The Lipari Landfill Birth Weight Study; A 25-Year Trend Analysis

NEW JERSEY DEPARTMENT OF HEALTH
A BETTER STATE OF HEALTH

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THE LIPARI LANDFILL BIRTH WEIGHT STUDY: A TWENTY-FIVE YEAR TREND ANALYSIS

NEW JERSEY DEPARTMENT OF HEALTH
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ABSTRACT

The purpose of the study was to evaluate the birth weights of infants born to residents living near the Lipari Landfill, a hazardous waste site that has been identified by the USEPA as the number one Superfund site in the country. The landfill, which operated from 1958 to 1971, was the site of disposal of nearly three million gallons of hazardous chemical waste that were dumped directly into a former gravel pit. Consequently, the landfill was the source of hazardous leachate which migrated from the site into two nearby streams and a lake in the vicinity of residences, schools, and playgrounds.

Twenty-five years of birth certificates (1961-1985) were collected from New Jersey Department of Health records for four towns near the landfill. Births were assigned an exposure area based on distance from the mother's residence to the landfill at time of birth. Residents living within one kilometer of the site (Area 1) were defined as "exposed". Those living beyond one kilometer in the four towns were defined as the "unexposed" population (Area 2). Because of concerns of exposure misclassification, Area 1 was further subdivided into two sectors: Area 1A, the neighborhood immediately adjacent to the landfill and Area 1B, the rest of Area 1 less Area 1A.

Births were grouped into five discrete five-year time periods. The distributions, means, and standard deviations of birth weights and major confounding factors were generated and compared for Area 1 (or Area 1A) versus Area 2. The birth outcome variables analyzed included the birth weight of the child in grams, proportion of low birth weight babies, birth weight distribution, and gestational age. Multiple and logistic regression methods were used to analyze differences in the two study populations. Three-year running odds ratios were calculated for term births in an effort to evaluate the risk of low birth weight within shorter time periods.

During the 1971-1975 time period for births with gestational age greater than 27 weeks, Areas 1 and 1A had significantly lower average birth weight than Area 2 (80 grams and 152 grams respectively). Area 1A had substantially higher average birth weight for all other time periods compared to Area 2. Area 1A average birth weight decreased substantially (187 grams) through the time period 1966-1975 and then rebounded by about 306 grams after 1975. The proportion of low birth weights in Area 1A was significantly higher than in Area 2 during 1971-1975 (OR = 2.87; 90% CI = 1.54, 5.34; $p < 0.005$). Multiple regression identified area of residence as statistically significantly associated with birth weight for children born in Areas 1 and 1A during 1971-1975 (a decrease of 83 grams and 166 grams respectively).

Term births (gestational ages between 37 and 44 weeks) showed similar though stronger associations than all births greater than

27 weeks gestation. Area 1A term births were substantially decreased (188 grams) through the 1966-1975 time period and then rebounded by about 332 grams after 1975. The proportion of low birth weights in Area 1A were substantially increased during 1971-1975 compared to Area 2 (OR = 5.12; 90% CI = 2.47, 10.64, p<0.0001). Multiple regression identified area of residence as statistically significantly associated with birth weight for children born in Areas 1 and 1A during 1971-1975 (a decrease of 84 grams and 177 grams respectively). The three-year running odds ratio analysis for Area 1A versus Area 2 showed significantly elevated odds ratios for 1971 through 1976. During that time period, the proportion of low birth weight was five to six times higher for Area 1A than Area 2.

The results of this analysis of twenty-five years of birth weights near the Lipari Landfill indicate that the population living immediately adjacent (Area 1A) were significantly impacted during the time period 1971-1975, the period postulated as having the greatest potential for exposure. The impact on birth weight appears restricted to the one time period with average birth weight returning to normal after 1975. The concentric ring approach to defining exposure categories is susceptible to exposure misclassification and biasing study results toward the null hypothesis of no effect, as was evident in this study. Information on other potential risk factors for low birth weight was not available for analysis, however, the consistency of the findings across the different analytic methods lends credence to the validity of the results. The magnitude of the effect identified in this study is in the range of birth weight reduction found in studies of cigarette smoking during pregnancy. The excess risk appeared stronger in term births suggesting a mechanism of growth retardation rather than prematurity.

INTRODUCTION

The Lipari Landfill is a 15-acre site located in Mantua Township, Gloucester County, New Jersey, and borders the towns of Pitman, Glassboro, and Harrison. The Landfill is ranked number one on the United States Environmental Protection Agency's (USEPA) National Priority List. In 1958 the site was first excavated as a source of sand and gravel leaving an empty pit that was later back-filled with municipal refuse, household wastes, liquid and semi-solid chemical wastes, and other industrial wastes. The landfill operated until 1971 and accepted an estimated 12,000 cubic yards of solid waste and 2.9 million gallons of liquid chemical waste. Liquid wastes were emptied from containers and dumped into the landfill from 1958 to 1969 and solid wastes were disposed of until May 1971 (USEPA 1985). It has been estimated by the USEPA that the heaviest period of dumping occurred between 1967 through 1969.

Hazardous waste deposited into the landfill included cleaning solvents, resins, paint and paint thinners, ester press cakes, phenol wastes, and amine wastes. According to the on-site Remedial Investigation/Feasibility Study (RI/FS), a major hazard identified in the landfill was bis (2-chloroethyl) ether (BCEE) (USEPA 1985). Other chemicals identified include benzene, toluene, methylene chloride, 1,2-dichloroethane, formaldehyde, phenol, chromium, nickel, mercury, lead, selenium, arsenic, and silver.

The landfill was the source of hazardous leachate which migrated from the site into two nearby streams and a lake in the vicinity of residences, schools, and playgrounds. Operation of the landfill ended because of residents' complaints regarding odors, respiratory problems, headaches, nausea, and dying vegetation.

In 1985, the Lipari Health Committee was formed by a group of concerned local residents and community officials. The Committee also included representatives from the New Jersey Department of Health (NJDOH), Centers for Disease Control, Agency for Toxic Substance and Disease Registry (ATSDR), USEPA, New Jersey Department of Environmental Protection, Gloucester County Health Department and the four neighboring communities. A subcommittee was then formed to evaluate specific health related issues and explore potential health study activities. The subcommittee agreed that NJDOH should study birth certificate data for low birth weight and State Cancer Registry data for selected cancer outcomes for evidence of exposure-related health effects.

Birth certificates were collected for children born in the four municipalities during three five-year time periods: 1961-1965, 1971-1975, and 1981-1985. These three time periods corresponded to three potential exposure periods: low potential exposure during early operation of the landfill, high potential exposure shortly after the heaviest dumping, and lesser exposure due to closure and fencing of the site, respectively. The results of the study (NJDOH, 1989) indicated that babies born during the 1971-1975 period in the population closest to the landfill (Area 1) had, on average, significantly lower birth weight (74 grams less) than births occurring over the same time period but further away from the site. Neither of the other time periods evaluated showed differences in birth weight between the study populations. The 1989 report concluded that the "results are consistent with the hypothesis that exposure to contaminants from the site is associated with average low birth weight."

After completion of the report, an external review panel was appointed to evaluate the study methods and results, and provide comments regarding recommendations for further efforts to address community needs. Although the panel could not conclude that the observed low birth weight effect was attributable to exposure to agents in the landfill, the panel did recommend analyzing birth weight for the intervening years 1966-1970 and 1976-1980 in order to add to the data on the time patterns of probable exposure in relation to birth weight (NJDOH, 1989).

This report is an update of the earlier birth weight study incorporating the missing ten years of births, 1966-1970 and 1976-1980, and reanalyzing the entire twenty-five years of birth certificate data.

METHODS

Study Period and Population

Twenty-five years (1961-1985) of birth certificate information was collected from the New Jersey Department of Health's Center for Health Statistics records for the four municipalities closest to the landfill (Mantua, Pitman, Glassboro, and Harrison). Additionally, birth certificates were requested and obtained from the Pennsylvania Vital Statistics Office for study area children born in Pennsylvania hospitals.

Exposure categories were developed for each birth based on the distance of the mother's residence from the site as identified on the birth certificate. An irregular polygon, which approximates a circle or ring with radius of 1.0 kilometers, was extended from the perimeter of the landfill and Alcyon Lake forming the basis of the "exposed" area, called Area 1 (see Figure 1). The area extending beyond the 1.0 kilometer boundary to the end of the municipal limits were combined to form the "unexposed" population sector or Area 2 (termed Areas 2 and 3 in the 1989 report). Area 1 was further subdivided into two sectors: Area 1A, the neighborhood immediately downwind and adjacent to the landfill and lake, and Area 1B, the rest of Area 1 less Area 1A, which is generally further from the site. Area 1A is comprised of approximately 600 residential homes located in Pitman and Glassboro. The Pitman Area 1A section is bounded on the north by Alcyon Lake and Alcyon Park, on the east by Cedar Avenue and on the west and south by the municipal line. The Glassboro section of Area 1A is defined by the self-contained residential subdivision of Lakeside Park.

