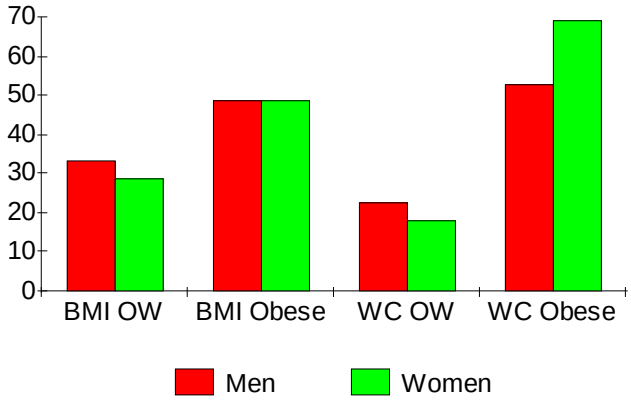
(BMI = 2008 data; WC = CHMS 2007-9)

(Source: Janssen et al 2011)

Figure 2.4 - Rates (%) of obesity in Canada based on BMI and WC.

measured for WC [6], and their BMI was calculated.

Overall, 29.4% of the adults were rated as overweight by BMI and 48.6% as obese, while 84.1% were viewed as abdominally overweight and obese based on WC (men ≥94 cm/women ≥80 cm). There were significant gender differences only for the WC measures (figure 2.5).



BMI OW = 25 - 29.9 kg/m²; BMI obese = ≥30 kg/m²; WC OW = men 94 - 101.9 cm/women 80 - 87.9 cm; WC obese = men ≥102 cm/women ≥88 cm

(Source: Foulds et al 2011 table 2 p e7)

Figure 2.5 - Gender differences (%) in overweight and obesity among Aboriginal Canadians.

[6] "Waist circumference was measured at the midpoint between the 12th rib and the iliac crest on the right side of the body using a flexible plastic tape to the nearest 0.1 cm. Participants were instructed tocross their arms over their chest and WC was measured at the end of exhalation" (Foulds et al 2011 p e5).

These figures are higher than the Canadian general population. Foulds et al (2011) explained it thus: "Traditionally, Canadian Aboriginal populations experienced active lifestyles centred on hunting, gathering, fishing and/or farming societies. Over the past four to five generations, cultural shifts experienced by this population include decreases in physical activity levels and alterations in diet. The current epidemic trend of sedentary behaviour occurring within Canada may be two- to threefold higher within the Aboriginal population" (p e4).

Sweden

Sjoberg et al (2011) reported that 16.6% of Swedish 7-9 year-olds were overweight and 3% obese in a national survey of 4538 children [7] [8]. Analysis of sub-groups found that overweight and obesity were more common in rural areas (as compared to urban and semi-urban areas), areas where less adults had university education [9], and in commuter municipalities [10]. The data were converted into odds ratios (table 2.1).

BASE (ie: 1.00)	RISK FACTOR	OVERWEIGHT	OBESITY
Urban	Rural	1.61	2.25
Urban - boys	Rural	1.63	4.64 *
Urban - girls	Rural	1.61	1.61
High education	Low education	2.21	3.69
Suburban municipality	Commuter	2.20	31.9

(* semi-rural - boys 5.92)

(Source: Sjoberg et al 2011 table 3 p310 and table 4 p311)

Table 2.1 - Odds ratios for overweight and obesity among Swedish children.

[7] Interestingly, 7.5% of the children were classed as thin.

[8] 5326 children were classed as eligible for the study, but 778 were not included for various reasons - parent or child refusal, sick or absent child on day of measurements, and missing information about child.

[9] "Area educational level" was used as a proxy for socio-economic status. "In 17 schools, 48–70% of the population aged 25–44 years in the municipalities had longer education as defined above [more than 12 years], and these were classified to be 'high-education areas'. In 47 schools, 31–43% had longer education and these were classified as 'medium-education areas', while in 30 schools only 18–30% had longer education and these were classified as 'low-education areas'" (Sjoberg et al 2011 p307).

[10] The municipality of the school were classified as: suburban, sparsely populated, commuter, metropolitan, large cities, manufacturing and three categories of other municipalities; smaller with <12 500 inhabitants, medium size with 12 500–25 000 inhabitants and larger with >25 000 inhabitants (Sjoberg et al 2011).

USA

Ogden et al (2008) reported a prevalence of overweight of 34% and obesity of 18% among US 12-19 year-olds nationally. But these figures are higher for low income, ethnic minorities, and/or males (Isasi et al 2011).

Isasi et al (2011) reported the details of data collected in 2008 from 1619 inner-city adolescents at eleven public schools in the Bronx, New York. Originally, 2661 individuals were approached, but there were student/parent refusals and absenteeism which reduced the numbers.

Using the BMI, 21.7% of participants were rated as overweight and 22.5% as obese. This latter figure was significantly higher for Hispanic adolescents (24% vs 17% non-Hispanics).

Significantly more girls were overweight than boys (24.5% vs 18.8%; p= 0.006), but obesity and severe obesity were significantly more common among boys (24.9% vs 20.1%; p = 0.02; and 6.7% vs 3.6%; p = 0.004 respectively).

The figure of 44.2% overweight and obese from this non-random Bronx sample is higher than among public school students in New York City as whole (39%), and in the South Bronx (38%) (quoted in Isasi et al 2011).

Isasi et al noted that the Bronx is the poorest borough in New York City with few adolescents eating the US Government's recommended amount of fruit and vegetables (20%), only half having regular exercise, and a large Latino population (who are "most affected by the obesity epidemic").

2.1. SOME REASONS FOR INCREASING OBESITY IN THE DEVELOPED WORLD

Seidell and Flegal (1997) observed that: "When we speak about the prevalence of obesity in populations we actually mean the fraction of people who have an excess storage of body fat. In adult men with an average weight, the percentage body fat is in the order of 15-20%. In women this percentage is higher (about 25-30%)" (p238).

Initially, as a society becomes more wealthy, increased weight is a sign of improved health as diet and food intake improve. But in a developed society, increasing weight becomes a problem as overweight and obesity.

So, why is adult obesity common in developed countries? The answer is increased energy intake (eg: eating more calorie-dense foods) and/or less energy expended (eg: driving around rather than walking) (table

2.2) [11]. The exact culpability of these factors is disputed (Bleich et al 2008). For example, in the UK between 1967 and 1992, mean energy intake fell by 20% for 1½-4½ year-olds, but overweight and obesity increased suggesting indirect evidence for reduced physical activity as the cause (Reilly and Dorosty 1999).

INCREASED ENERGY INTAKE	REDUCED ENERGY EXPENDED
• Reduced food prices. • Increased mass preparation of food. • Increased efficiency in food production. • Increased fast-food/calorie-dense food. • Increased opportunities for food in urban environments. • More women in workforce, less time for food preparation and dependence on convenience foods.	• Automated workplace (ie: sedentary). • Time cost of physical activity (eg: exercise at gym after work). • Non-active-based transport (eg: driving). • Less opportunity for physical activity in urban environment (and less physical activity than in rural environment).

Table 2.2 - Examples of factors in developed countries that encourage weight gain.

Bleich et al (2008) summarised the main trends in the developed world in recent years from the available data as follows [12]:

1. The percentage of the population classed as obese based on body mass index (BMI) (≥30kg/m²) has increased over the last thirty years (approximately 10% in the 1970s to around 20% by 2000). This is based on the Organisation for Economic Co-operation and Development (OECD) Health Database (OECD 2005).

2. The annual average change in percentage of obese adults has shown a consistent increase - eg: 0.8% in the USA in each year 1990-2002 (ie: approximately 1.5 million more adults becoming obese each year).

3. The 95th percentile of BMI is heavier now. If a frequency distribution graph is made of all the

[11] There are challenges to this idea. For example, Taubes (2008) was critical of the simple assumption that over-eating or sedentary behaviour causes obesity, and that dieting and exercise can reduce obesity. He argued that the consumption of refined carbohydrates, starches and sugars leads to excessive insulin secretion, and insulin regulates fat storage. These foods stimulate insulin secretion, and thus the accumulation of fat, which increases hunger and reduces energy expended.

In a different vein, Coghlan (2007) reported research that certain viruses (adenovirus-36 and SMAM-1) can stimulate fat cells and cause animals to put on weight (eg: Vangipuram et al 2007).

[12] Details of data at http://www.ecosante.org/OCDEENG/814010.html.

population, it is possible to see how heavy the individuals at the top end are becoming (statistically the 95th percentile is used; figure 2.6). For example, in the USA in the 1970s this point was a BMI of 35, while it became 40 by the 2000s.

Bleich et al observed that "Heavier people are getting heavier at a faster rate and thinner people are getting heavier at a slower rate" (p281). Between 1991 and 2000 in the USA, for example, the bottom percentile of BMI gained 19 pounds and the top percentile 40 pounds.

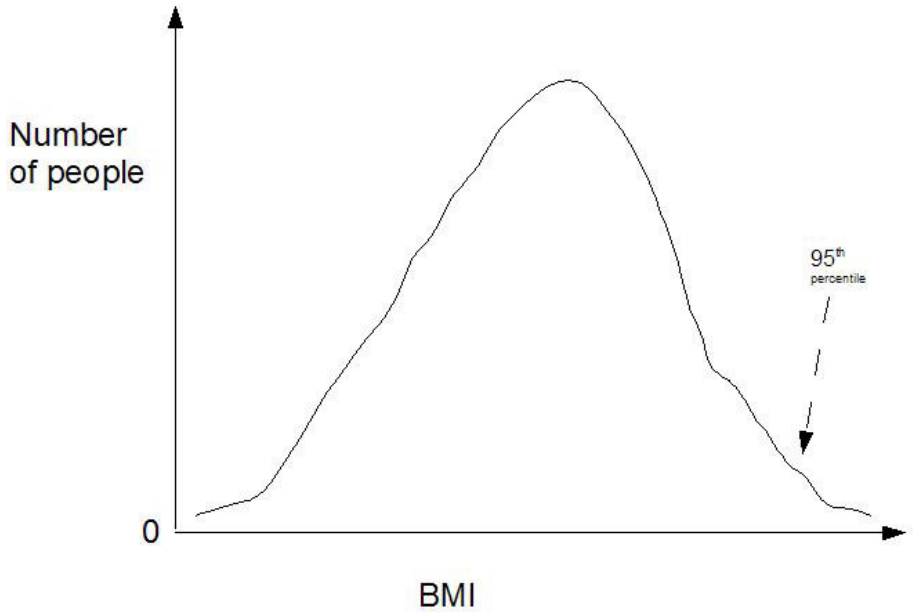


Figure 2.6 - The 95th percentile in frequency distribution curve of BMI in a population.

