

◆ Health Effects Review ◆

Volume 3 Issue 3

August 1999

Hazardous Waste Sites and Human Health

Many of the critical pollutants contaminating the Great Lakes ecosystem are also found in the setting of municipal and industrial waste sites. Hazardous waste sites can emit irritant gases, metals, solvents, pesticides, polyaromatic hydrocarbons and organochlorines and contaminate surrounding air, soil and ground water. The potential health effects from these compounds are a source of concern to residents living in close proximity to these sites.¹

This review will focus on nine studies from the recent literature, primarily from North America, examining the health effects associated with living close to a municipal or hazardous waste site. The first four studies unveiled the possibility of associations between exposures from hazardous sites and selected cancers, low birth weight and infants small for gestational age (SGA). In the following five studies, the authors found either a marginal or lack of association between exposure to contaminants and health outcomes, or were reluctant to suggest links due to study

limitations. Five of the nine studies involved reproductive health risks. The other four studies explored the relationship between exposure and increases in risk for cancer, renal or respiratory disease, or other health problems.

Studies by Goldberg and co-workers examined the health effects among residents living near the third largest municipal solid waste site in North America, the Miron Quarry in Montreal, Quebec, which opened in 1958^{2,3}. The authors note that the primary emission of concern is biogas, a complex mixture of vapors and gases resulting from anaerobic digestion of organic material. Biogas contains primarily methane and CO₂, but also various sulfur compounds (CS₂, H₂S, mercaptans) and VOC's. They note that some of the constituents of biogas are embryo- or fetotoxic (eg. benzene, tetrachloroethane, chloroform); and that some of the VOC's, in particular, are known or suspected carcinogens. The authors examined cancer, low birth weight and pre-term birth, among populations living close to the site. The measure of exposure was

residence in four "exposure zones", defined by distance from the site. In the cancer study (1981-1989)², incident cancer cases were identified from the Quebec Tumour Registry; sex- and age-standardized incidence rates were calculated using Canadian census data to estimate the population at risk. *Results:* In women, modest excess risks were found for stomach cancer (RR 1.14, 95% CI 1.01-1.45) in the medium exposure group and cancer of the cervix uteri in the medium and high exposure groups (RR 1.23, 95% CI 1.04-1.45 for high exposure group). There were fewer than expected breast cancers. In men, modest excess risk was found for stomach cancer in the high exposure group (RR 1.24, 95% CI 1.06-1.44) and for cancer of the liver and intrahepatic ducts (RR 1.79, 95% CI 1.21-2.64). For lung cancer, modestly elevated RR's were seen in low, medium and high exposure groups with no dose-response relationship evident; the risk in the high exposure group, using the most closely matched reference group was 1.06 (95% CI 0.98-1.16). One exposure group, adjacent to the site but upwind, had an elevated RR for prostate cancer (RR 1.18, 95% CI 1.02-1.37). The authors note the following limitations to interpreting their results: the use of place of residence at the time of diagnosis as a surrogate for exposure, unknown duration of exposure, and the limited latency for solid tumors (maximal 21 years from onset of exposure to last year of study).

A case-control design was used to examine the risk of pre-term birth, low birth weight, very low birth weight, and SGA among residents near the Montreal site of the previous study.³ Singleton births between 1979 and 1989 were identified from provincial birth registration files. These files contain selected maternal factors (age,

education, residence at birth, language usually spoken) and birth characteristics (weight, gender, length of gestation), but not maternal smoking, occupational or health status. Unexposed reference zones from other areas of Montreal were chosen to approximate the study population with regard to potential risk factors for prematurity (average household income, proportion of immigrants, and proportion of those with French as native language). *Results:* The risk of low birth weight was significantly elevated in the high exposure zone (OR 1.20, 95% CI 1.04-1.39). There were also excess SGA births in the medium and high exposure groups, with the OR's suggesting significance or near-significance, respectively. (OR for medium exposure: 1.11, 95% CI 1.08-1.31; OR for high exposure: 1.09, 95% CI 1.00-1.22). No significant increased risk for very low birth weight, or pre-term births was observed. Again, the authors note that the following factors limit the interpretation of these data: residence at the time of birth; the inability to control for several maternal factors known to be associated with prematurity; low birth weight; and absence of information on maternal occupation. They also note that while animal and limited human reproductive toxicity data do provide a basis for biologic plausibility for their observations, the relevant dose-response and outcome measures in animals may have uncertain applicability to humans.