Selection requirements for births to enter the study include:

1) the subject was a live birth;

2) the street address on the birth certificate indicated that the mother lived in Area 1 or Area 2 at the time of birth of the subject (excluded were those with missing addresses, addresses indicating only post office or rural delivery number, incomplete addresses and those addresses that could not be identified on the U.S. Census block maps or by the local health officer in consultation with the post office and field investigations;

3) the subject was a "singleton" live birth (no twins, triplets, etc.);

4) the birth occurred during 1961 through 1985; and

5) information was available on sex and birth weight of the child, and on mother's race.

Birth certificates that lacked information on birth weight or street address were not included in the study since residential proximity to the landfill and birth weight were factors of primary interest. Because sex and race are associated with birth weight, births lacking information on these potential confounders were also excluded.

Birth certificates were aggregated into five five-year periods selected to represent periods when exposure to toxic waste at the site was likely to be: 1) non-existent or minimal (1961-1965), 2) increasing and moderate to heavy due to increased dumping (1966-1970), 3) heaviest due to runoff into the neighboring community and contamination of Alcyon Lake (1971-1975), 4) decreasing and moderate (1976-1980) since dumping had ended in 1971 and air exposures would be expected to decrease over time due to earlier volatilization of contaminants, and 5) minimal due to remedial work (1981-1985).

Birth weight distributions usually differ by race and sex. In order to adjust for the effect of race on birth weight, a sufficient number of white and non-white births are needed for the analysis. However, in Area 1 there were few non-white births during the study period (approximately 1% of the Area 1 births were non-white). Because of the small number of non-white births and the difficulty of adjusting adequately for race, the study was restricted to white births only.

Information on Potential Risk Factors

Information on potential risk factors for low birth weight was obtained from the birth certificate. Variables evaluated included sex, gestational age in weeks, mother's race, age and education, parity, previous fetal deaths (born dead after 20 weeks gestation in N.J. and after 16 weeks in Pa.), month prenatal care began, total number of prenatal visits, and age and education of father. These variables were not always available for all time periods or for both states (N.J. and Pa.). Race of the mother was not always reported on N.J. birth certificates during the years 1962 and 1963 resulting in a loss of potential study subjects. No information on prenatal visits or on parental education was included in the N.J.

birth certificates for 1961-1967 or on the Pa. birth certificates for 1961-1965 and 1971-1975. Therefore, prenatal visits and parental education could not be evaluated for the 1961-1965 or 1966-1970 periods. APGAR scores and previous miscarriages (fetal loss before 20 weeks gestation) were not evaluated since they were only available on N.J. and Pa. birth certificates for the period 1981-1985.

Information on other risk factors for low birth weight was not available on the birth certificate and could not be evaluated. These factors include maternal health, cigarette and alcohol consumption during pregnancy, parental occupational information, and parental socioeconomic status.

Data Analysis

The distributions, means, and standard deviations of birth weights and major confounding factors were generated and compared for Area 1 (or Area 1A) versus Area 2. The birth outcome variables analyzed included: the birth weight of the child in grams, proportion of low birth weight (less than 2500 grams) babies, birth weight distribution and gestational age. In order to get a better sense of birth weight distribution differences between Area 1 (or Area 1A) and Area 2, birth weights were also grouped into six categories (less than 1500 grams, 1500-1999 grams, 2000-2499 grams, 2500-2999 grams, 3000-4699 grams, and greater than 4700 grams). Separate analyses were performed for each of the five five-year periods.

Mother's residence at the time she gave birth was the "exposure" variable. A "crude" analysis was performed comparing the birth outcomes for the two areas. Then, analyses were performed measuring the effect of the exposure variable on average birth weight and on low birth weight proportion after the effects of other potential risk factors were taken into account. These other factors included the age, parity, education and number of previous stillborns of the mother, length of gestation and sex of the child, and prenatal care (NAS, 1973). (Paternal age and education were not included in the analysis since they were highly correlated with maternal age and education and because there was a high proportion of missing data for these variables.) The National Academy of Science's standard formula for prenatal visits was used to define the quality of prenatal care (NAS, 1973) and is based on the total number of prenatal doctor visits and the gestational month the visits began. Not every birth certificate had complete information for gestational age, maternal education, prenatal care, parity, and previous fetal deaths. Dichotomous variables were created corresponding to each of these risk factors and were coded with a zero if the child had complete information for the risk factor and a one if not. Whenever a risk factor variable was included in the multiple regression analysis, its corresponding variable for missing information was also included (Cohen and Cohen, 1983). Table 1 presents the risk factor coding scheme used in the analysis.

Descriptive analyses of average maternal age, gestational age, parity, maternal education, and prenatal care are given separately for each time period studied. Comparisons of birth weight distribution and proportion of low birth weight between the two areas are presented. Statistical significance was indicated by p-values and confidence intervals (Breslow and Day, 1980).

Multiple regression and analysis of variance (ANOVA) methods (Snedecor and Cochran, 1980) were used to analyze differences in average birth weight between the two areas. Regression diagnostics were performed to identify study subjects who strongly influenced the analysis because they had extreme values for one (or more) of the risk factors and/or the birth weight (Cook and Weisberg, 1982). These subjects were then removed and an additional regression analysis was performed to evaluate any changes in the size of the difference between the two areas in average birth weight. Logistic regression (Breslow and Day, 1980) was used to analyze differences in the proportion of low birth weight babies between the two areas. In all regression analyses, a hierarchical backward elimination method (Greenberg and Kleinbaum, 1985) was used to assess interaction and to eliminate variables. Significance tests were standard t-tests based on the coefficients and their standard errors (Breslow and Day, 1980).

Differences of birth weight distribution and average gestational age between the two areas were evaluated by the chi-square test and t-test (Snedecor and Cochran, 1980), respectively. All p-values mentioned in the text and tables are two-tailed. Separate analyses were performed on births of greater than 27 weeks gestation and on births with gestational ages between 37 and 44 weeks ("term" births). In order to protect the validity of the analysis, the 27-week gestational age cutoff was used to eliminate data for early births with unreliable birth certificate data. Analysis of term births provides an indication of whether there are delays in the growth and development of fetuses.

Lastly, three-year running average odds ratios were calculated for term births in Area 1A and Area 2 in an effort to evaluate the risk of low birth weight within shorter time periods. Births for each year were summed over three year overlapping intervals in order to smooth out annual fluctuations of low birth weight proportions due to the effect of small numbers of births per annum. Odds ratios and p-values are presented.

RESULTS

Table 2 presents a breakdown of the race and sex for all eligible births stratified by five-year time periods. The vast majority (nearly 90%) of the births throughout the 25 year study period were identified as white. For Area 1, virtually all births were white (over 98%). Although race is an important risk factor for birth weight, there were too few non-white births in Area 1 to adjust for race in the analysis. As a result, only white births were analyzed. Among white births, approximately 53% were males.

A summary of the known potential risk factors of the study population births with gestational age greater than 27 weeks are listed in Table 3. In general, mothers in Area 1A were, on average, slightly older, more educated, and had better prenatal care for every aggregate time period where data was available. Although the quality of prenatal care were generally increasing for all groups over time, Area 1A mothers had significantly better prenatal care ($p<0.05$) than Area 2 mothers from 1971 through 1980.

Table 4 presents the average birth weight by five-year birth periods for each Area. During the time period 1971-1975, Area 1 had an average birth weight 80 grams less than Area 2 while Area 1A's average birth weight was 152 grams less than Area 2. With the exception of 1971-1975 period, Area 1A had substantially higher average birth weights for every time period studied (Figure 2). While Area 2 had consistently increasing average birth weight throughout the birth periods, Area 1A's average birth weight decreased substantially (187 grams) through the time period 1966-

1975 and then rebounded by approximately 306 grams after 1975.

Tables 5 and 6 present birth weight distributions and low birth weight proportions by birth period. Of note, Area 1A had a significantly larger proportion of low birth weights for 1971-1975 when compared to Area 2 (OR = 2.87; 90% CI = 1.54, 5.34; p<0.005). This strong result detected in Area 1A was responsible for the significantly high proportion of low birth weights detected in all of Area 1. The proportion of low birth weights in Area 1B was similar to Area 2 for each of the birth time periods analyzed.