4. Calorie supply has increased in developed countries. This is calculated as calorie per person per day for a country based on total amount of food available for consumption (including imports, excluding exports; and excluding net losses from processing at the mill and food for animal consumption). These data are collected as food balance sheets for a country by the Food and Agricultural Organisation (FAO 2004). However, it does not show actual individual calorie consumption.

In the USA, for example, calorie supply rose by 300 calories between 1985 and 2000, and 190 calories in the UK (1985-2002) [13].

[13] A net increase of only 50-100 calories per day is enough to explain rising obesity in the USA (Hill et al 2003).

5. Physical activity has declined in both work and leisure time. Calculations are made of the average number of hours per day spent on highly active work (eg: as in agriculture and construction), less active work, active leisure time, and everything else (including commuting).

For example, in the UK, in 2001, 0.9 hours were classed highly active work, 2.6 as less active work, 0.3 as active leisure time, and 20.2 hours for everything else in a day. This had changed from 1.2, 2.4, 0.3, and 20.1 hours respectively in 1990. However, Bleich et al (2008) calculated that this reduction in activity manifest as only 80 calories less used per day.

Bleich et al (2008) felt that, overall for adults, increased calorie intake rather than reduced physical activity was "the driving force behind the growing obesity epidemic". The increased calorie intake was facilitated by a decline in average food prices relative to other prices and income (average 12% decline between 1980 and 2002 in the developed world) (figure 2.7).

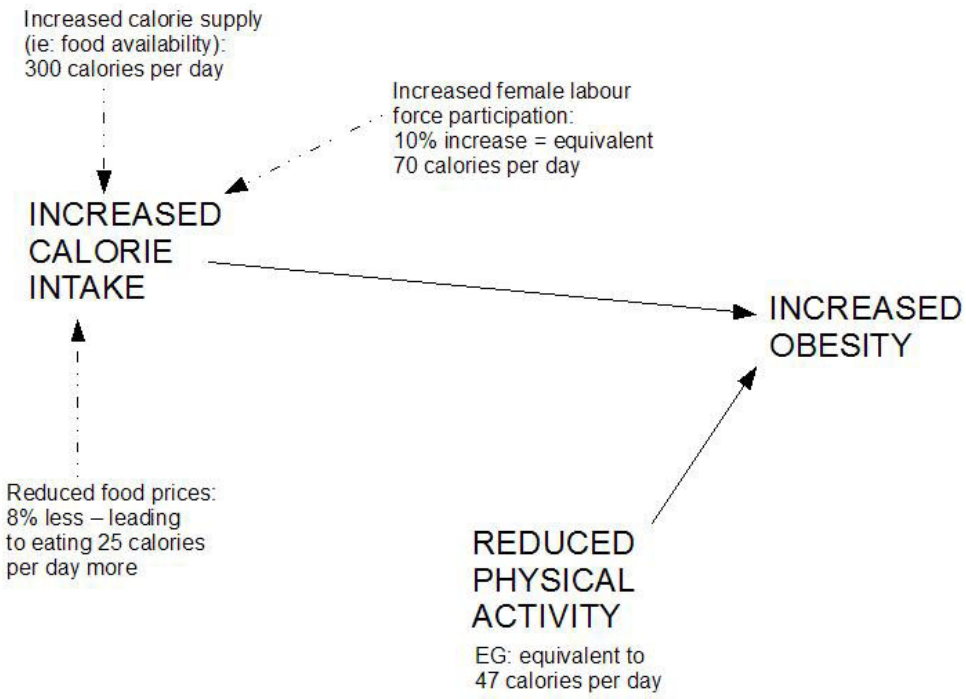


Figure 2.7 - Example of factors that led to increased obesity in developed countries (using calculations from USA data by Bleich et al 2008).

Soft Drink Consumption

Soft drink consumption has increased in the West over the second half of the 20th century, and this is a contributing factor to increased obesity due to the

energy overconsumption from the added sugar in the drinks. For example, the US per capita consumption of non-diet soft drinks rose nearly 100% between 1970 and 2000 (22 gallons to 41 gallons per year) (Vartanian et al 2007). While Frary et al (2004) calculated that US children and adolescents who are the highest consumers of soft drinks take in four to five times the US Government's recommended maximum of added sugar.

There is also concern that soft drinks displace other food and beverages leading to lower intake of nutrients. Industry trade groups, like the American Beverage Association, argue that soft drinks are unfairly criticised (Vartanian et al 2007).

Vartanian et al (2007) performed a systematic review and meta-analysis of studies of the effects of sugar-sweetened soft drink consumption on health. They found 88 relevant articles. The studies tended to use one of three methods: cross-sectional, longitudinal, or experimental design (table 2.3).

- Cross-sectional - compares groups at one point in time. Not able to determine causality. Eg: obesity among low and high soft drink consumers.
- Longitudinal - follows group over time. Able to show the direction of a relationship in time. Eg: soft drink consumption and who becomes obese in future.
- Experimental - compares an experimental and a control group. Best method for establishing causality. Eg: sugar-sweetened vs non-sweetened drinks to see who gains weight.

Table 2.3 - Three methods used to study soft drink consumption and health.

The strength of associations between soft drink consumption and health outcomes varied with the method used in a study.

1. Soft drink consumption and increased energy intake - Overall, individuals do not compensate for the added energy intake from the sugar in the drinks by reducing food intake. For example, one study found 17% more energy over a ten-week period (DiMeglio and Mattes 2000).

The association was strongest in longitudinal studies and weakest in cross-sectional ones. The association was also stronger for women (than men), adults (than children and adolescents), and in studies not funded by the food industry.

There was also some evidence that soft drinks stimulated appetite or suppressed satiety (feeling full).

2. Soft drink consumption and body weight - Studies varied in their findings based on method again, but also how body weight was operationalised. For example, cross-sectional studies reported positive correlations between consumption and BMI, consumption and body fat percentage, but not skinfold thickness. This method cannot establish the direction of the relationship. It is possible that individuals with a larger BMI are motivated to consume more soft drinks as well as consumption of soft drinks leading to higher BMI. However, studies using the other two methods did show the direction of the relationship as soft drink consumption leading to weight gain.

3. Soft drink consumption and calcium intake - Overall, there was a negative correlation between soft drink consumption and calcium intake (eg: via milk). It was calculated by one study that reducing soft drink consumption by one 16-oz serving per day would lead to an increase consumption of 4-oz of milk per day (Vartanian et al 2007).

4. Soft drink consumption and nutrient intake - There were not many studies here, but there was evidence of reduced intake of protein, for example, among high soft drink consumers.

However, it is not clear whether the soft drinks caused the reduced intake of protein, or that both variables are the product of a third variable (eg: unhealthy diet).

5. Soft drink consumption and health outcomes - A small number of studies reported different health problems among heavy soft drink consumers with the strongest association being type 2 diabetes. For example, Schulze et al (2004) followed 91 249 women over eight years in their longitudinal study. Individuals who consumed one or more serving of soft drink per day were twice as likely to develop diabetes than individuals who consumed less than one serving per month.

Overall, then, there seems to be an association between soft drink consumption and overweight, but not all studies agree. Vartanian et al (2007) found "clear associations of soft drink intake with increased energy intake and body weight", while Forshee et al's (2008) meta-analysis reported a "near zero" association. The latter included on longitudinal studies and randomised controlled trials, and focused on children and adolescents. In order to resolve such disagreements between studies, Mattes et al (2011) undertook a systematic review and meta-analysis of the best studies

(ie: randomised controlled trials; RCTs) focusing on nutritively sweetened beverages (NSBs). NSBs are soft drinks with a nutritive sweetener (eg: sodas, chocolate milks) and not including diet beverages, 100% fruit juice, and unsweetened milk.

RCTs are the best method to use because of the strict criteria as specified by Mattes et al (2011):

- A direct comparison of groups that differ on one variable - eg: consume/not NSBs or reduce consumption/normal consumption of NSBs.
- Only humans (not animal studies).
- Random assignment of participants to conditions.
- Clearly operationalised outcome variable - eg: BMI, percentage body fat.
- A study duration of longer than three weeks.
- The exclusion of stressed or ill participants (eg: soldiers in field exercises, pregnant women).

Using these criteria Mattes et al found twelve studies, mostly studying the consequences of increasing NSBs, or those looking at reducing NSBs.

1. Effect of increased NSB consumption - Four RCTs were included here, and they ranged from three weeks to 12 months in length, from thirty to 133 participants in size, and increased daily energy from NSBs from 150 - 530 kcals. NSB consumption led to greater weight gain from the control conditions, but only significantly in two of the studies.

Putting the data from the studies together for meta-analysis, it was calculated that the equivalent of an extra 20-oz bottle of NSB per day would increase weight by 0.2 kg over 3-12 weeks.

This type of study depends upon individuals in the control condition not consuming NSBs as instructed or consuming only non-NSBs. Usually participants are warned that compliance will be checked by a urine sample (whether it is done or not). For example, in one of the studies (Haub et al 2005) the control group was described as "usual lifestyle".

