March 2011: A combination of excess dietary calories and a lack of physical activity is the immediate cause of obesity. Only a slight positive energy imbalance, if sustained over several years, can result in substantial weight gain. Here we look at the hypothesis that routine exposure to man-made chemicals can alter energy balance, increasing an individual’s risk of obesity.

Obesity is a medical condition characterised by excess accumulation of body fat, to the degree that it becomes harmful to health.

Obesity reduces life expectancy while increasing the risk of illness and death from a range of other diseases. It is now so common in adults and children that the World Health Organisation characterises the condition as an epidemic.

The health consequences of obesity fall into two broad categories: those attributable to the physical effects of increased weight, including osteoarthritis and sleep apnoea; and those due to the increased size of and metabolic activity of fat cells, including diabetes, cancer and cardiovascular disease (Bray 2004).

Energy imbalance is the immediate cause of obesity, a combination of excess dietary calories and a lack of physical activity. Only a slight positive energy imbalance, if sustained over several years, can result in obesity. Assuming that 0.45kg (1lb) of fat contains 3,500 calories, then to gain 63 kilograms (140 pounds) requires an energy excess of 490,000 calories. This means a mere 134 calorie energy excess per day is sufficient for someone to become substantially overweight over a 10 year period.

The full set of reasons as to why someone might become obese must be more complex than loss of control over energy balance is, otherwise treatment of obesity through diet and lifestyle changes alone would be successful more often than in just 2-20% of cases (Wing et al. 2005).

“Thrifty” genes, genetic disorders, endocrine disorders, medications and psychiatric illness are already well-recognised reasons why some people find it relatively easy to maintain a constant weight while others struggle to do so. It is speculated that sleep deficit, stress, viruses, microbes and single mutations in an individual’s genetic code may also be contributing to the incidence of obesity (Keith et al. 2006).

In addition to these, it has been hypothesised that routine exposure to man-made chemicals may also be increasing an individual’s risk of obesity. The obesogen hypothesis “proposes that perturbations in metabolic signalling, resulting from exposure to dietary and environmental chemicals, may further exacerbate the effects of imbalances in diet and exercise, resulting in an increased susceptibility to obesity and obesity-related disorders” (Grun & Blumberg 2009).

The obesogen hypothesis is part of the research programme related to the campaign of US First Lady Michelle Obama to understand and reduce rates of obesity in the US. Not everybody is won over by the concept, however. Writing for the Wall Street Journal, social and political commentator Allysia Finley has said: “By ringing the alarm bells based on insufficient and inconclusive evidence, environmentalists have subverted serious discussion of the issue—and are on track to create another green scare.”

Contrary to what Finley may argue, there is a body of contextual evidence which at least makes the obesogen hypothesis worthy of careful consideration, not least that prenatal exposure to tobacco smoke is strongly associated with obesity (Monasta et al. 2010).

Diabetes drugs also make adults obese, by activating receptors which cause a type of stem cells to become fat cells. The antifouling agent tributyl tin (TBT) has been shown to act on these same receptors in animals at levels detected in a portion of the population (Kirchner et al. 2010). It is therefore plausible that other chemicals could be having the same effect.

Experimental data in animals shows that brief exposure early in development to chemicals with oestrogenic activity can increase weight gain later on. At two months of age, mice treated at birth with the oestrogenic drug diethylstilbestrol (DES) could be having the same effect.

Although they weigh the same at two months of age, the treated mice have considerably larger fat mass than the untreated controls. Experimental data in animals shows that brief exposure early in development to chemicals with oestrogenic activity can increase weight gain later on. At two months of age, mice treated at birth with the oestrogenic drug diethylstilbestrol (DES) weigh the same as untreated mice. By the time they are six months old, the treated mice have considerably larger fat mass than the untreated controls.

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Although they weigh the same at two months of age, the treated mice do show differences in levels of hormones which are produced by adipose (fat) tissue such as leptin, associated with appetite control, and adiponectin.
The altered hormone levels are not associated with changes in feeding habits or physical activity, strongly suggesting that DES induces a range of changes which set a mouse’s metabolism to conserve energy, as if it were living in a low-resource environment, thereby predisposing it towards obesity (Newbold et al. 2009).

**Conclusion**

Research into obesogens is still very much in its early stages. Little is known about people’s exposure to obesogens or which chemicals are problematic, although there is some evidence that phthalates (Stahlhut et al. 2007), BPA (Somm et al. 2009) and non-stick PFOAs may be obesogenic (Vanden Heuvel et al. 2006).

There is also a lack of human epidemiological evidence, but epidemiology is likely to be ill-suited for any chemical causes of obesity. This would require the detection of effects of exposure to a chemical that acts during a limited time-window of sensitivity to initiate a health problem which only manifests itself later in life and in a limited portion of the population (Grun 2010). Prospective epidemiological studies would take years to produce results, even assuming adequate controls could be defined in such a study so as to allow causation to be proven.

At the very least, however, the fact that prenatal maternal smoking causes obesity ought to provide proof-of-concept: exposure to a chemical cocktail before birth is capable of making people obese who would not otherwise be so. Furthermore, given that small alterations in energy balance can result in relatively drastic weight gain, obesogens themselves may not need to have dramatic effects on metabolism to induce obesity. Combining the effect of obesogens with poor diet and decreased activity could potentially have profound effects on obesity rates.

Given the pronounced effect of obesogens on animals combined with the in-principle plausibility of the obesogen hypothesis and the harm which obesity causes, it seems reasonable that obesogens should at least be a research priority. Given the difficulty of remediating obesity, prevention is vital, especially if some of the ultimate causes of obesity reside in long-term metabolic changes caused by chemical exposures at a young age.

**References**


