Exposure to Aerial Malathion Application and the Occurrence of Congenital Anomalies and Low Birthweight

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Abstract: The association between exposure to low dose malathion, after its aerial application to 13,000 square miles in the San Francisco Bay area, and the occurrence of birth defects and low birthweight was examined using newborn hospital discharge data and vital records. No biologically plausible pattern of association was found. Limitations in the data and analysis are discussed. (*Am J Public Health* 1987; 77:1009–1010.)

Introduction

From July 1981 through August 1982, in an effort to eradicate the Mediterranean Fruit Fly, the California Department of Food and Agriculture conducted aerial applications of the pesticide malathion, an organophosphate. Malathion was applied over more than 13,000 square miles, including several population centers adjacent to San Francisco Bay (Figure 1). Before the initiation of the program, the California Department of Health Services concluded that, based on animal studies, there would be no important human health risks associated with this low dosage application.[1] Nevertheless, there was considerable public apprehension about the program.

This investigation examined the relation between low-dosage aerial malathion exposure and the prevalence at birth of congenital anomalies and low birthweight. The analyses were limited to live births from mothers residing in treated zip codes of Alameda, San Mateo, and Santa Clara counties.

Methods

Aerial treatment data were provided by the California Department of Food and Agriculture and were used to determine monthly exposure "scores" for each treated zip code. Scores were computed by multiplying the number of applications per month for each zip code by the estimated proportion of the residences of the zip code that received the malathion treatment.

Data on congenital anomalies were obtained from all 1981 and 1982 newborn hospital discharges with zip code of residence in the treated areas. International Classification of Disease congenital anomaly codes (740.0–759.9) were included at the four-digit level (total = 152).[2] In addition, six embryologically related groupings of diagnoses were investigated.

For the birthweight analysis, a birth certificate data file was used that included all 1982 births to residents of the sprayed areas.

For the analysis of congenital anomalies, a first trimester 90-day vulnerability period was calculated counting backwards from the date of birth. For term births, a nine-month gestation period was assumed. Six-month and eight-month gestation periods were assumed for births with discharge diagnoses of "extreme immaturity" and "other preterm," respectively. For all births, an exposure score for the three-month period was then assigned on the basis of month and zip code of birth.

Use of these procedures resulted in an exposed cohort of 22,465 births for 1982. These births were compared separately to the 1982 unexposed births (N = 17,050) and to 1981 unexposed births (N = 37,854). It was predicted that any important association of malathion exposure with the occurrence of congenital anomalies would be revealed in *both* of these comparisons.

For the birthweight analysis, attention was focused on the entire gestation period because of the difficulty of identifying a specific period of vulnerability. Counting backwards from the date of birth, nine months of vulnerability were assumed for all births, an assumption that would exaggerate the potential for exposure to malathion for births of shorter gestation. Use of these procedures resulted in an 1982 exposed cohort of 24,987 births and a 1982 unexposed cohort of 15,278 births.

Results

As expected, given the infrequent occurrence of most congenital anomalies, patterns of association fluctuated between the two years. No category of anomaly was found to be materially elevated among exposed births in comparison

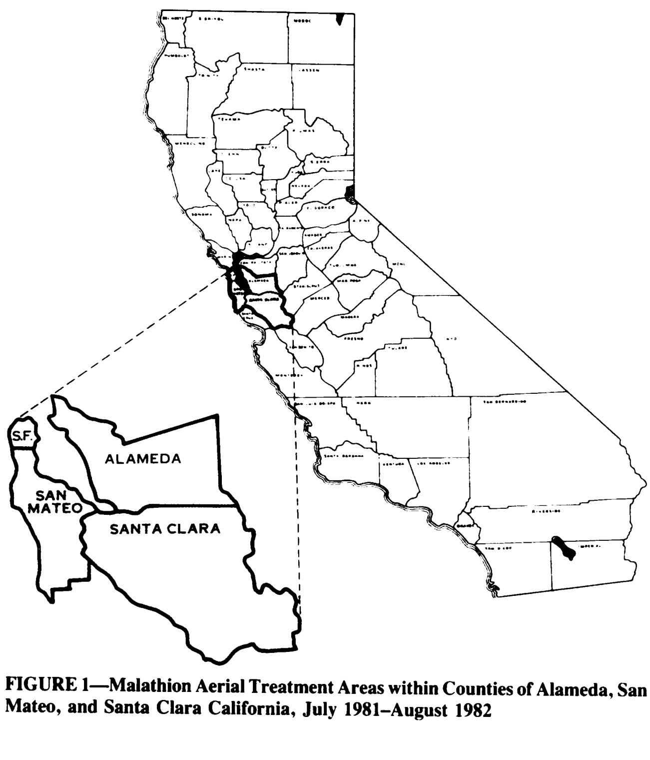

FIGURE 1—Malathion Aerial Treatment Areas within Counties of Alameda, San Mateo, and Santa Clara California, July 1981–August 1982

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TABLE 1—Relative Risk for Selected Congenital Anomaly Diagnoses by Malathion Exposure, Selected Counties, California, 1981 and 1982