2. Effect of reducing NSB consumption - Six studies were included here ranging in duration from four to 52 weeks. The participants used varied between children (7-12 years old) (three studies), adolescents (two studies), and adults, with some of them overweight at baseline. One study (Albala et al 2008), for example, encouraged compliance by nutritionists visiting the family each week to deliver the milk drinks (non-NSB), and to encourage parents to remove NSBs from the house. Generally compliance was checked by self reports (if checked) in

all the studies.

Meta-analysis of the combined data found no significant reduction in BMI from less NSB consumption compared to the normal level. A sub-group meta-analysis of participants overweight at baseline found that the control condition lost more weight than the intervention.

3. Other RCTs - One study (DiMeglio and Mattes 2000) compared fifteen adults' consumption of a NSB with an energy-matched solid carbohydrate food (jelly beans) over four weeks. Body weight increased significantly with the NSB. Mattes et al (2011) questioned the comparability of the two groups.

Another study (Williams et al 2007) evaluated a weight loss programme among overweight adolescents who were allowed a "treat" of either regular (NSB) or diet soda. There was no difference between the groups.

This review and meta-analysis by Mattes et al (2011) arrived at some different conclusions to meta-analyses by Vartanian et al (2007) and Forshee et al (2008). Why might that be? Mattes et al suggested some differences between the three analyses (table 2.4).

- Type of studies included (and excluded) in meta-analysis (eg: RCTs only).
- Participants included/excluded (eg: only children and adolescents).
- Differences in decision-making by researchers when data combined for meta-analysis - eg: Mattes et al (2011) used only BMI as outcome of weight loss for studies reducing NSB consumption.
- Inclusion of unpublished studies (Mattes et al 2011 did).
- Meta-analysis of sub-groups (eg: baseline overweight individuals only).
- Beverages included as soft drinks or as NSBs.
- Funding of the research and researchers.

Table 2.4 - Differences in method between three meta-analyses.

Fast Food

The World Health Organisation has argued that the "marketing of energy-dense foods and fast food outlets is a 'probable' cause of increasing overweight and obesity among the world's children" (Robinson et al 2007).

Over $10 billion per year is spent in the USA on marketing food and beverages to children with the particular aim of encouraging them to recognise and differentiate certain products and logos (which children between 2-6 years old can do) (Robinson et al 2007).

Robinson et al (2007) clearly showed the effect of

such marketing in a food-tasting experiment that gave pre-schoolers in the USA the same food in a branded package or an unbranded one. They preferred the former.

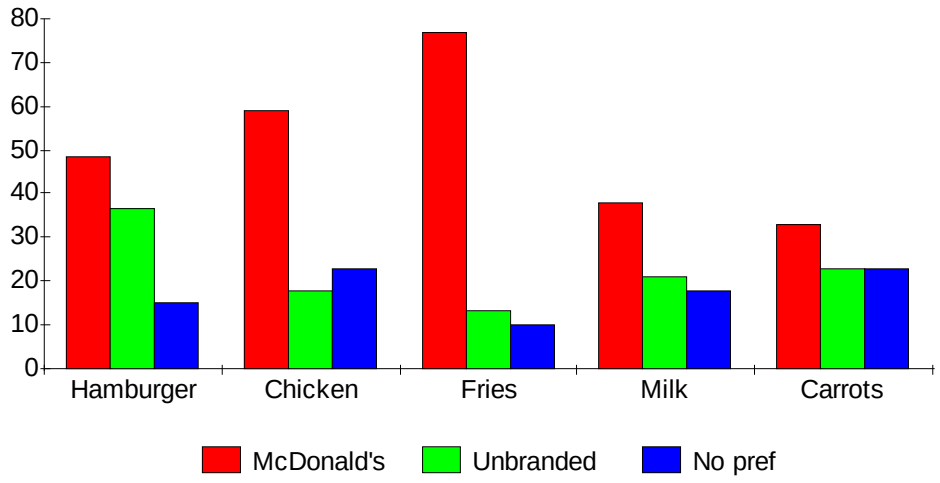
Sixty-three 3-5 year-olds from low-income families in San Mateo County, California were recruited. The children tasted portions of five pairs of identical foods:

- McDonald's hamburger in McDonald's wrapper and in matched plain white wrapper;
- Chicken McNugget in McDonald's wrapper and white bag;
- McDonald's french fries;
- Ordinary milk in McDonald's cup and plain white cup;
- Two carrots in McDonald's wrapper and plain white bag.

After checking the children knew which package was from McDonald's in each pair, they asked "if they taste the same, or point to the food that tastes best to you". The answers were scored as +1 (preference for food in McDonald's wrapper), -1 (preference for unbranded food), or 0 (no preference). This was nominal data.

The children significantly preferred all the foods in the McDonald's wrappers (except the hamburgers which not significant), even when, in the case of milk and carrots, the food was not from McDonald's (figure 2.8). The preference was significantly stronger for children with more television sets in their homes (1 vs ≥4), and those who ate food from McDonald's regularly (2-3 per week vs <1 per month).

This experiment showed that brand identity can influence the children's taste perceptions as young as 3-5 years old.



(Source: Robinson et al 2007 table 2 p795)

Figure 2.8 - Children's taste preferences (%).

Sedentary Behaviour

In a longitudinal study from birth to seven years old of 871 European children in Auckland, New Zealand, Blair et al (2007) listed the risk factors for obesity as maternal overweight/obesity, television watching, sedentary activity time, and rapid weight gain in infancy and early childhood.

If sedentary behaviour, due to television watching, for example, is behind the increasing child obesity, then reducing television watching may combat weight gain as children subsequently become more active. The problem is that television viewing not only reduces energy expenditure, but it increases energy intake as eating and television viewing become associated together (partly though embedded food advertising).

Epstein et al (2008) reported a randomised trial to reduce television viewing and computer use by 50% among overweight 4-7 year-olds in the USA. Seventy children, whose BMI was above the 75th percentile for age and sex, were recruited via newspaper advertisements, flyers, and direct mailing. The child had at least fourteen hours per week television viewing and/or computer game playing. Baseline measures for each child were made over a three-week period based on electronic monitoring devices on the television and computer.

The children were randomly assigned to the intervention or control group. The intervention group involved parents rewarding their child for keeping below their "TV budget" (which was incrementally reduced by 50% from baseline) over a six-month period. BMI was measured at baseline, and after 6, 12, 18, and 24 months.

The children in the intervention group had significant reductions in sedentary behaviour [14], BMI, and energy intake over 24 months as compared to the control group. Television viewing and computer game use declined by a mean of 17.5 hours per week in the intervention group and 5.2 hours in the control group.

It was noted that the intervention worked best for families of lower socio-economic status.

van Sluijs et al (2007) reviewed the effectiveness of interventions to promote physical activity in children and adolescents. Fifty-seven studies were found in a literature search that met the inclusion criteria, of which 24 were rated as high methodological quality. Thirty-three of the studies involved children, of which

[14] Sedentary behaviour (or physical activity) was measured by movement in one-minute periods on three randomly selected weekdays after school to bedtime and all day for one randomly selected weekend day. No movement during a one-minute period was scored as sedentary behaviour, and movement as physical activity.

18 were from the USA and seven the UK, while eighteen of the 24 studies with adolescents were in the USA.

Two-thirds of the studies reported a significant increase in physical exercise after the intervention to encourage exercise as compared to the control group. Multi-component interventions involving school (eg: special classes on physical activity and health education) and family (eg: encouraging parents to exercise more) were most effective.

An "obesogenic environment" for children will inhibit physical activity (eg: no local parks in which to play) and encourage consumption of unhealthy foods (eg: takeaways near schools). However, the relationship between access to food outlets and child obesity is not clear-cut with studies producing equivocal findings (Harrison et al 2011):

- Living nearer to a supermarket reduces the obesity risk while living near to a convenience store increases it.
- Number of fast-food outlets around a person's home can have no, a positive, or a negative relationship with obesity.

The relationship between the physical activity environment and obesity is more unequivocal. The number of neighbourhood amenities like parks, playgrounds, recreational centres, and pavements is inversely related to child overweight and obesity, though only for teenagers and not younger children (Harrison et al 2011).

Harrison et al (2011) reported a study of diet and physical activity as part of the SPEEDY study [15], which focused on 9-10 year-olds in the county of Norfolk, eastern England. Harrison et al collected data from 1995 children in April-July 2007 [16].

For each child fat mass was calculated by sending a minute electrical current through the body, and the speed of its travel can be converted into a measure of body fat [17]. A fat mass index (FMI) was then produced based on the height of the child.

Each child completed a questionnaire about their physical activity including means of travelling to school, and their eating habits. The researchers rated the local environment around the schools in the study on certain variables (table 2.5).

- Healthy/unhealthy food outlets - number of outlets along route to

[15] Sport, Physical activity and Eating behaviour: Environmental Determinants in Young people.
[16] Data were collected from 2064 children, but the data were not complete for 69 children, hence 1995.
[17] The speed of the current varies between fat, muscle and bone.

school divided by route length (based on Ordnance Survey map data).
- Accessible open land - area of open land within neighbourhood as a percentage of total neighbourhood area (based on eg Forestry Commission data).
- Road safety - eg: number of serious or fatal road traffic collisions in an area 2002-2005 divided by total length of roads (based on Norfolk and Suffolk Constabularies data).
- Effective walkable area (ie: pavements along side of road).

(Source: Harrsion et al 2011 table 1 p1413)

Table 2.5 - Examples of environmental variables used by Harrison et al (2011).

Just over half (57%) of the sampled children lived within 1.6 km (1 mile) of their school. Overall, 40.1% of children travelled to school on foot (with significantly more girls than boys), 9.3% by bicycle (significantly more boys), 6.2% by bus and/or train, and 44.5% by car.

