Department of Public Health & Policy
London School of Hygiene & Tropical Medicine

DEPARTMENT OF PUBLIC HEALTH & POLICY

research briefing

Congenital anomalies: health risks of landfill sites

The thalidomide tragedy of the late 1950s demonstrated only too well that environmental exposure to toxic substances during pregnancy can cause congenital anomalies. Many children born to women who had taken the drug thalidomide during early pregnancy were born with abnormally short limbs and other congenital anomalies.

Since then, the search for previously unknown causes of congenital anomalies has continued. Between 2 and 3 per cent of babies born in Europe suffer from a major congenital anomaly, such as Downs syndrome, spina bifida, or cleft palate/cleft lip. Many pregnancies are terminated following prenatal diagnosis of such conditions, and of those which continue, congenital anomalies are thought to cause an estimated average of 14 per cent of stillbirths.

Finding out what causes these congenital anomalies could help to alleviate the disability and human suffering that underlies these statistics, as well as avoiding many deaths. It has now been established, for example, that if women take a supplement of folic acid, beginning before conception and continuing until 12 weeks of pregnancy, their risk of carrying a fetus affected by neural tube defects such as spina bifida is greatly reduced. In other cases, genetic causes have been identified.

> "It questions whether governments should continue to make decisions on waste policy without good scientific knowledge of the health impacts of different waste disposal options."

To make it easier to identify the causes of congenital anomalies, the EUROCAT project started in 1979, funded by the European Commission, and has expanded ever since (see Box 1). Its aims include the collection and provision of baseline epidemiological information on congenital anomalies in Europe, and the detection and investigation of trends in frequencies of congenital anomalies. Many individual congenital anomalies are rare, so it is useful to pool data from across Europe.

Landfill sites

During the 1990s, some researchers in Europe decided to make use of some of these data, as well as some from other sources, to examine the impact of landfill sites containing hazardous waste on the risk of congenital anomalies among local populations. This came to be known as the EUROHAZCON study and was funded by the European Commission. Its results were published in *The Lancet* in 1998.[1]

Helen Dolk, Senior Lecturer in Environmental Epidemiology, Department of Public Health & Policy at the London School of Hygiene & Tropical Medicine, coordinated the EUROHAZCON study with Martine Vrijheid, Lecturer in Environmental Epidemiology, also at the London School of Hygiene & Tropical Medicine. Dolk says: "There was huge public concern at the time we began this study about the health impact of environmental pollution. We wanted to investigate the aetiology of congenital anomalies and decided to see what evidence we could find that landfill sites were an important cause of congenital anomalies. We chose landfill sites partly because there had been an interesting study from New York State that suggested that there was a small excess of congenital anomalies near landfill sites, and we thought we would follow that up and see whether it was also true in Europe. But we could have chosen other sources of environmental pollution."

The landfill sites considered in the study had been used for disposal of hazardous industrial waste such as heavy metals, solvents and pesticides.

Dolk and her colleagues throughout Europe used data from 7 regions which had registers of congenital anomalies. All these centres already had registers of all children born with congenital anomalies in their areas, including fetuses diagnosed with these conditions prenatally, and where there had been a termination of pregnancy.

The research group went on to identify hazardous waste landfill sites within each of the regions, and to delineate circles with a radius of 7 kilometres around each landfill site. All cases of non-chromosomal congenital anomaly where the mother was resident in each of these areas were identified. The researchers were also able to identify 2 control births for each case among all unaffected births to mothers resident in each circle.

Assisted by landfill specialists, Dolk and her colleagues decided from the outset to calculate whether mothers who were resident within a circle with a radius of 3 kilometres centred on each landfill site were more likely to have births and pregnancies affected by non-chromosomal congenital anomalies than those who lived in the 'outer circle' which lay between 3 and 7 kilometres from the landfill sites. The Figure shows some of their results.

Dolk says: "When we compared the 0 to 3 kilometre zone with the 3 to 7 kilometre zone, we found that there was an excess risk of 33 per cent of having a pregnancy affected by a non-chromosomal congenital anomaly. To put it another way, this means that the existing baseline risk for the general population of having a pregnancy or child affected by one of the congenital anomalies studied—which stands at about 1 per cent—is increased by 33 per cent, raising the overall risk to about 1.3 per cent."

So while about 10 births in every 1000 would normally be expected to be affected by these congenital anomalies, if there was a 33 per cent increase in non-chromosomal congenital anomalies, this figure would rise to 13 or 14.

Box 1: EUROCAT and the advent of 'envirovigilance'

Since January 2000, the London School of Hygiene & Tropical Medicine has been the coordinating centre for the EUROCAT network, which was previously coordinated from the Scientific Institute of Public Health in Brussels. EUROCAT is a collaboration of registers throughout Europe which record cases of congenital anomaly. There are currently more than 900 000 births per year in the population covered.