	(All Exposed Compared to Unexposed)		
Diagnosis	N*	RR	95% Confidence Interval
1981 Unexposed			
Anomalies of ear (744.2)	11	4.49	1.19–16.92
with "other" (744.29) excluded	1	**	**
Bowed legs (754.4)	25	2.99	1.32– 6.75
with "unspecified" (754.44) excluded	3	3.37	0.31–37.16
Varus deformities (754.5)	99	1.72	1.16– 2.55
with metatarsus varus (754.53) excluded	50	1.03	0.58– 1.82
Clubfoot grouping (745.5–754.7)	174	1.47	1.09– 1.98
with metatarsus varus (754.53) excluded	125	1.12	0.79– 1.61
1982 Unexposed			
TE Fistula (750.3)	9	2.66	0.55–12.78

*N of cases includes both exposed and unexposed.
**Too few cases to compute.

to *both* the 1981 and 1982 unexposed groups. Positive associations were noted for:

- other specific anomalies of ear (ICD 744.2) in 1981 only;
- bowing of long bones of leg (ICD 754.4) in 1981 only;
- varus deformities (ICD 754.5) in 1981 only;
- clubfoot grouped dx (ICD 754.5–754.7) in 1981 only;
- tracheoesophageal fistula (ICD 750.3) in 1982 only.

Table 1 gives the relative risk (RR) and confidence intervals (CI) for these diagnoses for the 2×2 comparison of all exposed to unexposed.

For each of the first four of these diagnoses, further analysis at the five-digit level (ICD) revealed the excess to occur within a subcategory representing poorly defined conditions. For the ear anomaly diagnosis, virtually all cases fell into the subcategory of "other" (744.29). Similarly, virtually all cases of bowed legs are found in the subcategory of "*un*specified long bones of leg" (754.44). For both varus deformities and clubfoot, the strength of the association is attributable to the five-digit diagnosis of metatarsus varus (754.53), an essentially normal condition.

For each of these poorly defined subcategories, the rate of occurrence is lower in 1981 than in the 1982 *un*exposed group, suggesting a general elevation in 1982 not limited to the exposed births. Moreover, the orthopedic conditions represented by three of these diagnoses are not congenital anomalies but rather positional deformities occurring late in gestation.

In comparison with the 1982 unexposed group, one four-digit diagnosis, tracheoesophageal fistula (750.3), is positively associated with exposure. As illustrated in Table 1, the number of cases is quite small, resulting in a wide confidence interval.

The birthweight analysis using birth certificate data found the expected differences between Whites and Blacks but little change in low birthweight associated with increasing exposure to malathion (Figure 2).

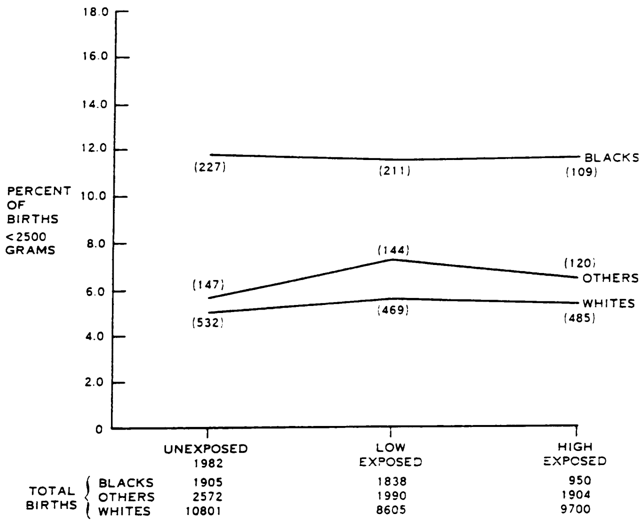

FIGURE 2—Per Cent of Births with Birthweight < 2500 Grams by Malathion Exposure Grouping, Birth Certificate Data, Selected Counties, California, 1982 (number of cases in parentheses)

Discussion

Overall no important association was found between low dosage aerial application of malathion and the occurrence of congenital anomalies and low birthweight among liveborn infants. The anomalies that occurred more frequently than expected do not represent a biologically consistent pattern. Most importantly, no anomaly was substantially elevated in comparison with both the 1981 and the 1982 *un*exposed births. Similarly, the birthweight analysis showed little association with malathion exposure. The evidence as a whole does not support a biologically plausible pattern of birth anomalies associated with this episode of low dose malathion exposure.

Non-biological explanations for our findings must also be considered, however. One such explanation is misclassification of exposure status. Potentially, as many as 10–15 per cent of exposed births were misclassified, thus reducing the possibility of finding an effect from exposure.

There are also misclassifications in the outcome data. Congenital anomaly diagnoses were limited to those identified during the newborn period. Only about half of all structural anomalies are identified at birth. In addition, spontaneous abortions and many neurological and endocrine conditions could not be studied. These limitations should be kept in mind when interpreting the present results.

REFERENCES

1. California Dept of Health Services: Assessment of the health risks from the proposed aerial application of malathion in Santa Clara County. Sacramento: Hazard Evaluation System and Information Service, State of California, 1980.
2. The International Classification of Diseases, 9th Rev. Clinical Modification, 2d Ed. Washington, DC: Department of Health and Human Services, Pub. No. (PHS) 80–1260, September 1980.