There were gender differences in the significant associations between environmental variables and FMI. Among girls, who were active travellers (ie: walk or cycle to school), access to healthy food outlets in home and school environments, and mixed land use (part residential/part rural) were associated with lower FMI. Access to unhealthy food outlets, and living near open land were associated with a higher FMI for all girls. It is usually assumed that open land encourages physical activity, but the researchers wondered whether such areas were perceived as unsafe which discouraged their use.

For boys, the only significant association was the presence of a major road in the local environment. For non-active travellers, a higher FMI was associated with the major road being near the home environment, while a major road near the school environment was associated with lower FMI for active travellers. Major roads are usually seen as a deterrent to activity with no pavements and the perception of traffic danger. The researchers were puzzled as to why the major road near the school was a positive association.

Evaluation of Harrison et al (2011)

1. It was a cross-sectional study, but that means that it is not possible to establish causality between environmental variables and the FMI.

2. A large sample was recruited. However, 57% of children refused to participate in the study, and 92 of 157 schools approached. There were more girls (1103) than boys (892) in the sample, and a lower percentage of obese children than in the wider Norfolk population.

3. A fat mass index was calculated for each child using an objective measure. But the technique did not measure where the body fat was distributed on the body.

4. Objective measures of the environmental variables were used. But the measures were based on other sources (eg: Forestry Commission for woodland and open land).

5. The study covered both rural and urban areas. But how representative is Norfolk of the counties in England?

More About the Obesogenic Environment

Huneault et al (2011) argued that the modern Western world is obesogenic, and weight is gained through the stress of such an environment. Modern work tends to produce a sedentary lifestyle, on the one hand, while the stress of competition and higher expectations mediate the accumulation of fat (figure 2.9). In animal experiments, socially stressed subordinate macaques, for example, had higher fat depositions in the central portion of the body (Shively and Clarkson 1988).

The term "globalisation" is used to describe the modern world. This can mean different things, one characteristic is the "'quest for the best' mentality" (Tokyo declaration on work-related stress and health 1999 quoted in Huneault et al 2011), which demands commitment to longer hours at work in a highly competitive economic environment. This environment is also stressful in many ways.

The effect of stress on the body can change blood sugar levels, energy intake, and sleep patterns (Huneault et al 2011). Animal experiments showed that emotional stress produced increased saccharine consumption in rats (eg: Pijlman et al 2003).

Most individuals in the West are involved in knowledge-based work (ie: mental rather than physical tasks). Mental work can lead to an increase in the desire to eat (eg: 15% more chocolate intake after a cognitive task than no task; Wallis and Hetherington (2004).

The obesogenic environment works in two ways: - (i) a sedentary lifestyle uses less calories in relation to intake, and (ii) certain behaviours like television viewing, video game playing, cognitive working, music listening, and short sleep promote overconsumption of food (Chaput et al 2011).

Chaput et al (2011) presented evidence to show that the five behaviours mentioned above increase food consumption.

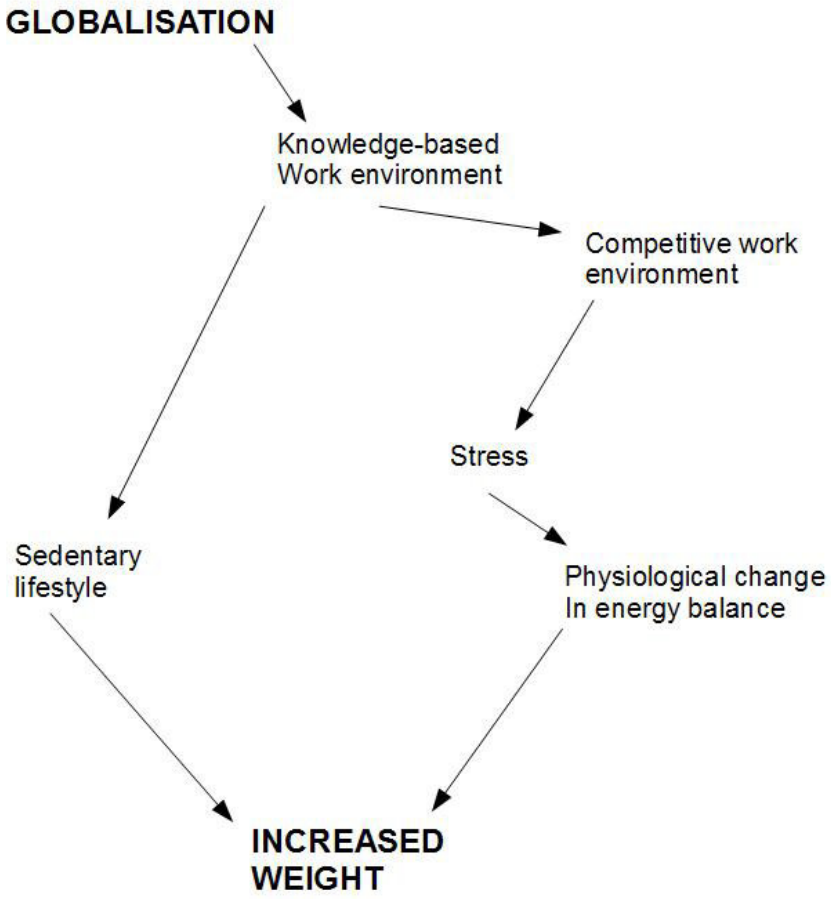


Figure 2.9 - How globalisation leads to weight gain (Huneault et al 2011).

i) Television viewing - Dietz and Gortmaker (1985) were the first to show the relationship between high television viewing and a higher risk of overweight and obesity. Television viewing goes with reduced physical activity, and increased food intake through advertising, and the association of certain foods with television viewing (eg: popcorn and movies). Furthermore, television viewing disrupts hunger-satiety signals by distracting individuals (Wansink and Park 2001).

ii) Video-game playing - For example, Stettler et al (2004) reported a twofold increased risk of obesity for every hour spent playing electronic games each day.

iii) Cognitive working - Mental work can lead to increased food intake. Chaput and Tremblay (2007) found that female students ate significant more after 45 minutes of a reading-writing task than sitting quietly for the same period despite the two activities involving almost equal energy expenditure. Mental work may also be

stressful, and lead to "comfort food" to reduce the stress (Dallman et al 2003).

iv) Music listening - Listening to music and the pace of the music can increase food intake. College students ate significantly more and had a longer meal duration when listening to music than not (Stroebele and de Castro 2006). While fast-paced music encourages individuals to drink faster (as in alcohol consumption) (eg: McElrea and Standing 1992).

v) Short sleep - For example, Spiegel et al (2004) found that students restricted to four hours sleep on each of two nights had a greater appetite for energy-dense foods due to hormonal changes [18].

Chaput et al (2011) concluded:

> Perhaps no other demographic group in the history of the westernised countries has undergone such a significant transformation in the past several decades as that of our children. Societal trends have dramatically altered the nature of play and the way children interact with their environment. These trends have included a significant decrease in outdoor recreation and sleep duration and an increased dependence on electronic media... More importantly, the increased food intake in the absence of hunger observed with the practice of these modern-life activities underscores that non-homeostatic, reward-driven regulatory mechanisms involved in feeding behaviour are probably more important than we think (p e18).

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[18] However, Horne (2011) questioned the relationship between short sleep and obesity, and highlighted methodological problems with the studies including:

- Subjective measures of sleep duration (prone to over-estimate).
- Lack of clarification of "sleep" as opposed to "time in bed".
- Where to make the cut-off point for risk of obesity (eg: <6 hours or <5 hours sleep).
- Focus on night-time sleep and ignoring daytime naps.

Horne concluded, after a review of recent studies: "Although often statistically significant, any association between short sleep and obesity for the majority of people is unlikely to be causal, and may not be of particular clinical importance in relation to other factors associated with obesity, even for those habitually sleeping around 5 h, who only comprise a small minority of the adult population. Of course, someone who has inadequate sleep such that it produces excessive daytime sleepiness, is more likely to be physically inactive and have an energy intake in excess of expenditure. But the point, here, is that irrespective of this possible cause, such sleep has to be endured for years, with a huge accumulation of 'lost' sleep, even for a relatively minor weight gain. Moreover, apart from dietary adjustment, rectification of this gain can be accomplished by relatively short exposures to exercise, whereas little is known about the comparable efficacy of extending sleep...[In fact].. The great majority of obese people are not habitual short sleepers and are as likely to be sleeping to excess... For short sleepers, excessive daytime sleepiness is likely to be of greater concern than is obesity" (p e91).

2.2. CHILDHOOD OBESITY INCREASING IN SCOTLAND AND ENGLAND?

It has been suggested that obesity is more common in Scotland than in England (eg: Chinn and Rona 2001).

Mitchell et al (2007) reported that the prevalence of obesity among a group of Scottish schoolchildren had declined between 1997 and 2004. Using the same geographical area (Aberdeen), three cohorts from primary schools were compared. This is a cross-sectional study.

The data were collected from school nurse records in Year 1 of the primary school (5 years old). The height and weight (in light underclothing) of each child was collected at a medical examination. The researchers used these to calculate the child's BMI, and then compared it to BMI centiles using UK 1990 reference data (Cole et al 1995 [19]) [20]. Overweight was defined as BMI ≥85th centile and obesity as ≥95th centile [21].

In 1997, the prevalence of obesity was 14.7%, then 11.4% in 2001 (McDougall and Crum 2006) [22], and 10.2% in 2004 [23].

Reilly and Dorosty (1999) reported rates of overweight of 21.4% (at age six years) and 31.1% (at 15), and 10.4% and 16.8% respectively for obesity among 2630 English children (using the Health Survey for England 1996 data). Stamatakis et al (2005) also reported increasing rates in Britain (table 2.6). They used data on 28 601 5-10 year-olds from the National Study of Health and Growth (NSHG) in 1974, 1984 and 1994 (which includes England and Scotland) and the Health Survey for England (HSE) yearly from 1996 to 2003.

