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Concentrations of selected organochlorines and chlorobenzenes in the serum of former Love Canal residents, Niagara Falls, New York , ☆, ☆ ☆

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ABSTRACT

Background: Love Canal, in Niagara Falls, NY is among the earliest and most significant hazardous waste sites in the USA, but no study has ever measured chemical body burdens in nearby residents to document that human exposure occurred. This study measured concentrations of selected organochlorines and chlorinated benzenes in archived serum samples collected from former Love Canal residents.

Methods: We analyzed serum samples collected from 373 former residents in 1978–1979 for compounds disposed of at Love Canal, and we compared their concentrations according to surrogate indicators of exposure such as residential proximity, adjusting for potential confounders.

Results: Three compounds were detectable in the serum of most participants: 1,2,4-trichlorobenzene (1,2,4-TCB), β -hexachlorocyclohexane (β -HCH) and 1,2-dichlorobenzene (1,2-DCB). Concentrations of 1,2,4-TCB and 1,2-DCB were 2–14 times greater among persons who at the time their blood was collected lived closest to the Canal compared to those living further away. We found no consistent trends for β -HCH with respect to any exposure definition.

Conclusions: These results provide evidence that residential proximity to Love Canal contributed to the body burden of certain contaminants, and helps validate the use of surrogate exposure measures in health effect studies. Further surveillance of the Love Canal cohort is warranted.

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1. Introduction

The residential community of Love Canal, a 16-acre tract of land in Niagara Falls, NY, was built around a landfill used for the disposal of about 21 800 tons of chemical wastes by Hooker Chemical Corporation between 1942 and 1953. In the 1970s, chemical odors, surfacing of chemicals and other signs of contamination coming from the landfill were detected. Between 1978 and 1980, several state and federal actions led to the relocation of families living next to the Canal and later to voluntary relocations farther from the Canal, with the eventual

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☆☆ This study was approved by the New York State Department of Health Institutional Review Board as part of the larger Love Canal Follow-up Health Study (study #99-312) at a full board meeting in August 1996 and annually thereafter.

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establishment of the Emergency Declaration Area (EDA—see Fig. 1) (New York State Department of Health, 1981). This man-made disaster encouraged the passage of the Comprehensive Environmental Response, Compensation and Liability Act by the US Congress in 1980, the enabling legislation authorizing federal funding for Superfund remedial activities at hazardous waste sites nationwide (CERCLA, 1980).

In response to this situation, the New York State Department of Health (NYSDOH) and independent researchers conducted a number of health studies of Love Canal residents between 1980 and 1987, focusing on health outcomes such as low birth weight, birth defects, childhood growth and development, and cancer incidence (Goldman et al., 1985; Janerich et al., 1981; Paigen, 1982; Paigen et al., 1987; Vianna and Polan, 1984). Most of these studies, however, relied on qualitative measures of exposure such as proximity to the Canal or residence near swales, which were believed to be conduits for exposure to chemicals from the site. Only one previous study attempted to measure body burdens in the blood of 36 Love Canal residents and 9 volunteer controls from North Carolina (Bristol et al., 1982). Little or no differences were found between the two groups in the concentrations of