Analysis of average birth weight by multiple regression and analysis of variance was performed in which an interaction term for area of residence and sex of child was included. Table 7 presents summary multiple regression results for area of residence only, while Tables 8a through 8e present the full results of all regression analyses by time period for births over 27 weeks gestation. Area of residence was statistically significantly associated with birth weight for children born in Area 1 and Area 1A for the 1971-1975 time period (a decrease of 83 grams and 166 grams respectively). The interaction term was not statistically significant indicating that the difference in average birth weight between the "exposed" and "unexposed" areas was consistent across the sexes for these births. For the time periods 1961-1965 and 1976-1980, Area 1A had a statistically significantly higher birth weight than Area 2. Area of residence did not display any associations with birth weight during any other time period evaluated. In 1981-1985 the interaction term was statistically significant for Area 1 (and Area 1A).

Logistic regression was used to analyze the difference in the proportion of low birth weights between the exposure areas. Again, area of residence was statistically significant for Area 1 (OR = 1.62; 90% CI = 1.52, 1.72) and Area 1A (OR = 3.16; 90% CI = 2.88, 3.44) for the time period 1971-1975. The interaction term for area of residence and sex of child was not statistically significant, indicating that the difference in the proportion of low birth weights between the exposure areas was consistent across the sexes. Area of residence did not display any association with low birth weight proportions during any other time period evaluated.

Births with gestational ages between 37-44 weeks (term births) were analyzed separately. The results are presented in Figure 3 and Tables 9 through 12e. Table 9 and Figure 3 present the average birth weight by five-year birth period for each Area. As seen with all births greater than 27 weeks gestation, term birth for Area 1A were substantially decreased (188 grams) through the 1966-1975 time period and then rebounded by about 332 grams after 1975. Table 10 presents the proportion of low birth weights by birth period. For Area 1A term births, there was a dramatically increased proportion of low birth weight babies for 1971-1975 compared to Area 2 (OR = 5.12; 90% CI = 2.47, 10.64; $p < 0.0001$).

In the multiple regression analysis (Table 11), Area 1 had a statistically significant lower average birth weight for term births (84 grams) than Area 2 during the time period 1971-1975. Area 1A also had a statistically significant lower average birth weight for term births (177 grams) than Area 2 for the time period 1971-1975 only. For the time periods 1961-1965 and 1976-1980, Area 1A had a statistically significant higher average birth weight for term births (114 and 152 grams respectively) than Area 2. The logistic regression analyses also detected a statistically significant association for area of residence (Area 1 and Area 1A) during the 1971-1975 time period.

Table 13 presents the results of the 3-year running average odds ratio analysis for Area 1A versus Area 2 low birth weight, term births. Again, the time periods with statistically significant odds ratios occurred from 1971 through 1976. During this critical time period, the proportion of low birth weights were five to six times higher for Area 1A than Area 2. No low birth weight babies were identified for Area 1A from the 1976-1978 period onward.

DISCUSSION

Low birth weight is a significant determinant of infant mortality and morbidity (NAS, 1985). Fortunately though, there is no evidence to suggest that lower birth weight children are at elevated risk for disease later in life.

After taking into account information on risk factors available on the birth certificate, a lower average birth weight and higher proportion of low birth weights were found in Area 1 compared to Area 2 during the period 1971-1975. It appears that this strong residential association detected for Area 1 was primarily concentrated in the section designated Area 1A. When Area 1A births were removed from the 1971-1975 analysis, the remaining Area 1B birth outcome was similar to the Area 2 "unexposed" experience.

For the five-year time period 1971-1975, the average decrease in birth weight in infants of gestational age greater than 27 weeks for Area 1A relative to Area 2 was 166 grams. For Area 1A term births, babies were on average 177 grams lower in birth weight than Area 2 babies during the critical time period of 1971-1975. This effect is in the range of birth weight reduction found in studies of cigarette smoking during pregnancy (150 grams to 250 grams; see Table 14 for a clinical perspective of this difference). Perhaps the real impact to Area 1A was even greater than the 177 grams decrease in average birth weight since Area 1A had significantly higher average birth weights prior to and after the 1971-1975 time period. The excess risk appeared stronger when only term births were analyzed suggesting a mechanism of growth retardation rather than prematurity. This is important since birth weight, after controlling for gestional age, has been found to be strongly associated with infant survival (Wilcox, 1992).

A serious potential weakness of this study, as well as most environmental studies, is the possibility of exposure misclassification. The critical piece of information required to meaningfully evaluate health data is information on the actual personal exposure to chemicals emanating from the landfill over time; that is, who was exposed and who was not exposed and what was the magnitude of the exposure that did occur. Since personal exposure information did not exist, residential distance from the landfill was used as a surrogate measure for potential past exposure. The results of this study indicate that the original "exposed" population designation of Area 1 was too large and resulted in exposure misclassification, biasing the earlier study and these results toward the null hypothesis of no effect. The smaller residential subdivision of Area 1A, the neighborhood immediately adjacent to the landfill, appears to be the better exposure surrogate, providing the strongest association between residential location and birth weight.

Information on other potential risk factors for low birth weight was not available on the birth certificate and could not be evaluated. These factors include maternal health, cigarette and alcohol consumption during pregnancy, parental occupational information, and parental socioeconomic status. Since these unmeasured risk factors cannot be controlled for in the analysis, incorrect results might have occurred in our study due to an uneven distribution of these other risk factors in the population. However, the consistency of the findings across the different analytic methods lends credence to the validity of the results.

The USEPA has identified numerous chemical contaminants on-site including benzene, bis(2-chloroethyl) ether (BCEE), chloroform, 1,2-dichloroethane, ethylbenzene, 4-methyl-2-pentanone, toluene, total xylenes, and a number of metals (arsenic, chromium, lead, mercury, nickel, and zinc). There are few studies available on the relationship between most of the compounds found at the Lipari Landfill and low birth weight in pregnancy outcomes. Positive associations with low birth weight have been reported for cadmium in animals (Rudolph, 1986; Ali, 1986), cadmium in humans (Frery, 1993), lead in humans (Heinrichs, 1983), benzene in animals (Davis, 1986), and xylene in animals (Mirkova, 1983). Negative results were reported in studies of the relationship between low birth weight and cadmium in humans (Huel, 1984), lead in rats (Winneke, 1983), and xylene in rats (Rosen, 1986). Although there is a lack of toxicity data for many of the compounds found at the landfill, the evidence from the metal and benzene studies provides a reasonable biological plausibility for a potential relationship between exposures to landfill contaminants and low birth weight in the community.

Two occupational studies have identified associations between chemical exposures and low birth weight: working mothers exposed to polychlorinated biphenyls (Taylor, 1989) and paternal exposure to auto body solvents (Daniell, 1988). However, two other studies did not detect an occupational effect on low birth weights: female veterinarians exposed to several known reproductive hazards (Schenker, 1990) and women working in dry cleaning shops (Olsen, 1990).

There have been several other studies where birth weight has been evaluated in proximity to an environmental pollutant. In a study of a community potentially exposed to arsenic from a nearby copper smelter in northern Sweden, investigators found a statistically significant decline in average birth weight of 68 grams (Nordstrom, 1978).

However, investigations of communities living near: a toxic waste site (Ozonoff, 1983), two different lead smelters (McMichael, 1986; Loiacono, 1992), dioxin contaminated soil (Stockbauer, 1988), and a toxic waste landfill (Hertzman, 1987) did not find declines in the birth weight or an elevated prevalence of low birth weight infants. These studies generally had far fewer numbers than did the Lipari study, and thus had less power to detect small differences than did the current study.

Two other studies evaluated communites exposed to environmental pollution using census tract codes as the surrogate measure of exposure. In the first study, industrial pollution from a plant could not be correlated with low birth weights in Monroe County, New York (Bell, 1991). In the second, environmental contamination in the San Francisco Bay area (Shaw, 1992) did not detect differences in census tract average birth weight. These last two studies were far less specific about defining the exposure surrogate (census tract) and likely suffer more from exposure misclassification than the current study.

In summation, the results of this twenty-five year analysis of birth weights near the Lipari Landfill indicate that the population living immediately adjacent (Area 1A) was substantially impacted during the time period 1971-1975.