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[19] Based on the data from eleven surveys in the UK between 1978 and 1990 (15 636 males and 14 899 females from 33 weeks to 23 years old). A cut-off point of BMI is used for adults and overweight, but because children are growing rapidly the BMI fluctuates (eg: BMI increases quickly in the first eight weeks of life, then declines, and flattens out at five years old; Cole et al 1995), and so it is better to express BMI as centiles (or standard deviation scores). For example, the median BMI for 11 year-old girls is 17.5, and one such individual with a BMI of 29 will be above the 90th centile (ie: obese) (Cole et al 1995).

[20] BMI is better with children than other measures of overweight, like waist circumference, waist-to-hip ratio or waist-to-height ratio, because intra-abdominal fat is limited (Lawlor and Chaturvedi 2010).However, the BMI underestimates obesity prevalence because the "BMI is a proxy for excessive fatness rather than a direct measure of fatness, and is specific (identifies few non-obese children as such) but insensitive (fails to identify large numbers of excessively fat children)" (Reilly and Dorosty 1999 p1875).

[21] This predicts that statistically 15% of children will be overweight and 5% obesity.

[22] This study involved 1018 children from nineteen primary schools. In terms of overweight, in 1997 28.7% of children and 21.5% in 2001 compared to 24% in 2004. The 1997 cohort were measured again five years later (n =367), and the prevalence of overweight and obesity had not changed.

[23] Mitchell et al (2007) speculated that this non-significant downward trend in Scotland may be due to greater awareness of obesity among parents from health campaigns in Scotland encouraging healthy eating and regular exercise.

	BOYS	GIRLS
Overweight: 1974 2002-03	 11.3 22.6	 9.6 23.7
Obesity: 1974 2002-03	 1.8 6.0	 1.3 6.6

(Source: Stamatakis et al 2005)

Table 2.6 - Rates (%) of overweight and obesity in 1974 and 2002-03 among 5-10 year-olds.

2.3. FOOD-INSECURE-OBESE CHILDREN IN THE USA

"Food insecurity" is a term used to describe the situation of not enough food through lack of financial means to access such food. More specifically, it is defined by the US Department of Agriculture as "limited or uncertain availability of nutritionally adequate and safe foods, or limited or uncertain ability to acquire acceptable foods in a socially acceptable way" (Eisenmann et al 2011 p e74). The US Government measure the status of households using eighteen questions known as the Core Food Security Module (CFSM) (table 2.7). Agreement with three of more questions is categorised as a food-insecure household with sub-categories of low food-secure (agreement with 3-7 questions) and very low food-insecure (eight or more questions).

- "We worried whether our food would run out before we got money to buy more". Was that often, sometimes or never true for you in the last 12 months?
- "The food that we bought just didn't last and we didn't have money to get more". Was that often, sometimes or never true for you in the last 12 months?
- "We couldn't afford to eat balanced meals". Was that often, sometimes or never true for you in the last 12 months?
- "We relied on only a few kinds of low-cost food to feed our children because we were running out of money to buy food". Was that often, sometimes or never true for you in the last 12 months?
- In the last 12 months, were you ever hungry, but didn't eat, because you couldn't afford enough food? (Yes/No)

(Source: Eisenmann et al 2011)

Table 2.7 - Example of questions on food insecurity in the CFSM.

Based on these categories, in 2008, 14.6% of

households in the USA were food-insecure and 5.7% very low food-insecure. These figures were 21.0% and 6.6% respectively for households with children. Households headed by a Hispanic individual had the highest rate of food-insecurity by ethnicity (26.9% of all Hispanic households), but Blacks had the highest very low food-insecure numbers (10.1%) (Eisenmann et al 2011).

An alternative concept is "food insufficiency" which is measured by four statements: "We have":

- enough of the kinds of food we want to eat;
- enough but not always the kinds of food we want to eat;
- sometimes not enough to eat;
- often not enough to eat (Eisenmann et al 2011).

There is interest in the apparent association between overweight and obesity among children and adolescents, and food-insecure households in the USA.

This was first highlighted by Dietz (1995), who reported the case of a seven year-old Black girl in Boston with a BMI of 38.6 kg/m^2, whose mother received US Government assistance in the form of food stamps (Aid to Families and Dependent Children). Dietz explained this contradictory situation of a very obese child from a family on very low income (food-insecure-obese child; FIO) as due to high fat consumption in an unbalanced diet, and/or an evolutionary adaptation to insufficient food whereby the body stores fat.

How common is the FIO child in the USA? Eisenmann et al (2011) reviewed the studies since Dietz up to December 2009. They found 21 relevant studies of children and adolescents in the USA.

The results of the studies were mixed with positive, negative, and no associations found (table 2.8), and the authors admitted that it was difficult to disentangle them in order to establish a clear pattern.

NATURE OF RELATIONSHIP	STUDY	SAMPLE	DETAILS
Positive	Casey et al (2006)	NHANES 1999-2002 *; 6995 3-17 year-olds	38.5% overweight in food-insecure households vs 28.8% food-secure households ($p<0.05$)
Negative	Jones et al (2003)	Panel of Income Dynamics Child Development Supplement; 772 5-12 year-olds	36% of boys and 23% of girls overweight in food=insecure households vs 46% and 22% respectively in food-secure households
No	Gundersen et al (2009)	NHANES 2001-4 *; 2516 8-17 year-olds	No significant association using five different measures of obesity

(* National Health and Nutrition Examination Survey)

Table 2.8 - Examples of studies finding different associations between food insecurity and child overweight and obesity.

3. DIFFERENCES IN OBESITY

3.1. GENDER AND WEIGHT

In many Western societies obese is more common among women than men, whereas overweight is the opposite (Broom and Dixon 2008).

Broom and Dixon (2008) observed that "Females are notoriously dissatisfied with their bodies, although gender comparisons indicate that men are becoming more body conscious, and that the sexes differ in the specific focus for body dissatisfaction. While women are likely to want to be thinner (whatever their weight) and to be unhappy about their waists, hips and thighs, men often want to be more muscular (rather than thinner) and are liable to be concerned about the appearance of their upper bodies/chests" (pp149-150).

Broom and Dixon (2008) noted that health messages about fatness have produced an "obesophobic" environment (a fear of obesity) with "an unhealthy fixation on food and eating in the general population, elevated rates of depression and social isolation among overweight and obese people, and harmful weight-loss practices" (p150).

There is an ambivalence in Western societies about weight: so "while many heavy people are ignoring the widespread advice to do something about their weight, many others – especially women – are actively engaged in individual or organized efforts to control or reduce their body size.." (Broom and Dixon 2008 p152).

Broom and Dixon (2008) explored the issue of gender and how it was constructed in "Weight Watchers" programmes in Australian - particularly "Weight Watchers at Home" (WWaH) (aimed mainly at women) and "Weight Watchers for Men" (WWfM). Content analysis of the text of both programmes was performed. They are basically the same programme, but "marketed" differently - "Eating and exercise are practices common to both programmes, but the presentation of how to get started is different. Men are introduced to exercise, then food, while women begin with food, then go on to exercise, then to feelings" (p154).

For example, WWfM involves sporting metaphors and images (eg: personal calorie record is called a "Scorecard"), and those related to business (eg: "treat WWfM like a work project - set goals, plan your schedule and take time out to do regular progress reports"; quoted in Broom and Dixon 2008 p155). While WWaH focused on "rewards" for weight loss, like purchases of lipstick or jewellery. "Although statistically we know that the majority of Australian women do paid work, WWaH rarely addresses women as employees. Instead, it foregrounds their family relationships and unpaid domestic

activities.." (Broom and Dixon 2008 p155). Also WWaH focused on emotions related to eating which WWfM did not mention.

In opposition to the "weight loss industry" is the "fat acceptance movement" (eg: US group - National Association to Advance Fat Acceptance). Broom and Dixon (2008) highlighted four themes that emerge from such groups as their "resistance" to thinness:

"1. The obsessive self-surveillance and self-denial entailed in regimes of weight-loss or weight-control;
2. The presumption that one's overall life and personal success are contingent on one's physical appearance and particularly weight;
3. The trend toward 'healthism'... with its associated deference to the authority of experts and the implication that good health (as defined by experts) is the top priority; and
4. Size-based discrimination (overt and covert)" (p158).

A survey of websites of he different groups showed that their focus was female membership. "In light of the longstanding link between women and dieting, it is logical that resistance to the culture of dieting would also have a strongly female constituency. Having been most harmed by the downsides of diets and dieting, and being subjected to a more stringent range of acceptable body norms, women have a greater potential stake in resisting obesophobia" (Broom and Dixon 2008 p160).

Broom and Dixon (2008) were downbeat about their study:

> Many of the findings from this study are unremarkable. It is no surprise that the largest commercial weight-loss scheme mobilises conventional elements of gender in its materials. Bright colours and photographs of smiling, slim, dynamic young women adorn the pages of booklets designed for women, while a low-key professional look characterises the publications for men who are offered a business-like factual text...
> At the very least, these strategies reproduce markedly gendered and heterosexist concepts of appropriate social and personal life and of the body. For example, they rely on and implicitly reinstate stereotyped notions of men as paid workers and women at home, despite women's high and rising employment and the gradual decline in men's labour force participation. Apparently no lesbian or gay client is envisaged for either programme (pp160-161).

3.2. OBESITY AND EDUCATIONAL LEVEL

As a generalisation, overweight and obesity are negatively correlated with educational level in Europe. In other words, individuals with a higher education are less likely to be obese, and the lower educated are more likely.

Roskam et al (2010) reported the details of survey data from nineteen European countries with a total sample size of 127 018. Education level was scored at four levels: "tertiary" (eg: university degree), "upper secondary and post-secondary non-tertiary", "lower secondary" and "no or only primary". BMI was the measure of overweight and obese based on self reports of weight and height [24].

The relative index of inequality (RII) was calculated. This summarised the association between being overweight/obesity and educational level. A RII greater than one means overweight/obesity is associated with lower education, whereas RII <1 shows that overweight/obesity and higher education are more common.