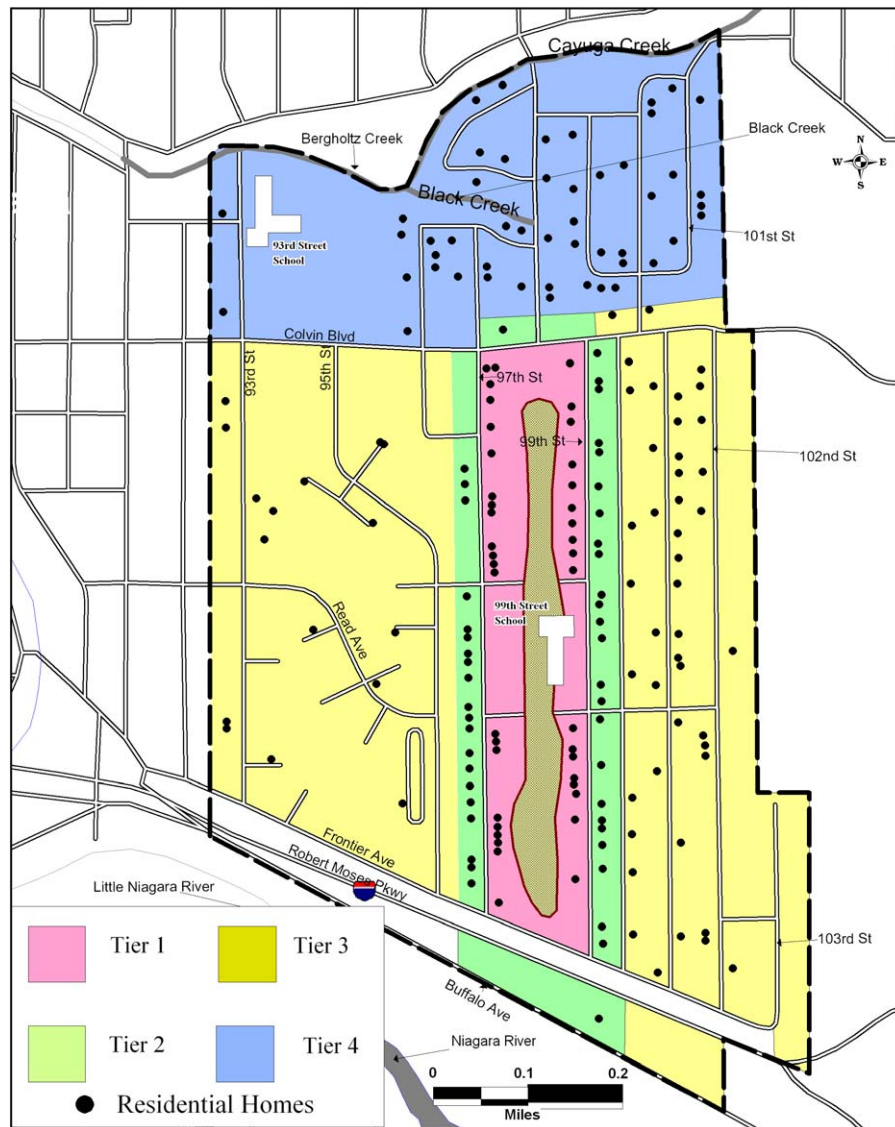


Fig. 1. Map of Love Canal Emergency Declaration Area and residences of current sera cohort members, 1978.

25 organochlorines. However, this study was handicapped by very small sample size and high detection limits characteristic of the analytical methodology available at the time.

The current study presents an opportunity to re-examine the question as to what extent previous Love Canal residents were exposed to chemicals from the site by analyzing serum samples that had been archived since 1978–1979 with current and sensitive analytic methods. It also evaluates the association between body burdens of chemicals suggestive of exposure and more qualitative measures such as time and location of residence commonly used when studying health effects of hazardous waste sites. This effort is part of a larger investigation of the long-term mortality, cancer incidence, and reproductive experiences of former Love Canal residents (Gensburg et al., 2009a,b; NYSDOH, 2008).

2. Materials and methods

2.1. Study population

Our source population consisted of 6026 persons who: (1) lived in the Love Canal EDA sometime between 1940 and June 1978 and (2) completed an interview between 1978 and 1982 ($N=4507$) or were children ($N=1519$) listed by either

interviewed parent. Some Love Canal residents, along with other area residents, volunteered to participate in a blood testing program in 1978–1979 to assess various clinical parameters (New York State Department of Health, 1981). Residual serum samples were stored and archived at the NYSDOH and later matched according to identification number, name and age to determine which of these samples were taken from members of the cohort. Among serum samples successfully linked to Love Canal cohort members, persons not known to be deceased and for whom there was a known address were mailed a consent form to obtain permission to analyze their serum.

2.2. Chemical selection and analysis

In 1986, Love Canal Indicator Chemicals (LCICs) for air and soil were selected for a habitability study (NYSDOH and DHHS, 1986) and reviewing that selection process was an initial step in selecting chemicals for the serum analyses. After considering their criteria (e.g. known to have been disposed of at Love Canal, chemicals unlikely to be confounded by other sources of contamination) and the ability in 2000 to measure the LCICs (plus other chemicals in the same analytical suite) in human serum, the following eight chemicals were selected for analysis: 1,2-dichlorobenzene (1,2-DCB); 1,2,4-trichlorobenzene (1,2,4-TCB); 2-chloronaphthalene (2-CN); 1,2,3,4-tetrachlorobenzene (1,2,3,4-TCB); α -hexachlorocyclohexane (α -HCH); β -hexachlorocyclohexane (β -HCH); γ -hexachlorocyclohexane (γ -HCH); and δ -hexachlorocyclohexane (δ -HCH).

Serum from the blood samples drawn in 1978–1979 were stored in freezers at $-20\text{ }^{\circ}\text{C}$ at the NYSDOH. Uncompromised specimens of sufficient quantity were analyzed between 1999 and 2004. Specimens of 1 g were spiked with 0.5 ng each of surrogates 1,3,5-tribromobenzene and heptachlor epoxide isomer A and left at

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