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TABLES

TABLE 1. LIPARI RISK FACTOR CODES FOR STATISTICAL ANALYSES

Area of residence (exposure):	0 = Unexposed (Area 2) 1 = Exposed (Area 1 and 1A)
Sex of child:	0 = Male 1 = Female
Gestational age:	Weeks
Maternal age:	
- Continuous variable:	Years
- Dichotomous variable:	0 = Aged 19 to 35 1 = Not aged 19 to 35
Maternal education:	
- Continuous variable:	Years
- Dichotomous variable:	0 = 12+ Years of education 1 = Less than 12 years of education
Parity:	0 = First live birth 1 = Not first live birth
Prenatal care:	0 = Greater than or equal to the minimum standard set by the NAS for number of visits and month of pregnancy care begun 1 = Below the standard
Previous Stillbirths:	0 = No previous stillbirths 1 = One or more previous stillbirths

TABLE 2. RACE AND SEX FOR ALL BIRTHS STRATIFIED BY FIVE-YEAR TIME PERIOD, 1961-85

CATEGORY	YEARS	TOTAL	AREA 1	(AREA 1A)*	AREA 2
ELIGIBLE BIRTHS**:	1961-65	2801	583	(172)	2218
	1966-70	2509	540	(120)	1969
	1971-75	2151	485	(90)	1666
	1976-80	2132	434	(81)	1698
	1981-85	1986	423	(91)	1563
RACE:					
NON-WHITE	1961-65	187	9	(0)	178
	1966-70	197	2	(0)	195
	1971-75	234	13	(1)	221
	1976-80	269	1	(0)	262
	1981-85	260	5	(1)	255
WHITE	1961-65	2148	478	(150)	1670
	1966-70	2255	527	(115)	1728
	1971-75	1910	472	(90)	1438
	1976-80	1858	426	(80)	1432
	1981-85	1685	405	(88)	1280
MISSING DATA ***	1961-65	466	96	(22)	370
	1966-70	57	11	(5)	46
	1971-75	7	0	(0)	7
	1976-80	5	1	(0)	4
	1981-85	41	13	(2)	28
SEX (WHITES ONLY):					
MALES	1961-65	1144	253	(84)	891
	1966-70	1139	282	(63)	857
	1971-75	1025	261	(50)	764
	1976-80	960	228	(44)	732
	1981-85	867	218	(43)	649
FEMALES	1961-65	1004	225	(66)	779
	1966-70	1116	245	(52)	871
	1971-75	885	211	(40)	674
	1976-80	898	198	(36)	700
	1981-85	818	187	(45)	631

* Area 1A numbers are also counted in the Area 1 column.

** Singleton births with information on residence, birthweight and with maternal residence in Areas 1 or 2 at time of birth.

*** During part of the time period 1962-1963 information on race was not requested on the NJDOH Vital Statistic birth certificate.

TABLE 3. POTENTIAL RISK FACTORS FOR BIRTH WEIGHT BY FIVE-YEAR PERIODS: WHITE BIRTHS, GESTATIONAL AGE > 27 WEEKS, 1961-85

POTENTIAL RISK FACTOR	AREA 1			AREA 1A			AREA 2		
	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N
MATERNAL AGE (YEARS)									
1961-65	26.2	5.6	477	28.1	4.7	149	26.9	5.8	1660
1966-70	25.7	5.7	518	28.7	5.9	112	26.3	5.8	1701
1971-75	24.6	4.7	446	27.3	4.3	84	25.5	5.2	1369
1976-80	26.0	5.0	417	27.8	4.8	78	25.7	5.0	1401
1981-85	26.2	5.3	399	28.4	4.9	87	26.1	4.9	1256
GESTATIONAL AGE (WEEKS)									
1961-65	39.8	1.5	477	39.7	1.4	149	39.8	1.5	1661
1966-70	40.1	2.0	518	39.9	1.8	112	40.0	2.1	1701
1971-75	40.1	2.5	446	39.6	2.4	84	40.2	2.4	1369
1976-80	40.2	2.3	417	40.1	2.8	78	40.2	2.4	1401
1981-85	40.1	2.4	399	39.6	2.3	87	40.1	2.6	1257
MATERNAL EDUCATION (YEARS)									
1961-65	-	-	-	-	-	-	-	-	-
1966-70	12.2	2.2	298	13.1	2.0	57	12.2	1.8	966
1971-75	12.4	2.1	425	13.8	2.1	79	12.4	2.0	1269
1976-80	13.3	2.1	400	14.3	1.9	76	12.8	2.1	1366
1981-85	12.9	2.2	398	14.2	2.0	86	13.1	2.1	1253
PARITY (NUMBER OF PREGNANCIES)									
1961-65	2.8	1.8	477	2.8	1.3	149	2.9	1.7	1659
1966-70	2.6	1.7	517	2.8	1.6	112	2.7	1.7	1695
1971-75	2.1	1.4	446	2.3	1.1	84	2.4	1.7	1363
1976-80	2.0	1.2	417	2.2	1.1	78	2.0	1.2	1399
1981-85	1.9	1.0	396	1.9	1.0	85	1.9	1.1	1248
% POOR PRENATAL CARE *									
1961-65	-		-	-		-	-		-
1966-70	50.3%		294	46.6%		58	49.9%		940
1971-75	53.4%		416	42.1% **		76	53.8%		1227
1976-80	32.4%		392	23.3% **		73	36.5%		1330
1981-85	24.4%		390	19.3%		83	27.4%		1227

* The method is described in Institute of Medicine, National Academy of Sciences' study on infant death, 1973. The variables are month prenatal care began and number of prenatal visits as reported on the birth certificate. Data for these variables were not available for the earlier time period.

** Statistically significant (p<0.05), Area 1A compared to Area 2.

TABLE 4. AVERAGE BIRTH WEIGHT BY FIVE-YEAR PERIODS:
WHITE BIRTHS, GESTATIONAL AGE > 27 WEEKS, 1961-85

AVERAGE BIRTH WEIGHT BY YEAR	AREA 1			AREA 1A			AREA 2		
	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N
1961-65	3384.5	554.5	477	3474.6	556.9	149	3384.0	554.2	1661
1966-70	3381.8	513.1	518	3409.7	524.5	112	3387.6	527.3	1701
1971-75	3360.4	568.4	446	3287.9	657.5	84	3440.1	545.6	1369
1976-80	3498.7	542.4	417	3600.3	674.9	78	3465.1	540.7	1401
1981-85	3481.5	535.6	399	3586.6	500.2	87	3459.4	576.8	1257

TABLE 5. BIRTH WEIGHT DISTRIBUTIONS BY FIVE-YEAR PERIODS: WHITE BIRTHS, GESTATIONAL AGE > 27 WEEKS, 1961-85

BIRTH WEIGHT DISTRIBUTION BY YEAR	AREA 1 NUMBER (%)	AREA 1A NUMBER (%)	AREA 2 NUMBER (%)
YEAR: 1961-65			
501-1499	4 (0.8)	1 (0.7)	1 (0.1)
1500-1999	3 (0.6)	0 (0.0)	16 (1.0)
2000-2499	18 (3.8)	6 (4.0)	74 (4.5)
2500-2999	85 (17.8)	16 (10.7)	278 (16.7)
3000-4699	364 (76.3)	123 (82.6)	1271 (76.5)
4700 +	3 (0.6)	3 (2.0)	21 (1.3)
	$p < 0.05$ *	$0.10 > p > 0.05$ *	
YEAR: 1966-70			
501-1499	0 (0.0)	0 (0.0)	6 (0.4)
1500-1999	5 (1.0)	1 (0.9)	7 (0.4)
2000-2499	20 (4.0)	5 (4.5)	68 (4.0)
2500-2999	82 (15.9)	16 (14.3)	270 (15.9)
3000-4699	408 (78.8)	89 (79.5)	1338 (78.7)
4700 +	3 (0.6)	1 (0.9)	12 (0.7)
	$p > 0.10$ *	$p > 0.10$ *	
YEAR: 1971-75			
501-1499	2 (0.4)	0 (0.0)	7 (0.5)
1500-1999	11 (2.5)	4 (4.8)	10 (0.7)
2000-2499	15 (3.4)	5 (6.0)	38 (2.8)
2500-2999	68 (15.2)	14 (16.7)	188 (13.7)
3000-4699	346 (77.6)	59 (70.2)	1109 (81.0)
4700 +	4 (0.9)	2 (2.4)	17 (1.2)
	$0.10 > p > 0.05$ *	$p < 0.005$ *	
YEAR: 1976-80			
501-1499	1 (0.2)	1 (1.3)	3 (0.2)
1500-1999	4 (1.0)	1 (1.3)	10 (0.7)
2000-2499	11 (2.6)	1 (1.3)	44 (3.1)
2500-2999	42 (10.1)	4 (5.1)	176 (12.6)
3000-4699	350 (83.9)	66 (84.6)	1150 (82.1)
4700 +	9 (2.2)	5 (6.4)	18 (1.3)
	$p > 0.10$ *	$p < 0.005$ *	
YEAR: 1981-85			
501-1499	1 (0.2)	0 (0.0)	13 (1.0)
1500-1999	4 (1.0)	0 (0.0)	7 (0.6)
2000-2499	11 (2.6)	2 (2.3)	33 (2.6)
2500-2999	42 (10.1)	6 (6.9)	158 (12.7)
3000-4699	350 (83.9)	78 (89.7)	1026 (81.6)
4700 +	9 (2.2)	1 (1.1)	20 (1.6)
	$p > 0.10$ *	$p > 0.10$ *	

* Chi-square test, 5 degrees of freedom. Area 1 or Area 1A compared to Area 2.