Berry and Bove (New Jersey Dept. of Health and ATSDR) examined 11,579 births during 5 five-year time periods between 1961 and 1985 in four New Jersey towns closest to the Lipari Landfill.⁴ Lipari accepted such hazardous wastes as cleaning solvents, resins, paint and paint thinners, ester press cakes, phenol and amine wastes, metals, and the particularly hazardous bis (2-chloroethyl) ether, until 1971. Inhalation of VOC's from the landfill and from a nearby contaminated lake was considered to be the greatest public health threat. The exposure period was presumed to be greatest during 1971 to 1975, just after the site closed and before clean up began. *Results:* There was an increased risk of low birth weight for mothers living adjacent to the site between 1971 - 1975 (OR 5.12, 95% CI 2.14 - 12.27), the period of presumed greatest exposure. This finding was especially significant because in the years both before and after that 4-year period, the average adjusted birth was significantly higher in the adjacent site, suggesting that in general, mothers in the exposed area may have had fewer other risk factors for low birth weight than controls. There was also an increased risk of being born preterm in this exposure group (OR 2.1 95% CI 1.01 - 4.36). The authors conclude that the population living immediately adjacent to this landfill was significantly impacted regarding birth weight in the period of probable greatest exposure.

Kharrazi and co-workers examined a population of 25,216 live births and fetal deaths to mothers living within three miles of the BKK landfill from 1978 to 1986. The BKK landfill is a huge hazardous waste site located in West Covina, Calif., 18 miles east of Los Angeles. The site had been subject to numerous complaints from residents, including odors, surface water runoff, dust releases, and hazardous waste spills from trucks going to the landfill. Earlier studies had shown an increase in early neonatal deaths and low birth weights for those living near the site. In this study, potential for exposure was assessed as high, medium, low, or intermittent, based on the number of historical odor complaints. Births in these areas were compared with those in a control area that had no such odor complaints. Data on birth weight, fetal, neonatal and infant mortality were obtained from vital records. *Results:* After adjusting for potential confounders, the authors found an average difference of -59 grams in birth weight among infants born to 226 mothers in the high odor complaint zone, and a -1.8 day gestational age for infants in the target population compared with mothers in the reference area (p < 0.05). The highest odor area also corresponded to high exposure estimates by other measures (environmental sampling, topography and meteorology). When using distance from the site as a measure of exposure, the authors found much less dramatic differences in birth weight and gestational weight than with the odor complaint measure. The authors concluded that the observed health effect was modest, but may have been underestimated due to misclassification inherent in the exposure determination.

The following studies, though not suggesting associations, are still of interest. The researchers reveal the difficulties they have in methodology, particularly in establishing accurate measures of exposure to contaminants from hazardous waste sites. Marshall and Gensburg⁶ (New York Department of Health) examined whether pregnant women who gave birth to babies with birth defects
(Continued on page 2)



International Joint Commission
Commission mixte internationale

A quarterly summary of recent findings in the scientific literature on human health effects and environmental pollutants, with an emphasis on pollutants of the Great Lakes ecosystem. Prepared under the direction of the Health Professionals Task Force of the International Joint Commission. This newsletter does not represent the official position of the International Joint Commission.

Health Professionals Task Force
Secretary: Jim Houston
International Joint Commission
Canadian Section
100 Metcalfe Street
Ottawa, Ontario K1P 5M1
phone (613) 995-0230
fax (613) 993-5583
email houstonj@ottawa.ijc.org

of the CNS and the MUS system were more likely to have been exposed to hazardous waste than mothers with children without such outcomes. The study population included all single births during 1983 to 1986 in 18 New York counties, excluding New York City, Long Island, and 38 sparsely populated rural counties. The authors studied 473 babies born with CNS defects and 3,304 babies born with MUS defects. They compared them with 12,000 randomly selected controls. The potential for exposure for solvent, metal, and pesticide release was assessed for each of the 643 hazardous waste sites in the study area based on an extensive review of environmental data. Analyses were done for: mothers living proximal to one or more of the hazardous waste sites with exposure to solvents, metals or pesticides; mothers living within one mile of 304 industrial air pollution emitters as identified by the Toxic Release Inventory (TRI) database; and mothers in communities with known contaminated water supplies. **Results:** No increase in risk for CNS birth defects was seen for maternal exposure to solvents or metals or for MUS defects and exposure to metals or pesticides, after controlling for confounders. Among mothers living within one mile of a TRI facility, there was a marginally significant increased risk for CNS birth defects from solvent exposure (OR 1.3, 95% CI 1.0 - 1.7) and metals exposure (OR 1.37, 95% CI 1.05 - 1.79) compared with those living more than one mile away. The authors noted that the confounding effects of the industrial emissions from the TRI facilities and the absence of precise exposure data may have limited their ability to find associations attributable to living near a hazardous waste site. They note that between <1% and 5% of the general population studied was exposed to one of the three contaminants: solvents, metals, or pesticides. This relatively small proportion made it difficult to examine particular pathways, disease subgroups or geographic area. In addition, the data on which the exposure assessment for each waste site was at times insufficient. The authors suggest studying populations with greater or more intense contaminant exposures to develop more definitive data.