Overall, for men, the RII for overweight was 1.10 with France (1.63) and Sweden (1.62) the highest individual countries. Five countries showed a RII of less than one (eg: Estonia 0.83).

The overall RII for women and overweight was higher (1.98) with Portugal (3.72) and Italy (3.30) the highest individual countries. No countries had a RII <1.

The RII for men and obesity was 1.97 and 2.99 for women (table 3.1).

In the case of England, 26.5% of men and 29.4% of women were obese in the lowest education category compared to 16.3% and 15.6% respectively in the highest education category.

Across Europe, the relationship between lower education and higher weight was strongest among women in Mediterranean countries, and lowest in Baltic and eastern European countries [25].

Evaluation

1. Self-reported data from nineteen national health interview surveys were pooled and standardised to overcome the differences in each survey. However, different questions were asked in some cases and the sample sizes varied.

2. Individuals with a high BMI tend to under-report their

[24] Overweight = BMI≥25kg/m²; obesity = BMI≥30kg/m².
[25] But men have more overweight in all nineteen countries (Howe et al 2010).

CATEGORY	OVERALL RII	HIGHEST RII	LOWEST RII	ENGLAND RII
Men overweight	1.10	France 1.63	Slovak Republic 0.64	1.02
Women overweight	1.98	Portugal 3.72	Latvia 1.28	1.62
Men obesity	1.97	Czech Republic 3.64	Latvia 0.86	1.70
Women obesity	2.99	Portugal 6.78	Latvia 1.50	2.19

Table 3.1 - Relative index of inequality (RII) for different categories.

weight, while individuals generally over-report their height (Ziebland et al 1996). This could produce an underestimation of overweight and obesity.

3. There may be differences between educational groups and overestimation of height, though studies are divided (eg: lower educated individuals overestimate more or vice versa) (Roskam et al 2010).

4. Self reports of education level does allow for the possibility of misclassification.

School Performance Predicting Adult Obesity

Obesity in childhood predicts poor school performance, but low school performance can predict adult obesity (Alatupa et al 2010).

In Finland, for example, in 2007, 43% of adult women and 57% of adult men had a BMI ≥25 (ie: overweight) (Alatupa et al 2010). With numbers like this it is important to isolate predictors of adult obesity, of which one of the "most robust" is socio-economic disadvantage in childhood (Parsons et al 1999). Such disadvantage is reflected in poor school performance, and, in turn, adult obesity. Taras and Potts-Datema (2005) reported a relationship between these two factors in individuals from Brazil, China, Finland, Portugal, Thailand, UK, and USA.

Obesity in adulthood negatively correlates with school performance, however the latter is measured - eg: grade point averages (GPAs), intelligence quotient (IQ), school attendance, or years of education (Alatupa et al 2010).

Most studies of the relationship between school performance and obesity are short-term. Alatupa et al (2010) aimed to rectify that weakness with a longitudinal

study over twenty years (ie: school performance at 6-9 years old and obesity at 27-30 years old). The researchers used data from the Cardiovascular Risk in Young Finns study began in 1980 with 3596 children and adolescents in five areas of Finland.

The school performance in 1980 among a cohort of six year-olds and a cohort of nine year-olds was the baseline with subsequent measures after 3, 6 and 9 years (n = 1229). GPAs [26] for several subjects were collected from the mother's reports and self reports. Obesity measures (BMI and waist circumference) were collected at age 27-30 for 732 participants.

It was found that low GPAs at the three points during schooling significantly predicted adult obesity for women only. The risk of obesity was nearly twice as high for every standard deviation below the mean GPA at ages 12 and 15. The mean GPAs for women were 8.12 at twelve years old and 8.27 at fifteen years old with standard deviations of just over one point. So, for example, put simply, a GPA of five points at 12 years old (three standard deviations below the mean) would predict adult obesity about six times more likely than a woman with mean GPAs.

But what potential mechanism explains this relationship? One suggestion is that poor performance at school creates emotional stress which leads to eating as a means of coping. Or that an inability to do well at school, and to control eating behaviour have a common origin (Warschburger 2005).

3.3. OBESITY AND AMERICAN FOOTBALL PLAYERS

Laurson and Eisenmann (2007) found that overweight was a problem and/or a potential problem among linemen [27] in high school American football teams in Iowa, USA. The researchers analysed publicly available data on weight and height for over 3500 male players.

The mean BMI across all ages of players was above the 85th percentile based on age-specific US data (where ≥85th and <95th percentile are classed as risk of overweight) with 28% classed as at risk of overweight, and 45% as overweight (≥95th percentile) (compared to 18.3% of US 12-19 year-old males in 2003-4). Nine percent of the players would have been classed as severely obese by adult weight definitions (ie: BMI≥35).

BMI can be a problematic measure with growing adolescents. Using another technique, skinfold measurement, Gomez et al (1998) found mean body fat of 25.7% among 215 high school linemen.

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[26] Range of 4 (fail) to 10 (excellent).

[27] Linemen are players who defend the quarterback, and being physically large is an asset.

4. OBESITY AND TREATMENT

Weight loss treatments produce an average long-term reduction in weight of 7% among obese individuals. Such treatments also produce reductions in depression, irrelevant of the weight loss (Blaine et al 2007).

Any benefits are less for obese individuals with binge eating disorder (BED). Blaine and Rodman (2007) collected the data from sixteen studies comparing weight loss treatments (including drugs, surgery, or psychotherapy) among obese individuals with and without BED (n = 388 and 465 respectively). Weight loss in the latter group was over four times greater than that of the BED sample (an equivalent of 23.5 lbs/10.7 kg or 11% of body weight lost versus 3.41 lbs/1.5 kg or 2% of body weight). Both groups showed significant reductions in depression between pre- and post-weight loss treatment.

Modest weight loss (eg: 5-10% of body weight) among obese individuals reduces the risk of obesity-related problems (eg: diabetes, heart-related). Many treatments produce this amount of weight loss, but weight is often regained after the treatment ends. Failure to complete treatment and/or maintain weight loss after treatment is associated with lack of motivation, personal problems, and unrealistic weight-loss expectations (Minniti et al 2007). While "successful weight maintainers" are active individuals who control over-eating, have good social support, and few psychological problems (Elfhag and Rossner 2005).

Comparing Some Treatments

Short-term weight loss for obese individuals occurs with cognitive-behavioural therapy (CBT). CBT focuses upon how the individual thinks about dieting and food consumption with the aim of enhancing motivation to diet and reducing the barriers to it. CBT can be used as an individual or a group treatment.

Cresci et al (2007) found that both versions of CBT were equally effective over 36 months. The researchers recruited 141 obese patients at the Outpatients Clinic of Metabolic Diseases of the University of Florence, Italy in 1997-8. Group A (n = 57) underwent individual CBT and group B (n = 84) the group version (table 4.1).

The primary measure was weight loss as a percent reduction of baseline body weight with a loss of 5% or more seen as a response to the treatment. Measures were taken at 6, 12, and 36 months.

Significantly more participants in group B than group A lost 5% or more of body weight at six months

(16.6% vs 5.3%), but no difference at 36 months (38.1% vs 35.0% respectively). The mean weight loss at 36 months was just under 4% of body weight for all participants.

INDIVIDUAL CBT	GROUP CBT
10 consultations with a dietician lasting about 30 minutes each, every 2-4 weeks.	10 weekly sessions of 90 minutes each with 10-15 patients and a dietician. Each session had a formal presentation followed by a discussion of the topic.

Table 4.1 - Comparison of the individual and group sessions.

In terms of completing weight loss programmes, which treatment is better - individual- or group-based? Minniti et al (2007) compared individual nutritional counselling (12 20-minute meetings with a dietician over six months) (IT) and group CBT (twelve 90-minute sessions over six months) (GT). The participants were 129 Italian women seeking treatment for their obesity.

After six months, significantly more women from the IT group had dropped out (54.2% - 39 of 72) than from the GT group (15.8% - 9 of 57) [28]. Otherwise, both groups were similar in terms of amount of weight lost by six months.

Commercial weight loss programmes and products make many claims about their effectiveness, but few of them have been tested. One such product is meal replacement supplements.

Haddock et al (2008) investigated the use of Medifast meal replacement supplements (MMRS) combined with appetite suppressant medication (eg: Phentermine HCL) in a medically-supervised weight control clinic in north California, USA. The MMRS involve shakes for breakfast, lunch, and snacks, and a calorie-controlled meal for dinner (average 750 calories per day). The programme was designed to last fifty-two weeks with a minimum of 12 weeks. To maintain the programme for the whole year would cost the patient about $2000 with consultations (including $100 per month for MMRS).

The total sample was 1351 individuals with a BMI greater than 30, of which 90.2% were female. Of the study completers, 324 individuals, 87.7% were women. Measurements were taken at baseline, week 12, week 24, and week 52 (end of study).

[28] But the two groups were not randomised as some women refused group therapy. This accounts for the difference in number of participants between the two groups, and there may have been differences in motivation between the women that explain the results.

The study completers lost an average of 12% of baseline weight by week 52 with over 80% of them losing at least 5% weight. Individuals who reported following the programme consistently lost slightly more weight than those who were inconsistent users of either part of the programme (ie: MMRS or drugs).

The findings were "extremely encouraging" for the use of MMRS for weight loss. The amount of weight lost compared well to other studies using medication (eg: Padwal et al 2003) or partial meal replacement (eg: Heymsfield et al 2003).

Table 4.2 lists the reservations about the findings.

1. The drop-out rate was 76% (ie: not completing study). However, this is lower than comparable studies (eg: "Jenny Craig Platinum program" 93.4%; Finlay et al 2007).

2. The participants were volunteers, who made a financial investment in the programme. This may mean that they were more motivated than the average.

3. The success of the weight loss was based on two elements (MMRS and drug). How much of the actual success was due to MMRS? Appetite suppressant drugs and any calorie-controlled diet may be as effective.