TABLE 6. LOW BIRTH WEIGHT PROPORTIONS BY FIVE-YEAR PERIODS: WHITE BIRTHS, GESTATIONAL AGE > 27 WEEKS, 1961-85

LOW BIRTH WEIGHT BY YEAR		AREA 1 NUMBER (%)	AREA 1A NUMBER (%)	AREA 2 NUMBER (%)
YEAR: 1961-65				
<2500 GRAMS:	YES	25 (5.2)	7 (4.7)	91 (5.5)
	NO	452	142	1570
		Odds Ratio = 0.96 90% C.I. = 0.65, 1.49 p > 0.10	Odds Ratio = 0.85 90% C.I. = 0.44, 1.64 p > 0.10	
YEAR: 1966-70				
<2500 GRAMS:	YES	25 (4.8)	6 (5.4)	81 (4.8)
	NO	493	106	1620
		Odds Ratio = 1.13 90% C.I. = 0.56, 2.31 p > 0.10	Odds Ratio = 1.01 90% C.I. = 0.69, 1.49 p > 0.10	
YEAR: 1971-75				
<2500 GRAMS:	YES	28 (6.3)	9 (10.7)	55 (4.0)
	NO	418	75	1314
		Odds Ratio = 1.56 90% C.I. = 1.08, 2.37 p < 0.05 *	Odds Ratio = 2.87 90% C.I. = 1.54, 5.34 p < 0.005 *	
YEAR: 1976-80				
<2500 GRAMS:	YES	16 (3.8)	3 (3.8)	57 (4.1)
	NO	401	75	1344
		Odds Ratio = 0.94 90% C.I. = 0.59, 1.51 p > 0.10	Odds Ratio = 0.95 90% C.I. = 0.35, 2.54 p > 0.10	
YEAR: 1981-85				
<2500 GRAMS:	YES	17 (4.3)	2 (2.3)	53 (4.2)
	NO	382	85	1204
		Odds Ratio = 1.01 90% C.I. = 0.63, 1.61 p > 0.10	Odds Ratio = 0.55 90% C.I. = 0.16, 1.77 p > 0.10	

* Statistically significant p-value. Chi-square test, 1 degree of freedom. Area 1 or Area 1A compared to Area 2.

TABLE 7. MULTIPLE REGRESSION ANALYSIS: WHITE BIRTHS, GESTATIONAL AGE > 27 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1961-85
SUMMARY TABLE OF AREA OF RESIDENCE VARIABLE ONLY

BIRTH YEAR PERIOD	AREA OF RESIDENCE VARIABLE ONLY					
	AREA 1			AREA 1A		
	COEFFICIENT	SE	P-VALUE	COEFFICIENT	SE	P-VALUE
MULTIPLE REGRESSION						
1961-1965	14.5	25.5	0.5712	99.8	42.3	0.0185
1966-1970	-14.9	23.7	0.5316	13.7	46.4	0.7732
1971-1975	-83.3	27.6	0.0026	-166.5	59.0	0.0049
1976-1980	16.3	27.4	0.5524	145.7	57.9	0.0120
1981-1985	-49.8	40.6	0.2205	46.7	81.4	0.5662

TABLE 8a. REGRESSION ANALYSIS: WHITE BIRTHS, GESTATIONAL AGE >27 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1961-65

REGRESSION METHOD AND VARIABLE	AREA 1 COEFFICIENT	AREA 1 SE	AREA 1 P-VALUE	AREA 1A COEFFICIENT	AREA 1A SE	AREA 1A P-VALUE
A. MULTIPLE REGRESSION						
AREA OF RESIDENCE	14.5	25.5	0.5712	99.8	42.3	0.0185
SEX OF CHILD	-148.5	21.3	< 0.0001	-162.4	24.3	< 0.0001
GESTATIONAL AGE	163.7	7.0	< 0.0001	160.4	7.8	< 0.0001
MATERNAL AGE	5.8	1.8	0.0015	-	-	-
PRIMIPARITY	-	-	-	65.5	27.5	0.0161
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-
	R SQUARED = 0.22			R SQUARED = 0.21		
B. LOGISTIC REGRESSION						
AREA OF RESIDENCE	-0.06	0.28	0.8225	-0.20	0.46	0.6639
SEX OF CHILD	-	-	-	-	-	-
GESTATIONAL AGE	0.78	0.06	< 0.0001	0.75	0.06	< 0.0001
MATERNAL AGE	-	-	-	-0.75	0.36	0.0396
PRIMIPARITY	0.46	0.24	0.0603	0.60	0.27	0.0282
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-

TABLE 8b. REGRESSION ANALYSIS: WHITE BIRTHS, GESTATIONAL AGE > 27 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1966-70

REGRESSION METHOD AND VARIABLE	AREA 1			AREA 1A		
	COEFFICIENT	SE	P-VALUE	COEFFICIENT	SE	P-VALUE
A. MULTIPLE REGRESSION						
AREA OF RESIDENCE	-14.9	23.7	0.5316	13.7	46.4	0.7732
SEX OF CHILD	-146.5	20.1	< 0.0001	-151.7	22.3	< 0.0001
GESTATIONAL AGE	103.9	4.9	< 0.0001	105.1	5.5	< 0.0001
MATERNAL AGE	4.2	2.0	0.0348	4.9	2.2	0.0253
PRIMIPARITY	92.5	24.8	0.0002	107.7	27.9	0.0001
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-
	R SQUARED = 0.19			R SQUARED = 0.20		
B. LOGISTIC REGRESSION						
AREA OF RESIDENCE	0.08	0.26	0.7691	0.20	0.48	0.6682
SEX OF CHILD	-	-	-	-	-	-
GESTATIONAL AGE	0.64	0.05	< 0.0001	0.62	0.05	< 0.0001
MATERNAL AGE	-	-	-	-	-	-
PRIMIPARITY	-	-	-	-	-	-
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-

TABLE 8c. REGRESSION ANALYSIS: WHITE BIRTHS, GESTATIONAL AGE > 27 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1971-75

REGRESSION METHOD AND VARIABLE	AREA 1			AREA 1A		
	COEFFICIENT	SE	P-VALUE	COEFFICIENT	SE	P-VALUE
A. MULTIPLE REGRESSION						
AREA OF RESIDENCE	-83.3	27.6	0.0026	-166.5	59.0	0.0049
SEX OF CHILD	-193.3	24.1	< 0.0001	-199.2	27.4	< 0.0001
GESTATIONAL AGE	86.2	5.0	< 0.0001	81.2	5.7	< 0.0001
MATERNAL AGE	-	-	-	-	-	-
PRIMIPARITY	107.4	25.0	< 0.0001	130.0	28.8	< 0.0001
MATERNAL EDUCATION	14.9	5.9	0.0014	18.6	6.8	0.0063
PRENATAL CARE	-71.7	24.2	0.0030	-93.8	27.6	0.0007
PREVIOUS FETAL DEATH	88.9	35.8	0.0131	115.5	40.3	0.0042
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-
	R SQUARED = 0.21			R SQUARED = 0.20		
B. LOGISTIC REGRESSION						
AREA OF RESIDENCE	0.48	0.30	0.0869	1.15	0.45	0.0115
SEX OF CHILD	-	-	-	-	-	-
GESTATIONAL AGE	0.56	0.05	< 0.0001	0.49	0.05	< 0.0001
MATERNAL AGE	-	-	-	-	-	-
PRIMIPARITY	-	-	-	-	-	-
MATERNAL EDUCATION	-	-	-	-0.66	0.37	0.0717
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-

TABLE 8d. REGRESSION ANALYSIS: WHITE BIRTHS, GESTATIONAL AGE > 27 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1976-80