The aims of EUROCAT are to:

- *provide essential epidemiological information on congenital anomalies in Europe;*
- *facilitate the early warning of new teratogenic exposures;*
- *evaluate the effectiveness of primary prevention (such as public health messages to reduce the incidence of pregnancies affected by spina bifida and other neural tube defects);*
- *assess the impact of developments in prenatal screening (eg for Downs syndrome);*
- *provide information and advice for those concerned about risk factors or apparent clusters of congenital anomalies;*
- *provide support for research related to the causes and prevention of congenital anomalies, and the treatment and care of affected children.*

EUROCAT will be receiving funding for its core activities from the rare diseases programme of the European Commission. Helen Dolk, the new Project Leader of the EUROCAT collaboration, says: "We intend to build on the experience of the EUROHAZCON study by going further down the road of 'environmental surveillance' or 'envirovigilance', looking at a range of different potential environmental exposures."

Dolk likens her concept of 'envirovigilance' to that of 'pharmacovigilance'. She suggests that if it is generally accepted that post-marketing surveillance of drugs is required, then it should also be accepted that there should be ongoing surveillance of various types of environmental pollution—such as post-licensing surveillance of industrial sites. She thinks that envirovigilance should also help to avoid some of the problems of investigating clusters and prioritising their investigation.

When investigating clusters, Dolk says, researchers are faced with the 'Texas sharp shooter effect'. She explains: "The Texas sharp shooter draws his gun and fires randomly at the barn door. When he has finished firing, he draws the target around the densest cluster of bullet holes and says this is where the target was—I'm a great shot. What you have to avoid is saying, here is the cluster of congenital anomalies and look, here is the landfill site. Instead, what you have to do is identify the landfill sites, and see whether in general they increase the incidence of birth defects."

Dolk, along with Martine Vrijheid and Ben Armstrong, Senior Lecturer in Medical Statistics at the London School of Hygiene & Tropical Medicine, along with colleagues across Britain, has also received funding from the Department of Health, jointly with the Department of Environment, Transport and Regions, and the Environment Agency, to carry out a study examining how the prevalence of congenital anomalies varies geographically within Britain. "We want to find out to what extent congenital anomalies vary in space, and if so what sort of pattern of variation are they showing," Dolk says.

To do this, she and her colleagues will be studying prevalence of congenital anomalies in 5 regions in the UK which maintain good registers of these conditions. They will be studying the variation at the level of areas the size of census wards.

Confounding factors

Although the result is statistically significant, because the relative risk is quite small at 1.33, it is difficult to say with certainty that the excess of cases is real and not due to chance or confounding factors, or some sort of unexplained bias, Dolk explains.

Socioeconomic status

One of the most obvious potential confounding factors could be socioeconomic status. If people belonging to more deprived socioeconomic groups are more likely to have higher rates of congenital anomalies and are more likely to live near landfill sites, this could explain the excess.

When the researchers examined this possibility, they found that the available data on socioeconomic status (which was measured in different ways in each European country) showed no clear link between risk of congenital anomalies and socioeconomic status—except in the UK.[2] They also found that there was no particular pattern of more

Box 2: Are new landfill sites less of a threat?

In their original Lancet *paper,[1] Dolk and her colleagues hypothesised that if they could show that the most hazardous landfill sites were associated with the highest risk of congenital anomaly among women living locally, and those which were less hazardous were associated with a lower risk, then this would strengthen the case for a causal association between the risk of congenital anomaly and residence near sites.*

This study has now been done.[5] Martine Vrijheid and her colleagues at the Environmental Epidemiology Unit at the London School of Hygiene & Tropical Medicine, together with the EUROHAZCON Collaborative Group, enlisted the help of landfill specialists to score 21 landfill sites as high, medium or low hazard sites. When they looked at the relative risk of affected births around each of these sites, they found no evidence for a dose-response relationship.

Dolk says: "Logically, you would not expect all landfill sites to have the same risk—they are all different. These results either indicate that the association we found is not causal, or that the differences in risk were very slight, or that the method we used to score landfill sites did not distinguish the more and less hazardous sites very well. This is very difficult to do, especially when considering less recent dumping which was little documented."

Recently, hazardous waste landfill sites have been more strictly controlled. Data for the original EUROHAZCON study was collected in the late 1980s and early 1990s. Some sites had been carefully engineered and capped, while others were uncontrolled industrial dumps, Dolk says. "It is therefore a study about contamination that existed during that period, from any time in the past. We cannot tell when the contamination was from, simply that it was still there during the period of the study." The only way to address this problem, she adds, would be to identify new landfill sites—to eliminate the chance of old contamination from the days when controls were less strict—and evaluate their influence in the future on the prevalence of congenital anomalies.