4. There was no control or comparison group (eg: MMRS and no drug).

5. There are concerns about the long-term use of appetite suppressant drugs (particularly when amphetamine-based).

6. The study was based on one private clinic (New Dimensions Medical Group Clinic) only.

7. The study was funded by Medifast Inc. This is not to say that it was biased, but independent evaluations are better.

8. Over one year consistent use of the MMRS required great self-discipline. Only self reports were possible to establish such consistency, and 73 study completers reported consuming at least two shakes per day throughout the study. It would be difficult to keep individuals in a controlled environment for one year so that their calorie intake could be completely monitored.

9. No details were given about why individuals dropped out of the programme. It is not clear if they were contacted and asked why.

10. The large number of women in the sample meant that it was not representative of the general population. The majority of participants (75%) were also over 30 years old.

11. The study was not blind. This means that both the participants and the researchers knew what was happening, and so expectations become a factor. Good studies are double-blinded.

Table 4.2 - Criticisms of Haddock et al (2008) study.

Take Off Pounds Sensibly (TOPS) is a national non-profit programme in the USA to aid in managing weight

problems. It uses education about healthy eating, exercise, behaviour modification, and group support. It is much cheaper than commercial programmes (eg: at least one-fifth of Weight Watchers; Mitchell et al 2010).

Mitchell et al (2010) evaluated the effectiveness of TOPS using data from the TOPS' national database of members. This included base weight and weight recorded at weekly meetings over a year. Membership is renewed annually. The period from 1st January 2005 to 31st December 2007 was used, and this produced 42 481 members' data to analyse. The majority of them were female.

Overall, members who remained on the programme for three years lost around 6% of body weight and maintained that loss. Individuals who continued on the programme (consecutive renewals) lost more weight than those who joined, left, and re-joined later (non-consecutive renewals) over the study period.

The US Institute of Medicine (Thomas & Institute of Medicine, Committee to Develop Criteria for Evaluating the Outcome of Approaches to Prevent and Treat Obesity 1995) defined successful long-term weight loss as at least 5% of body weight and maintained for at least one year. Approximately 50% of TOPS' members who renewed their annual membership fulfilled this criteria (Mitchell et al 2010).

Regaining Weight

The process of not regaining weight is different to that of weight loss, so separate programmes may be needed.

Wilfley et al (2007) evaluated two types of weight maintenance programme with 150 7-12 year-olds in California. Behavioural skills maintenance (BSM) is based on cognitive-behavioural principles and focuses on self regulation behaviours and relapse prevention. Social facilitation maintenance (SFM) is aimed at helping parents to support healthy eating and physical activity. The programmes were designed for 16 weeks (table 4.3).

After sixteen weeks, the two programme groups had maintained their BMI scores at baseline significantly better than the control group, but after two years, only the SFM group was significantly better (ie: less individuals had regained weight).

Svetkey et al (2008) compared monthly personal contact, interactive technology, and self-directed strategies for maintaining weight loss over thirty months. Personal contact was best with 45.2% of individuals maintaining a 4kg loss and 76.7% "at or below entry weight" (compared to 40.8% and 69.3% for technology, and 39.5% and 66.6% for self-direction). Interactive technology showed early but transient benefits.

Weeks	BSM	SFM
1-5	Promote small change in eating	Encourage child to form friendships with physically active peers
6-11	Identify high-risk situations and pre-planning to avoid	Address body image concerns that limit participation in physical activity (eg: teasing)
12-16	Develop plans for permanent lifestyle change	Solidify child's social support network for physical activity

Table 4.3 - Main points of weight maintenance programmes.

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4.1. FACTORS IN LOSING WEIGHT

"Losing weight has never been an easy endeavour, as anyone who has ever tried knows. Among the challenges: changing ingrained habits that led to the weight gain. Everyone attributes his or her success to different strategies and programmes, be it Weight Watchers, gastric bypass surgery or sheer willpower, but all tend to agree that eating less and moving more are at the heart of any successful effort" (Yu 2011 p60).

Only about 20% of people who lose at least one-tenth of their body weight manage to maintain the loss for over a year (Yu 2011), while two-thirds of dieters end up two years later weighing more than before the diet (Freedman 2011).

Individuals in the West have both an appetite for food and an appetite for diet fixes (as shown by the popularity of celebrity and gimmick diets). This is not helped by contradictory academic research about what does and does not work (Freedman 2011).

Obesity and weight loss success or failure depend on a combination of factors including (Freedman 2011):

- Evolutionary - eg: the body's tendency to store fat; the slowing of metabolism during dieting.

- Biological - eg: genetic predisposition for storing fat; sensitivity of taste buds.

- Environmental - eg: eating habits of self and others; easy availability of food; opportunity for exercise.

- Social - eg: price of "junk food"; marketing of certain foods.

Programmes to lose weight based on Behaviourism principles (Behaviour Modification) have reasonable success records. These programmes use concepts like reinforcement (and less so, punishment) to teach new eating behaviours/habits. "Weight Watchers" is an example of such a programme using social support and reward points as the reinforcements. This has been found to aid small weight loss (eg: 3% of body weight) and long-term maintenance (eg: over two years) (Freedman 2011).

Personality traits may be involved in who can lose weight (and maintain it) and who cannot. The motivation to eat less, avoid certain foods, and to exercise can be influenced by traits like optimism, neuroticism, and novelty-seeking. For example, in a Japanese study, individuals high on neuroticism and low on agreeableness (less concern about the opinion of others) lost more weight than individuals showing the opposite traits (quoted in Yu 2011).

While optimistic obese patients were less successful at dieting, partly because they underestimated their health risks (Saito et al 2009). Novelty-seeking obese individuals (eg: impulsive) are also less likely to lose weight (Sullivan et al 2007), and there is a positive correlation between weight and novelty-seeking in the general population (Yu 2011).

Motivation is a key factor in weight loss. Self-determination (Deci and Ryan 1985) accounts for the specific motivation to d a behaviour in relation to the innate motivation to personal growth. Intrinsic motivation (doing a behaviour for its inherent satisfaction) is self-determined, while extrinsic motivation (doing a behaviour for an external reward) can bo both self-directed or forced by external demands. Generally, there is perceived choice with intrinsic motivation, which may not by there with extrinsic motivation, and consequently more positive emotions related to the behaviour.

In relation to weight loss and exercise, self-determination will lead to more positive psychological well-being than where external demands are the

motivation. Viera et al (2011) investigated this idea in relation to health-related quality of life (HRQOL) among overweight and obese women involved in a programme to increase exercise to aid long-term weight control in Portugal. Data were collected at baseline and at twelve months from the 239 middle-aged women.

Self-determination was measured with the Perceived Choice sub-scale of the Self-Determination Scale (Sheldon et al 1996), which has items like, "I do what I do because it interests me", "I do what I do because I have to", and "What I do is often not what I'd choose to do". Other questionnaires measured HRQOL, psychological well-being, and the motivation to exercise.

Self-determination was found to correlate positively with HRQOL, and self-determination and exercise/treatment self-regulation (ie: perceived choice and control) correlated positively with psychological well-being. Put another way, women who felt that they choose to exercise (and so had intrinsic motivation) had more positive emotions about the programme after one year. Those women who felt forced to do the behaviour by external demands (including guilt and shame) were more likely to be anxious and depressed (ie: poor psychological well-being). These relationships appeared to be independent of actual weight changes.

4.2. PHYSICAL ACTIVITY AND WEIGHT LOSS

Physical activity (PA) aids in prevention of weight gain (ie: weight stability), weight loss, or prevention of weight regain. The American College of Sports Medicine (2009) reviewed the literature on the amount of PA in each case.

1. Preventing weigh gain - Moderately vigorous physical activity of 150-250 minutes per week (equivalent to walking 12-20 miles per week or 1200-2000 kcal per week expended).

2. Weight loss - Simplistically, a negative energy balance (more calories expended than consumed) reduces weight, but it is difficult for individuals, particularly obese and overweight, to sustain the high levels of PA needed over time.

PA of 150 minutes per week produces 2-3 kg weight loss, studies have found, and 225-420 minutes per week results in 5-7.5 kg weight loss.

Increasing PA and diet restriction aid weight loss (eg: 20% more than diet only; Curioni and Lourenco 2005), but not if the diet restriction is severe. In this case, the body adapts and PA does not reduce weight.

The type of PA can be important. American College of Sports Medicine (2009) concluded that "resistance training" (exercise designed to increase muscle mass like weight training) does not aid weight loss (with or without diet restriction). But when combined with aerobic exercise (eg: running), there may be benefits.

3. Maintaining weight loss (preventing weight regain) - Greater PA aids maintenance of greater weight loss is a simple answer, but studies support an amount of 200-300 minutes per week as best.

Programmes designed for weight loss often involve specific PA like exercise regimes, but "lifestyle PA" is more effective overall. This is the integration of PA into the everyday life of obese and overweight individuals (eg: walking down stairs instead of using a lift). In this sense, walking for commuting is better than a structured period of exercise involving walking. Accurately measuring "lifestyle PA" can be difficult, and is usually based on self-reports (though measures like pedometers - counting number of steps - can be used) (American College of Sports Medicine 2009).

Exercise and Children

Sedentary behaviour among children is proposed as a reason for increased childhood (and adult) obesity. There are also reasons proposed for the increased sedentary behaviour by children, including the development of video games and computers (ie: non-physical leisure activity).

Mattocks et al (2008) investigated the factors in the first five years of life that might predict physical activity at 11-12 years old using the Avon Longitudinal Study of Parents and Children (ALSPAC). This UK study enrolled all pregnant women between 1st April 1991 and 31st March 1992 in the Avon health area (ie: Bristol, south-west England).

Physical activity at 11-12 years old was measured by wearing an actigraph accelerometer, that records movement, for one week, and self-reported diaries. These measures were converted into average counts per minute (cpm) (measure of total activity), and amount of time spent each day in moderate to vigorous physical activity.