REGRESSION METHOD AND VARIABLE	AREA 1 COEFFICIENT	AREA 1 SE	AREA 1 P-VALUE	AREA 1A COEFFICIENT	AREA 1A SE	AREA 1A P-VALUE
A. MULTIPLE REGRESSION						
AREA OF RESIDENCE	16.3	27.4	0.5524	145.7	57.9	0.0120
SEX OF CHILD	-183.0	22.8	< 0.0001	-170.3	25.6	< 0.0001
GESTATIONAL AGE	83.4	4.9	< 0.0001	84.7	5.4	< 0.0001
MATERNAL AGE	-	-	-	5.9	2.8	0.0394
PRIMIPARITY	155.3	23.1	< 0.0001	127.3	28.5	< 0.0001
MATERNAL EDUCATION	15.6	5.5	0.0044	-	-	-
PRENATAL CARE	-105.1	24.1	< 0.0001	-108.2	28.5	0.0001
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-
	R SQUARED = 0.20			R SQUARED = 0.20		
B. LOGISTIC REGRESSION						
AREA OF RESIDENCE	-0.09	0.36	0.8071	-0.56	1.05	0.5916
SEX OF CHILD	-0.83	0.29	0.0047	-0.83	0.32	0.0098
GESTATIONAL AGE	0.47	0.05	< 0.0001	0.48	0.06	< 0.0001
MATERNAL AGE	-	-	-	-	-	-
PRIMIPARITY	0.59	0.28	0.0369	0.76	0.31	0.0145
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-0.89	0.29	0.0024	-1.1	0.32	0.0004
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-

TABLE 8e. REGRESSION ANALYSIS: WHITE BIRTHS, GESTATIONAL AGE > 27 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1981-85

REGRESSION METHOD AND VARIABLE	AREA 1 COEFFICIENT	AREA 1 SE	AREA 1 P-VALUE	AREA 1A COEFFICIENT	AREA 1A SE	AREA 1A P-VALUE
A. MULTIPLE REGRESSION						
AREA OF RESIDENCE	-49.8	40.6	0.2205	46.7	81.4	0.5662
SEX OF CHILD	-175.5	29.1	< 0.0001	-175.9	28.8	< 0.0001
GESTATIONAL AGE	82.5	5.1	< 0.0001	87.8	5.6	< 0.0001
MATERNAL AGE	-	-	-	-	-	-
PRIMIPARITY	108.2	25.5	< 0.0001	114.9	28.1	< 0.0001
MATERNAL EDUCATION	18.4	6.2	0.0032	17.7	7.0	0.0112
PRENATAL CARE	-77.4	29.2	0.0083	-65.0	32.2	0.0407
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	138.9	59.3	0.0193	223.1	114.6	0.0518
	R SQUARED = 0.18			R SQUARED = 0.20		
B. LOGISTIC REGRESSION						
AREA OF RESIDENCE	0.18	0.32	0.5810	-0.85	0.80	0.2870
SEX OF CHILD	-	-	-	-	-	-
GESTATIONAL AGE	0.53	0.05	< 0.0001	0.56	0.05	< 0.0001
MATERNAL AGE	-	-	-	-	-	-
PRIMIPARITY	0.69	0.29	0.0162	0.76	0.33	0.0226
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-

TABLE 9. AVERAGE BIRTH WEIGHT FOR TERM BIRTHS BY BIRTH PERIOD: WHITE BIRTHS, GESTATIONAL AGE 37-44 WEEKS, 1961-85

AVERAGE BIRTH WEIGHT BY YEAR	AREA 1			AREA 1A			AREA 2		
	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N
1961-65	3425.5	496.8	462	3523.3	501.1	143	3419.5	518.9	1600
1966-70	3424.7	482.2	482	3455.6	487.1	105	3420.1	483.7	1593
1971-75	3410.5	498.0	402	3334.7	618.6	74	3475.3	499.7	1251
1976-80	3548.2	492.7	384	3705.6	560.5	69	3497.3	503.3	1264
1981-85	3522.9	510.4	362	3627.8	469.9	80	3510.5	494.2	1132

TABLE 10. LOW BIRTH WEIGHT PROPORTIONS FOR TERM BIRTHS BY BIRTH PERIOD: WHITE BIRTHS, GESTATIONAL AGE 37-44 WEEKS, 1961-85

LOW BIRTH WEIGHT BY YEAR	AREA 1 NUMBER (%)	AREA 1A NUMBER (%)	AREA 2 NUMBER (%)
YEAR: 1961-65			
<2500 GRAMS: YES	14 (3.0)	3 (2.1)	58 (3.6)
NO	448	140	1542
	Odds Ratio = 0.83 90% C.I. = 0.51, 1.37 p > 0.10	Odds Ratio = 0.57 90% C.I. = 0.21, 1.52 p > 0.10	
YEAR: 1966-70			
<2500 GRAMS: YES	14 (2.9)	4 (3.8)	43 (2.7)
NO	468	101	1550
	Odds Ratio = 1.08 90% C.I. = 0.65, 1.80 p > 0.10	Odds Ratio = 1.43 90% C.I. = 0.59, 3.42 p > 0.10	
YEAR: 1971-75			
<2500 GRAMS: YES	15 (3.7)	7 (9.5)	25 (2.0)
NO	387	67	1226
	Odds Ratio = 1.90 90% C.I. = 1.10, 3.28 p < 0.05 *	Odds Ratio = 5.12 90% C.I. = 2.47, 10.64 p < 0.0001 *	
YEAR: 1976-80			
<2500 GRAMS: YES	6 (1.6)	0 (0.0)	30 (2.4)
NO	378	69	1234
	Odds Ratio = 0.65 90% C.I. = 0.31, 1.37 p > 0.10	p > 0.10	
YEAR: 1981-85			
<2500 GRAMS: YES	9 (2.5)	0 (2.3)	17 (1.5)
NO	353	80	1115
	Odds Ratio = 1.67 90% C.I. = 0.84, 3.61 p > 0.10	p > 0.10	

* Statistically significant p-value. Chi-square test, 1 degree of freedom. Area 1 or Area 1A compared to Area 2.

TABLE 11. MULTIPLE REGRESSION ANALYSIS: WHITE TERM BIRTHS, GESTATIONAL AGE 37-44 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1961-85
SUMMARY TABLE OF AREA OF RESIDENCE VARIABLE ONLY

	AREA OF RESIDENCE VARIABLE ONLY					
	AREA 1			AREA 1A		
BIRTH YEAR PERIOD	COEFFICIENT	SE	P-VALUE	COEFFICIENT	SE	P-VALUE
MULTIPLE REGRESSION						
1961-1965	19.8	25.9	0.4445	113.9	43.1	0.0083
1966-1970	-4.2	23.5	0.8587	22.7	45.6	0.6193
1971-1975	-84.0	27.6	0.0024	-177.0	59.8	0.0032
1976-1980	31.2	27.8	0.2611	151.8	59.2	0.0105
1981-1985	-64.0	40.7	0.1123	23.0	79.3	0.7719

TABLE 12a. REGRESSION ANALYSIS: WHITE TERM BIRTHS, GESTATIONAL AGE 37-44 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1961-65

REGRESSION METHOD AND VARIABLE	AREA 1			AREA 1A		
	COEFFICIENT	SE	P-VALUE	COEFFICIENT	SE	P-VALUE
A. MULTIPLE REGRESSION						
AREA OF RESIDENCE	19.8	25.9	0.4445	113.9	43.1	0.0083
SEX OF CHILD	-148.4	21.6	< 0.0001	-156.0	23.7	< 0.0001
GESTATIONAL AGE	142.8	11.1	< 0.0001	141.7	12.1	< 0.0001
MATERNAL AGE	6.0	1.9	0.0015	-	-	-
PRIMIPARITY	-	-	-	61.6	28.1	0.0285
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-
	R SQUARED = 0.10			R SQUARED = 0.10		
B. LOGISTIC REGRESSION						
AREA OF RESIDENCE	-0.21	0.31	0.4490	-0.56	0.61	0.3546
SEX OF CHILD	-	-	-	-	-	-
GESTATIONAL AGE	0.82	0.10	< 0.0001	0.77	0.11	< 0.0001
MATERNAL AGE	-0.75	0.39	0.0549	-0.88	0.40	0.0270
PRIMIPARITY	0.69	0.27	0.0106	0.71	0.30	0.0163
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-

TABLE 12b. REGRESSION ANALYSIS: WHITE TERM BIRTHS, GESTATIONAL AGE 37-44 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1966-70

REGRESSION METHOD AND VARIABLE	AREA 1 COEFFICIENT	AREA 1 SE	AREA 1 P-VALUE	AREA 1A COEFFICIENT	AREA 1A SE	AREA 1A P-VALUE
A. MULTIPLE REGRESSION						
AREA OF RESIDENCE	-4.2	23.5	0.8587	22.7	45.6	0.6193
SEX OF CHILD	-146.0	19.9	< 0.0001	-151.4	21.9	< 0.0001
GESTATIONAL AGE	104.8	7.1	< 0.0001	105.1	7.9	< 0.0001
MATERNAL AGE	4.1	2.0	0.0398	4.0	2.2	0.0632
PRIMIPARITY	108.5	24.4	< 0.0001	128.6	27.4	< 0.0001
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-
	R SQUARED = 0.13			R SQUARED = 0.13		
B. LOGISTIC REGRESSION						
AREA OF RESIDENCE	0.12	0.32	0.7154	0.39	0.54	0.4640
SEX OF CHILD	-	-	-	-	-	-
GESTATIONAL AGE	0.60	0.10	< 0.0001	0.56	0.11	< 0.0001
MATERNAL AGE	-	-	-	-	-	-
PRIMIPARITY	-	-	-	0.53	0.31	0.0856
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-