Miller and McGeehin (ATSDR) analyzed health questionnaires completed by 414 residents living about four miles east of two National Priority List Superfund sites near Houston, Texas.⁷ The study was a follow up to a 1989 citizens' survey that had unveiled concerns about elevated rates of respiratory illness and birth defects among residents living near the two facilities -- the Brio Refining Company and the Dixie Oil Processors -- both open from 1957 until 1982. VOC's had contaminated groundwater under both sites; metals contaminated the Dixie site. Community wells were not contaminated. There was also exposure to low levels of VOCs from site emissions. The study participants (who must have lived in their homes at least one year prior to survey) were compared with a demographically matched population of 360 residents. **Results:** The authors found differences in the self reported health effects of nearby residents compared with controls. For example, the OR for self-reporting of all four respiratory symptoms, adjusted for smoking status, ranged from 2.1 to 2.6, with CI's all excluding unity for those living nearby the site compared with controls. There was also an increase in the number of reports for eczema or other skin problem (OR 9.2, 95% CI 2.5 - 33.4). Increased OR's for the reported diagnosis by a health care provider were significant for the following diseases: ulcer or other non-cancerous stomach disease (OR 3.3, 95% CI 1.4 - 7.8); hay fever or other non-asthma respiratory allergy (OR 2.4, 95% CI 1.3 - 4.4); and eczema or other skin problem (OR 1.9, 95% CI 1.04 - 3.5). However, the authors made no conclusions about potential risks to nearby residents due to study limitations, particularly exposure misclassification and the inability to validate illness. The effect of ongoing litigation and media attention may have introduced recall, bias, as well.

In a 1997 study, authors from the University of California studied the risk of NTDs, conotruncal heart cases, and oral cleft defects in newborns of mothers living near hazardous waste sites.⁸ In contrast to Marshall *et al.*⁹, in this study, Croen *et al.*⁸ determined the time of exposure as maternal residence at three months before and after conception instead of at the time of birth. Mothers were studied who lived either in a census tract with a hazardous waste site or within one mile of a site. **Results:** The authors found no increased risk of NTDs, heart defects, or oral cleft defects in newborns of mothers living within a census tract containing a hazardous waste site listed on the National Priority List (NPL) compared with mothers living in a tract with no such site. For NTDs, increased crude OR's (albeit with wide CI's) were observed for exposure to cyanide (OR 2.5, 95% CI 0.8 - 7.2) and pesticides (OR 1.8, 95% CI 0.6 - 5.0). There was a slightly increased risk for NTDs and conotruncal heart defects when the mothers lived within one-fourth mile of an NPL site (chiefly military bases). As in Marshall *et al.*⁹, the relatively small number of cases made a causal link difficult; again, distance from the site was noted to be an inadequate measure of exposure. The authors suggest that in the absence of adequate biological markers during the relevant embryologic periods, further studies will be unlikely to clarify the risks of exposure to hazardous waste sites in pregnancy.

In a recent Australian study, Williams and Jalaludin⁹ examined cancer rates and mortality in a study area of 3,922 people living in around the Castlereagh Regional Waste Disposal Depot outside Sydney, Australia. The waste disposal site, which opened in 1974, receives domestic, industrial, and undefined hazardous chemical waste. The study was prompted by concerns among community residents about adverse health effects due to contaminants from the waste site. The target population included census districts where at least one-half of the residents lived within three kilometers of the site; it was compared with to a control population in New South Wales. **Results:** While 120 cases of cancer were diagnosed between 1974-1991 in the target area, only brain cancer cases in males were elevated at greater than expected levels (six cases; SIR, 380, 95% CI 139 - 827). The only other statistically significant elevated SIR was for a cluster of breast cancer cases in females between 1979 and

1983 (SIR 252, 95% CI 109 -246) and uterine cancer cases between 1984 and 1988 (SIR 522, 95% CI 108 -1525). The authors note that the elevation of the brain cancer SIR in males but not in females suggests an occupational role. This study also shows the limits of small sample sizes and inadequate surrogate exposure measurements.