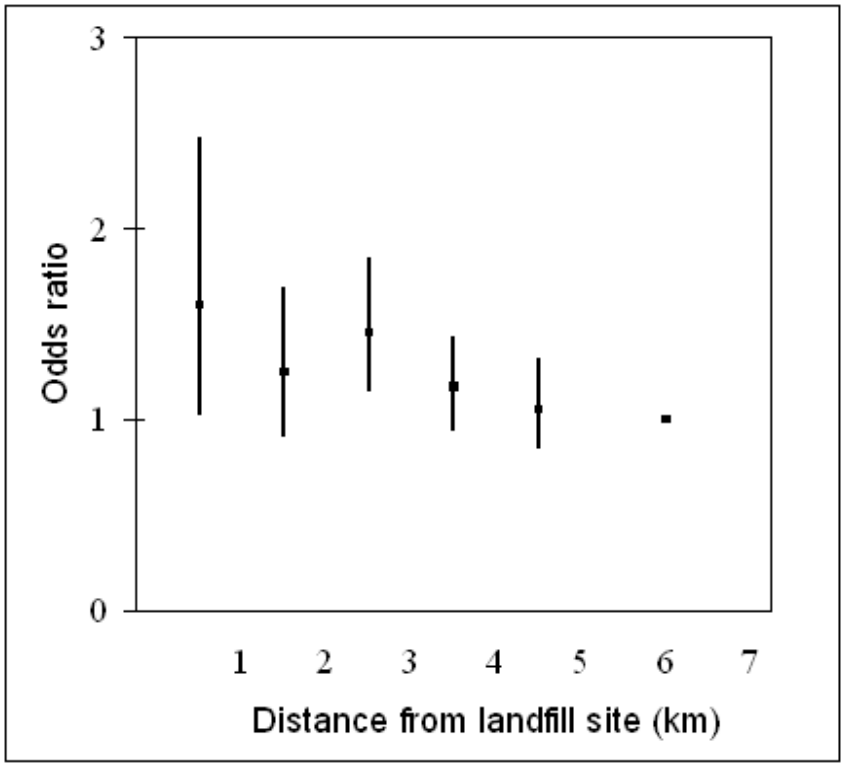
What about different types of landfill sites like municipal dumps which do not take hazardous industrial waste? These were not included in the study. Dolk says, however, that the level of control of off-site contamination can be as important as the source of the waste, and that household wastes also contain potentially toxic substances.

deprived socioeconomic groups living close to the sites; in some cases, the reverse was true. "So we could not find a strong reason to believe that socioeconomic status could be confounding the results", Dolk says.

Industrial pollution

Another potential confounding factor could be some other source of industrial pollution. As Dolk points out, however, such an effect would not completely negate the findings, which would still indicate that some source of environmental pollution was causing an excess of congenital anomalies.

> ". . . the level of control of off-site contamination can be just as important as the source of the waste, and household wastes also contain potentially toxic substances "



The relative risk of having a pregnancy affected by a non-chromosomal congenital anomaly (vertical axis) falls as distance from a landfill site (horizontal axis) increases -- (vertical bars show 95% confidence intervals)

Chance

Could the excess be due to chance? This is difficult to rule out—but a second study carried out by the EUROHAZCON team has recently found similar results for chromosomal congenital anomalies, including Downs syndrome.[3]

This analysis showed that the increase in risk of having a child or pregnancy affected by a chromosomal anomaly, for a woman living within 3 kilometres of a hazardous waste landfill site, was very similar in magnitude to that for non-chromosomal anomalies. This suggests that these findings are unlikely both to be due to chance, Dolk says. She adds that if socioeconomic status was influencing the results, a different picture would be expected for chromosomal anomalies, because women of higher socioeconomic status tend to have children at later ages when they are at greater risk of having a fetus with a chromosomal anomaly.[2] These results therefore reinforce the researchers' judgment that confounding by socioeconomic status does not explain the results. However, this still leaves the possibility of some unidentified bias.

No one knows how the effect on congenital anomalies might be mediated: which chemicals, or mixtures of chemicals, are involved, nor the route by which they are encountered in the environment.[4]

Finally, a study examining whether women living close to more hazardous landfill sites were at higher risk of having a pregnancy affected by congenital anomaly failed to find any evidence of a dose-response relationship (see Box 2).

What the EUROHAZCON study does highlight, says Dolk, is the need for more research. She concludes: "It questions whether governments should continue to make decisions on waste policy without good scientific knowledge of the health impacts of different waste disposal options. There is now a trend towards a greater input of health impact assessment into policy making in all sectors—and this study shows that such a change is needed."

References

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