TABLE 12c. REGRESSION ANALYSIS: WHITE TERM BIRTHS, GESTATIONAL AGE 37-44 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1971-75

REGRESSION METHOD AND VARIABLE	AREA 1 COEFFICIENT	AREA 1 SE	AREA 1 P-VALUE	AREA 1A COEFFICIENT	AREA 1A SE	AREA 1A P-VALUE
A. MULTIPLE REGRESSION						
AREA OF RESIDENCE	-84.0	27.6	0.0024	-177.0	59.8	0.0032
SEX OF CHILD	-204.7	24.1	< 0.0001	-208.6	27.4	< 0.0001
GESTATIONAL AGE	95.3	7.4	< 0.0001	93.2	8.4	< 0.0001
MATERNAL AGE	-	-	-	5.6	3.2	0.0820
PRIMIPARITY	111.2	25.1	< 0.0001	108.1	32.7	0.0010
MATERNAL EDUCATION	13.5	5.9	0.0230	13.8	7.0	0.0492
PRENATAL CARE	-56.6	24.1	0.0190	-76.1	27.6	0.0058
PREVIOUS FETAL DEATH	103.4	35.9	0.0040	109.5	40.7	0.0073
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-
	R SQUARED = 0.16			R SQUARED = 0.16		
B. LOGISTIC REGRESSION						
AREA OF RESIDENCE	0.71	0.35	0.0435	1.53	0.49	0.0018
SEX OF CHILD	-	-	-	-	-	-
GESTATIONAL AGE	0.53	0.11	< 0.0001	0.42	0.13	0.0009
MATERNAL AGE	-	-	-	-	-	-
PRIMIPARITY	-	-	-	-	-	-
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-

TABLE 12d. REGRESSION ANALYSIS: WHITE TERM BIRTHS, GESTATIONAL AGE 37-44 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1976-80

REGRESSION METHOD AND VARIABLE	AREA 1			AREA 1A		
	COEFFICIENT	SE	P-VALUE	COEFFICIENT	SE	P-VALUE
A. MULTIPLE REGRESSION						
AREA OF RESIDENCE	31.2	27.8	0.2611	151.8	59.2	0.0105
SEX OF CHILD	-189.6	23.3	< 0.0001	-175.9	26.3	< 0.0001
GESTATIONAL AGE	88.6	7.2	< 0.0001	91.9	8.1	< 0.0001
MATERNAL AGE	5.2	2.8	0.0621	7.7	2.9	0.0085
PRIMIPARITY	105.7	26.4	< 0.0001	111.4	29.5	0.0002
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-72.7	25.0	0.0498	-73.9	28.0	0.0085
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-
	R SQUARED = 0.15			R SQUARED = 0.15		
B. LOGISTIC REGRESSION						
AREA OF RESIDENCE	-0.29	0.47	0.5277	-5.71	18.70	0.7601
SEX OF CHILD	-1.21	0.40	0.0024	-1.15	0.43	0.0077
GESTATIONAL AGE	0.71	0.13	< 0.0001	0.69	0.14	< 0.0001
MATERNAL AGE	-	-	-	-	-	-
PRIMIPARITY	0.70	0.36	0.0484	0.93	040	0.0197
MATERNAL EDUCATION	-	-	-	-	-	-
PRENATAL CARE	-1.06	0.36	0.0031	-1.29	0.41	0.0016
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-

TABLE 12e. REGRESSION ANALYSIS: WHITE TERM BIRTHS, GESTATIONAL AGE 37-44 WEEKS, AREA 1 AND AREA 1A COMPARED TO AREA 2, 1981-85

REGRESSION METHOD AND VARIABLE	AREA 1			AREA 1A		
	COEFFICIENT	SE	P-VALUE	COEFFICIENT	SE	P-VALUE
A. MULTIPLE REGRESSION						
AREA OF RESIDENCE	-64.0	40.7	0.1123	23.0	79.3	0.7719
SEX OF CHILD	-181.9	28.7	< 0.0001	-181.3	28.1	< 0.0001
GESTATIONAL AGE	79.0	7.8	< 0.0001	83.3	8.5	< 0.0001
MATERNAL AGE	-	-	-	-	-	-
PRIMIPARITY	83.9	25.1	0.0009	93.0	27.3	0.0007
MATERNAL EDUCATION	-82.7	37.6	0.0281	-	-	-
PRENATAL CARE	-58.3	29.1	0.0458	-66.1	31.2	0.0340
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	154.1	58.2	0.0082	223.3	109.6	0.0418
	R SQUARED = 0.10			R SQUARED = 0.12		
B. LOGISTIC REGRESSION						
AREA OF RESIDENCE	0.49	0.42	0.2422	-5.90	17.92	0.7420
SEX OF CHILD	-	-	-	-	-	-
GESTATIONAL AGE	0.51	0.14	0.0002	0.48	0.17	0.0039
MATERNAL AGE	-	-	-	-	-	-
PRIMIPARITY	-	-	-	-	-	-
MATERNAL EDUCATION	-0.85	0.45	0.0632	-1.05	0.55	0.0551
PRENATAL CARE	-	-	-	-	-	-
PREVIOUS FETAL DEATH	-	-	-	-	-	-
AREA AND SEX (INTERACTION TERM)	-	-	-	-	-	-

TABLE 13. LOW BIRTHWEIGHT (<2500 GMS) FOR TERM BIRTHS BY 3-YEAR RUNNING AVERAGES: WHITE BIRTHS, GESTATIONAL AGE 37-44 WEEKS, 1961-85

3-YEAR PERIOD	AREA 1A YES	AREA 1A NO	AREA 2 YES	AREA 2 NO	ODDS RATIO	90% CONFIDENCE INTERVAL	P-VALUE
	|------LOW BIRTH WEIGHT-------|						
1961-63	1	83	37	876	0.285	0.054-1.519	> 0.10
1962-64	1	80	35	781	0.279	0.052-1.488	> 0.10
1963-65	2	66	33	832	0.764	0.222-2.569	> 0.10
1964-66	3	70	31	972	1.344	0.488-3.697	> 0.10
1965-67	3	65	29	956	1.521	0.551-4.205	> 0.10
1966-68	3	58	21	892	2.197	0.779-6.193	> 0.10
1967-69	2	64	23	892	1.212	0.355-4.136	> 0.10
1968-70	2	59	26	935	1.219	0.359-4.143	> 0.10
1969-71	2	57	29	962	1.164	0.344-3.941	> 0.10
1970-72	3	52	19	909	2.760	0.970-7.851	> 0.10
1971-73	3	35	16	778	4.168	1.430-12.151	< 0.05
1972-74	4	34	14	704	5.916	2.235-15.659	< 0.001
1973-75	5	39	16	669	5.361	2.218-12.958	< 0.001
1974-76	4	39	13	669	5.278	1.989-14.005	< 0.005
1975-77	2	41	15	678	2.205	0.624-7.792	> 0.10
1976-78	0	42	20	715	0	-	> 0.10
1977-79	0	43	21	752	0	-	> 0.10
1978-80	0	47	19	774	0	-	> 0.10
1979-81	0	46	13	759	0	-	> 0.10
1980-82	0	57	8	707	0	-	> 0.10
1981-83	0	52	6	674	0	-	> 0.10
1982-84	0	51	10	653	0	-	> 0.10
1983-85	0	42	14	669	0	-	> 0.10

TABLE 14. COMPARISON OF EFFECTS OF LIFESTYLE ON BIRTH WEIGHT TO PRESENT FINDINGS (1)

LIFESTYLE FACTOR DURING PREGNANCY	CHANGE IN BIRTH WEIGHT	
Cigarette smoking	-150 to -250 grams	(5.3-8.8 oz.)
Lipari findings for term births 1971-1975 Area 1A	-177 grams	(6.2 oz.)
Marijuana use 2-3 times/week	-127 grams	(4.5 oz.)
Caffeine consumption of over 300 mg/day	-105 grams	(3.7 oz.)
Community exposure to nearby copper smelter in Sweden	- 68 grams	(2.4 oz.)
Caffeine consumption of 151-300 mg/day	- 31 grams	(1.1 oz.)
Caffeine consumption of 1-150 mg/day	- 6 grams	(0.2 oz.)
Medically supervised lifestyle change: supplementation of maternal diet due to mild to moderate malnutrition during pregnancy	+40 to +80 grams	(1.4-2.8 oz.)