Finally, in a study of New York State residents, Hall and others¹⁰ reported on the risk of end-stage renal disease and living near a hazardous waste site. The study included 216 pairs matched by age, race and sex living in 20 New York State counties. They excluded cases of diabetes, polycystic kidney disease, lupus, congenital nephropathy, and nephropathy due to malignancy, analgesic abuse, or infections. **Results:** A non-significant elevated OR was seen for the disease for those ever having lived within a 1-mile radius of a hazardous waste site (1.40, 95% CI 0.92 -2.11). Elevated OR's were also found for other confounders (painting pictures, making pottery, education, income, lead poisoning, ever having smoked, kidney disease in family); all had broad confidence intervals including unity. After adjusting for gout, hypertension and a family history of kidney disease, the OR was higher for the target population compared with controls (1.63, 95% CI 0.87 -3.03). The authors note that this study is the first to examine the link between end-stage renal disease and hazardous waste, but because of limitations including small sample size (shown in the wide CI's), further investigation is needed.

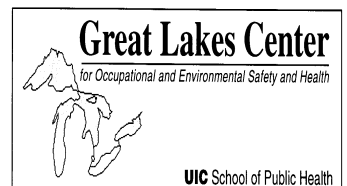
In summary, these reports suggest associations between exposures to chemicals emitted from hazardous waste sites and low birth weight, SGA, and shortened gestation. The reports demonstrate the methodologic difficulties in examining these potential associations. Primary among these difficulties is the absence of personal exposure data. Approaches to exposure assessment used in these studies included distance from site, odor complaints, and environmental and meteorologic data. Several authors noted drawbacks to simply using a uniform distance from the site as a measure of exposure, although this approach was used in some studies at the request of concerned community members. In some cases, small sample size, when studying particular outcomes, was an obstacle. The availability of more extensive environmental data, and the development of biomarkers of exposure to relevant pollutants would help overcome these limitations.

Abbreviations

VOC's: volatile organic compounds
 SGA: small for gestational age
 ATSDR: Agency for Toxic Substances and Disease Registry
 OR: odds ratio
 CI: confidence interval
 CNS: central nervous system
 MUS: musculoskeletal system
 NPL: National Priority List
 SIR: standardized incidence ratio
 RR: relative risk
 NTD: neural tube defect

REFERENCES:

1. Eyles, J., Taylor, M. *et al.* Worrying about waste: living close to solid waste disposal facilities in southern Ontario. *Soc Sci Med* 1993;37:805-812.
2. Goldberg, M., Al-Homsi, N., *et al.* Incidence of cancer among persons living near a municipal solid waste landfill site in Montreal, Quebec. *Arch Environ Health* 1995;50:416-424.
3. Goldberg, M., Goulet, L., *et al.* Low birth weight and preterm births among infants born to women living near a municipal solid waste landfill site in Montreal, Quebec. *Env Res* 1995;69:37-50.
4. Berry, M., Bove, F. Birth weight reduction associated with residence near a hazardous waste landfill. *Environ Health Perspect* 1997;105(8):856 - 861.
5. Kharrazi, M., Von Behren, J. *et al.* A community-based study of adverse pregnancy outcomes near a large hazardous waste landfill in California. *Toxicology and Industrial Health* 1997;13(2/3):299-310.
6. Marshall, E.G., Gensburg, L.J., *et al.* Maternal residential exposure to hazardous wastes and risk of central nervous system and musculoskeletal birth defects. *Arch Environ Health* 1997; 52:416-425.
7. Miller, M.S., McGeehin, M.A. Reported health outcomes among residents living adjacent to a hazardous waste site, Harris County, Texas, 1992. *Toxicology and Industrial Health* 1997; 13 (2/3):311-319.
8. Croen, L.A., Shaw, G.M., *et al.* Maternal residential proximity to hazardous waste sites and risk for selected congenital malformations. *Epidemiology* 1997;8:347-354.
9. Williams, A., Jalaludin, B. Cancer incidence and mortality around a hazardous waste depot. *Aust NZ J Public Health* 1998;22:342-346.
10. Hall, H.I., Kaye, W.E., *et al.* Residential proximity to hazardous waste sites and risk of end-stage renal disease. *Environmental Health* 1996: September 17-22.



PREPARED BY:

Great Lakes Center for
 Occupational and Environmental
 Safety and Health
 School of Public Health
 University of Illinois at Chicago
 2121 West Taylor Street
 Chicago, Illinois 60612-7260
 (312) 996-7887

Reviewer:

Anne Krantz, M.D., MPH
 Ruth Tupper, M.A.
 Senior Science Advisor:
 Daniel O. Hryhorczuk, MD, MPH



World Health Organization
 Collaborating Centre for Occupational
 and Environmental Health