Data from questionnaires were collated about early life factors like parent(s)' physical activity, their body mass index (BMI), and the child's early TV viewing.

Few factors in early life were found to predict physical activity at 11-12 years old:

a) No birth outcomes (eg: birth weight).

b) Among pre-natal characteristics, mother's BMI before pregnancy (but not partner's), parents' smoking status during pregnancy [29], and mother's physical activity during pregnancy (brisk walking/swimming) showed significant associations with child's activity.

c) Among early life factors, parental physical activity when child 21 months old and child's television viewing at 38 and 54 months old were the only significant associations with later physical activity.

Though there were a limited number of factors that predicted physical activity at 11-12 years old, Mattocks et al (2008) felt that they had "shown that children are slightly more active if their parents are active early in the child's life. This suggests that encouraging physical activity in parents may also influence their children to become more active, with the added advantage that physically active parents are healthier".

[29] This relationship was unexpected compared to previous studies - ie: more smoking and more exercise (positive correlation).

5. MISCELLANEOUS ISSUES

5.1. COMMUNICATING ABOUT CHILD OBESITY

In the "obesogenic" environments of the West (Swinburn and Egger 2002) obesity and overweight is increasing among children. Many parents are not concerned or aware of their children's overweight (Edvardsson et al 2009). Health professionals can communicate concerns to these parents.

Edvardsson et al (2009) explored the experiences of maternal and child health nurses in Australia in raising issues with parents about their children's overweight. These nurses see children up to the age of six years old.

From the interviews, "nurses experienced overweight as a sensitive subject to broach, especially if the parents themselves were overweight. They had to walk a fine line because of fear of offending parents, but felt confident in their roles as experts during the counselling situation. Excuses, rationalisation and denial from parents were common and nurses feared losing the families, if they pushed them too hard" (Edvardsson et al 2009 p2545).

The use of tactful language with the parents was a theme in the research interviews with the nurses. The word "obese" was hardly ever used compared to "large", "heavy", or "out of the recommended range" - eg: "I suppose I'm really careful about using that word 'obese'. I'll usually – I probably would never say, 'Your child is obese'. I would say, 'He's overweight according to this chart'" (Nurse 3) (p2546).

The parents' own weight was an issue, as different nurses noted:

- "I find it more difficult if the parents themselves are overweight" (Nurse 8).
- "I think an overweight parent might be a bit more defensive because they are already conscious of their own size, weight, whatever and so it might be even more difficult, but I don't know, I just think it's difficult" (Nurse 4).
- "If they have got their barriers up or, you know, their ears are closed, and you are bashing your head against a brick wall quite often, just – you know they don't want to hear it. They don't want to know about it" (Nurse 6) (p2546).

5.2. EXTREME OBESITY AND COGNITIVE IMPAIRMENT

Being extremely obese is known to lead to medical problems, like diabetes or high blood pressure (hypertension), but it can also lead to cognitive dysfunction.

Boeka and Lokken (2008) tested 68 extremely obese

individuals (BMI >40) in south-east USA seeking surgical treatment for their condition using a selection of cognitive tests (eg: memory, verbal fluency, problem-solving ability, executive functioning). For example, the Rey complex figure test involves copying from memory a complex figure drawing after a short delay.

Compared to normative data on these tests, the obese individuals were significantly poorer on most measures (even controlling for individuals with learning problems, and medical conditions that could impair cognitive performance). For example, on the Rey complex figure test, the normative mean for accuracy for immediate copying was 35.5 and the obese sample mean was 27.27, and with a short delay, 21.50 and 13.86 respectively.

Boeka and Lokken (2008) described an implication of the findings:

> Results from an increasing number of studies suggest a link between obesity and deficits in executive functioning. Executive dysfunction is associated with the inability to control aberrant behaviours, such as chronic overeating. Obese individuals often report great difficulties controlling eating behaviours, despite a desire to successfully lose weight. This deficit in inhibiting eating behaviours is a likely contributor to the extraordinarily high percentage of obese individuals who are unable to maintain weight loss with traditional weight loss interventions and may also be related to the difficulties many patients face in making permanent lifestyle changes after weight loss surgery (p472).

However, it is not clear whether obesity is a cause or a result of the cognitive dysfunction. In terms of obesity causing it, Boeka and Lokken (2008) speculated: "it is possible that since a larger body mass requires more blood flow for optimal functioning, the brain is deprived of blood flow that it normally receives under circumstances when the body is not as large. In turn, this lack of essential blood flow could be a contributing factor to poor cognitive performance in individuals with a larger body mass index. Alternatively, adipocytes, once thought only to store fat, are now known to secrete proteins (eg: cytokines, leptin) that may alter cognitive functioning when present in abnormal levels.." (p473).

5.3. MATERNAL SMOKING AND OFFSPRING OBESITY

Studies have found an association between maternal smoking during pregnancy and offspring obesity "although the mechanism by which pre-natal smoking exposure influences offspring's risk of overweight remains

uncertain" (Iliadou et al 2010 p1194) [30].

One possibility is that smoking during pregnancy limits the foetal growth, which signals a food shortage to the embryo, and as an evolutionary response, the child is "programmed" to store calories leading to obesity (eg: Simmons 2008).

The relationship between maternal smoking and offspring obesity is only an association (or correlation), and the relationship may be explained by a third variable, like diet. For example, mothers who smoke during pregnancy feed their children in such a way (eg: quantity or type of food) that leads to obesity. There is a need in research to control for this third variable. One research design is based upon studying mothers with two or more children who smoke during one pregnancy, but not the other(s).

Iliadou et al (2010) investigated 124 203 Swedish single (ie: not twins) males born to Nordic mothers between 1983-8 as to how many were overweight at age 18 years and whether the mother had smoked during the pregnancy. Within the cohort, 8250 sibling pairs and 182 half-sibling pairs were analysed further.

Compared to offspring of non-smokers, there was a greater risk of overweight in sons of smokers. This risk was highest for mothers who smoked in the first and second pregnancies (table 5.1).

MATERNAL SMOKING - 1st son/2nd son	OBESITY - 1ST SON	OBESITY - 2ND SON
No/No	1.0	1.0
Yes/No	1.19	1.20
No/Yes	1.15	0.96
Yes/Yes	1.65	1.71

(Source: Iliadou et al 2010 table 3 p1199)

Table 5.1 - Adjusted odd ratios for offspring obesity based on maternal smoking.

But the relationship was explained by other factors, like socio-economic status and education, argued the authors. This is because the risk of becoming overweight did not vary that much between sons where the mother smoked during one pregnancy and not during the other, and other factors predicted obesity as well - eg: young

[30] For example, smoking behaviours vary between individuals in terms of inhaling the smoke, and how the body metabolises the toxins as well as when during the pregnancy the mother smokes (Iliadou et al 2010).

maternal age, mother's own weight, maternal unskilled or skilled manual worker, and less years in education.

This study showed that there is not a simple relationship between smoking during pregnancy and offspring's weight. Though maternal smoking is important, it is one of a number of factors that (combine to) explain obesity in male offspring.

Table 5.2 lists the main strengths and weaknesses on the Iliandou et al (2010) study.

STRENGTHS	WEAKNESSES
1. A very large-scale study. 2. Using detailed official records kept in Sweden (eg: Swedish Medical Birth Registry; Military Service Conscription Register). 3. Self-reported smoking habits in pregnancy was recorded by midwives at first ante-natal visit. 4. Wide range of variables collected about mothers from different official sources. 5. A study with a prospective design which predicts future behaviour (obesity) from a measured variable (maternal smoking during pregnancy).	1. Only males studied. 2. Accuracy of self-reported data about smoking (or misrecorded by midwives). Because this study was based on secondary information (ie: authors did not carry out interviews), it is dependent on accuracy of information recorded. 3. Only includes men conscripted in military, which excludes those with chronic diseases and handicaps. 4. Some sub-groups were quite small - eg: mother does not smoke for first pregnancy, but does for second, n = 228 and 46 overweight. 5. Many women continued to smoke after pregnancy (ie: when child young), and it was not possible to distinguish between the effects of pre-natal and post-natal smoking exposure.

Table 5.2 - Main strengths and weaknesses of Iliandou et al (2010) study.

5.4. OBESITY AND ADHD

Generally it is assumed that the hyperactivity with Attention Deficit Hyperactivity Disorder (ADHD) would reduce the risk of obesity, but Altfas (2002) reported the presence of ADHD among extremely obese adults (42.6% among sample of US adults with BMI ≥40, 22.8% of those with BMI 30-39, and 18.9% with BMI 25-29.9 [31] [32]).

[31] The sample was 215 obese adults at a bariatric clinic. Overall, 27.4% were diagnosed with ADHD using DSM-IV criteria (AD group), 33.5% showed some symptoms of ADHD but not enough for full diagnosis (ADSx), and 39.1% had no symptoms (NAD). The mean BMI between these three groups was significantly different - 39.2 (AD), 35.5 (ADSx), and 34.6 (NAD).

Bazar et al (2006) proposed a link between obesity and ADHD under the heading of the "environmental oversampling syndrome": "An excess of exogenously supplied information in the form of nutritional content and sensory content may independently predispose to both obesity and ADHD" (p264). Key to this idea is childhood television viewing which produces lifestyle changes (ie: less exercise and increased caloric intake) associated with obesity, and sensory overload related to ADHD.

Bazar et al suggested a potential mechanism for both conditions related to dopamine (and a dopamine receptor gene). This may manifest itself in impulsivity generally (ADHD) and in eating behaviour (eg: binge eating).

Cortese et al (2008) confirmed, in a systematic review, that obese individuals referred to obesity clinics had higher prevalence of ADHD than in the general population (based on five studies). Furthermore, the weight of ADHD sufferers was heavier than the expected average (based on ten studies).

[32] Among the general population the rate of ADHD is up to 10% in the USA (Altfas 2002).

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