(1) see Kline, 1987; Martin, 1987; Nordstrom, 1978; Susser, 1984.

FIGURES

Figure 1. Lipari Landfill Birthweight Study Area

Part of Gloucester County, N.J.

FIGURE 2

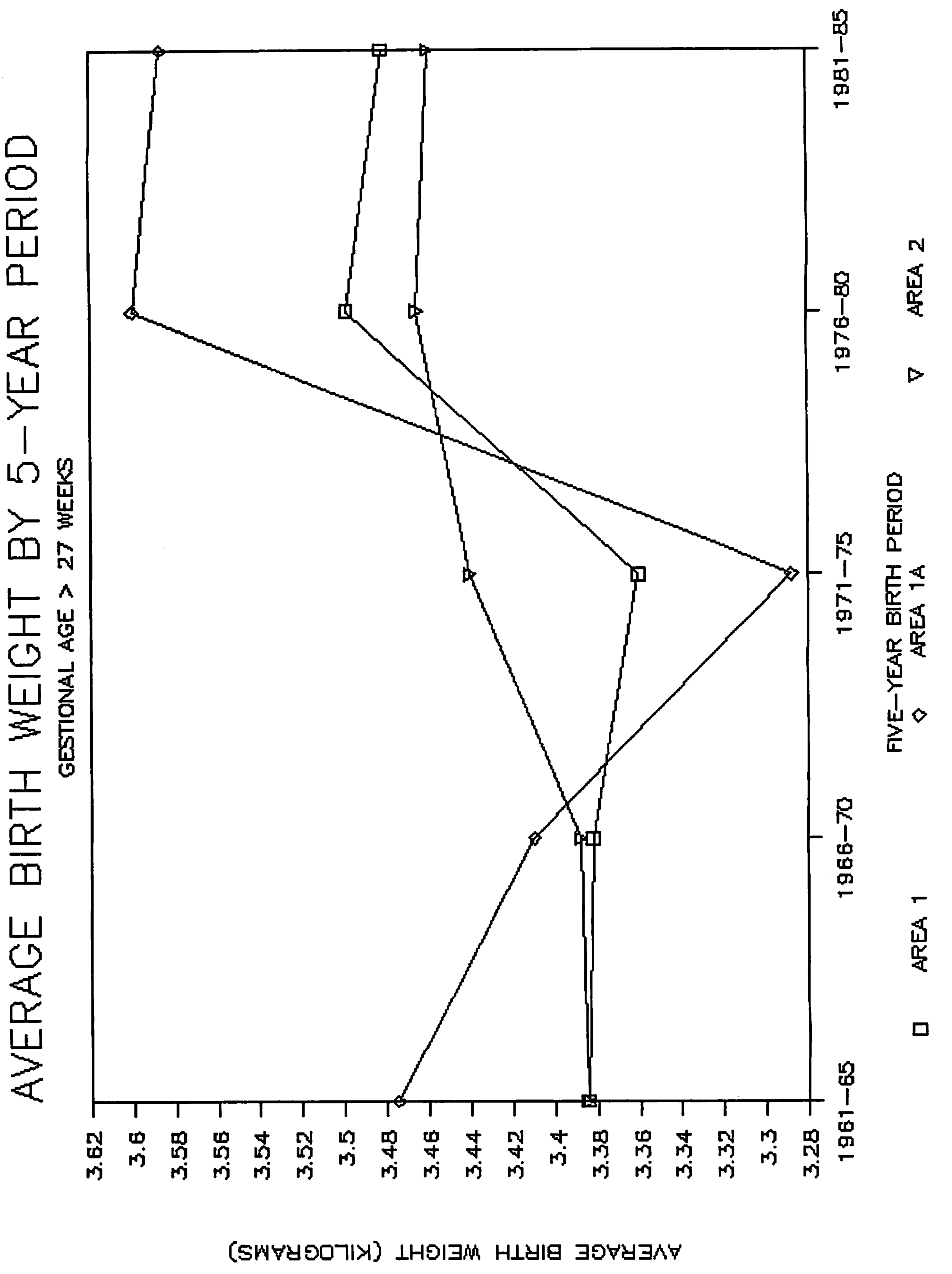
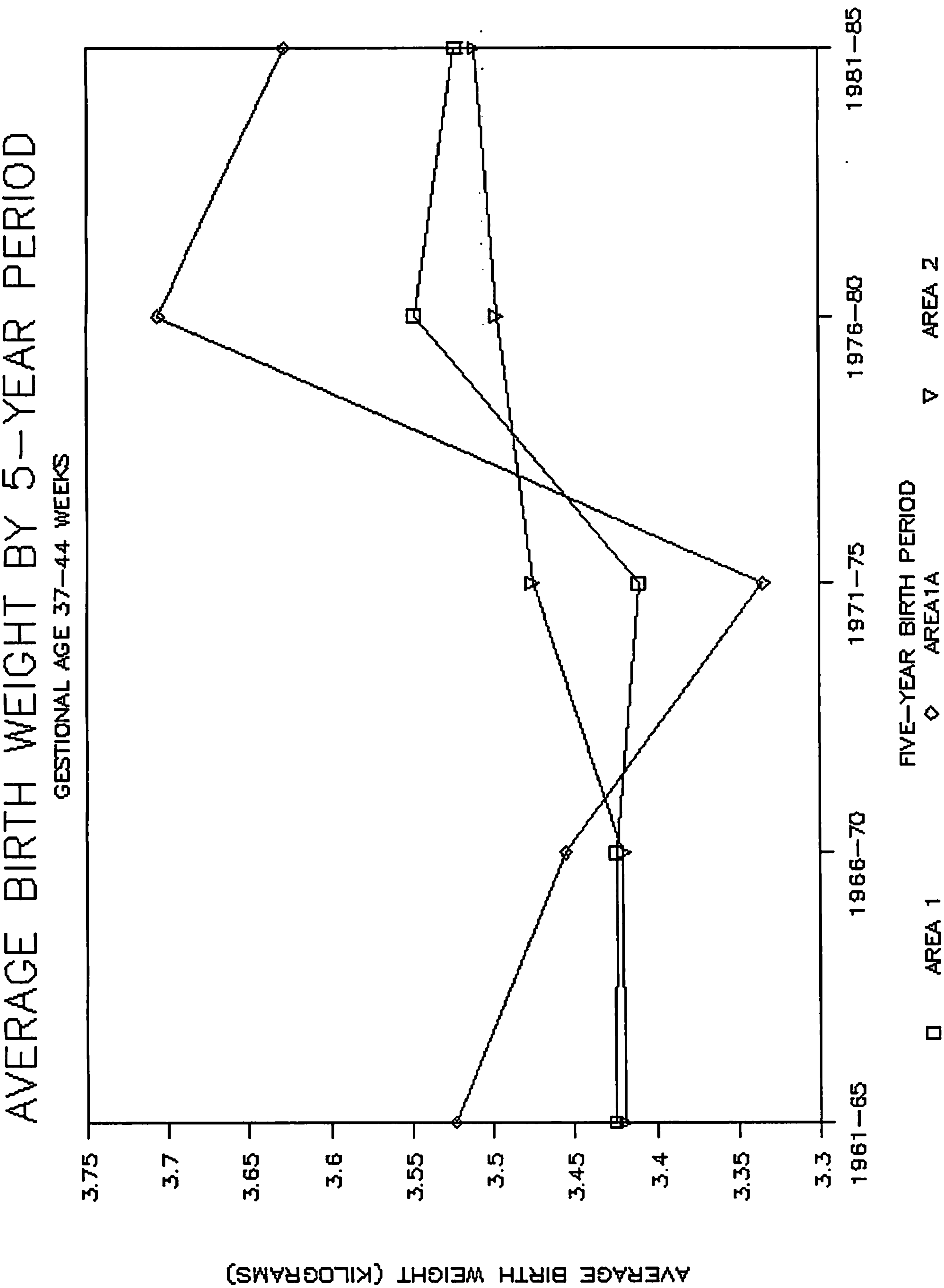

AVERAGE BIRTH WEIGHT BY 5—YEAR PERIOD
GESTIONAL AGE > 27 WEEKS
AVERAGE BIRTH WEIGHT (KILOGRAMS)
3.62
3.6
3.58
3.56
3.54
3.52
3.5
3.48
3.46
3.44
3.42
3.4
3.38
3.36
3.34
3.32
3.3
3.28
1961—65
1966—70
1971—75
1976—80
1981—85
FIVE—YEAR BIRTH PERIOD
AREA 1
AREA 1A
AREA 2

FIGURE 3



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