

Parental occupation and birth outcome in an agricultural community

By David A Schwartz, MD, MPH,^{1,2} Linda A Newsum, MSW,^{1,3} Ruth Markowitz Heifetz, MD, MPH^{1,4}

SCHWARTZ DA, NEWSUM LA, MARKOWITZ HEIFETZ R. Parental occupation and birth outcome in an agricultural community. *Scand J Work Environ Health* 12 (1986) 51–54. The general birth outcome and prevalence of specific birth defects was investigated within an agricultural community through the review of birth records in a major hospital in Imperial County, California. Of all singleton births (N = 2 463) occurring within a four-year period, 990 or 40.2 % involved offspring with one or both parent(s) who were agricultural workers. The progeny of agricultural and nonagricultural workers were similar with regard to sex ratios, prevalence of low birth-weight infants, stillbirth rate, minor and major malformation rates, and prevalence of neonatal deaths. Limb reduction defects, however, occurred more frequently among offspring of agricultural workers (5.05 per 1 000 total births versus 2.19 per 1 000 total births, rate ratio = 2.3). Furthermore, the prevalence of limb reduction defects among agricultural workers was 3- to 14-fold higher than available United States rates (0.36–1.65 per 1 000 total births). Findings from our study suggest that agricultural communities and, in particular, agricultural workers may be at excess risk of producing a child with a limb reduction defect.

Key terms: agricultural workers, congenital malformations, limb reduction defects.

Although congenital malformations are a frequent event (affecting 5 to 7 % of all births), their etiology remains obscure in over 65 % of the cases (20). Birth defects, however, represent only a fraction of the possible fetotoxic outcomes. Other adverse outcomes include fetal loss, stillbirth, decreased birth weight, change in the sex ratio, neonatal morbidity and mortality, childhood malignancies, and postgestational developmental problems (13). The identification of gestational exposures that adversely alter birth outcome requires an examination of all possible fetotoxic effects with particular emphasis on the dose-response relationship and the period of vulnerability (17).

Because of the increasing dependence of modern agriculture on synthetic chemicals (insecticides and fertilizers) and the subsequent exposure of agricultural workers to these agents, we felt that it would be important to explore a range of adverse birth outcomes within an agricultural community. This investigation was accomplished with a cross-sectional study design.

Methods

Study population and data collection

This study was conducted at Pioneer's Hospital in Brawley, California. The hospital is one of the three major facilities in Imperial County and cares for a representative sample of residents in this agricultural community.

Our cross-sectional investigation was conducted through a retrospective review of all births occurring at Pioneer's Hospital between 1 January 1975 and 31 December 1978. It was accomplished by a detailed review of both the mother's and baby's charts. The total number of births (live and stillborn) during this study period was 2 523. There were nine unretrievable cases. Of the 2 514 mother-baby pairs reviewed, 2 463 resulted in singleton births. Approximately one-third of all singleton births in Imperial County were reviewed in this survey.

The chart review was carried out by two of the investigators (DS and LN). For each birth, both the mother's and baby's charts were reviewed. It was unusual for the mother's chart not to have a copy of the prenatal record. Information obtained from the mother's chart included maternal and paternal demographic characteristics (age, ethnicity, residence, and occupation), previous maternal medical and obstetrical history, and current gestational history. Information concerning delivery and infant characteristics was obtained from the baby's chart. Malformations were recorded only if noted on the chart by the baby's pediatrician. In all cases, maternal and paternal demographic characteristics were recorded without knowledge of birth outcome.

¹ California Public Interest Research Group, San Diego, California, and the Department of Community Medicine, University of California, San Diego, California, United States.

² Currently: Robert Wood Johnson Clinical Scholars Program, University of Washington, Seattle, Washington, United States.

³ Currently: California Public Interest Research Group, San Diego, California, United States.

⁴ Currently: Department of Community and Family Medicine, University of California, San Diego, California, United States.

Table 1. Categorization of maternal, paternal, and parental^a occupation (total number of subjects 2 463).

Occupation	Maternal ^b	Paternal ^b	Parental ^{a, b}
Agricultural			
Farm owner	1	21	.
Farm manager	—	26	.
Farm laborer	83	893	.
Pesticide applicator	—	20	.
Total	84 (3.4)	960 (39.0)	990 (40.2)
Nonagricultural			
Professional/technical	67	147	.
Managerial	8	77	.
Clerical/sales	102	85	.
Craftsman	11	238	.
Operative	4	70	.
Service	93	304	.
Laborer	5	181	.
Student	104	60	.
Homemaker	1 683	1	.
Unemployed	174	152	.
Total	2 251 (91.4)	1 315 (53.4)	1 365 (55.4)
Unknown			
Total	128 (5.2)	188 (7.6)	108 (4.4)

^a This parental category was created by recording an agricultural occupation if either or both the mother and father were involved in agriculture, recording a nonagricultural occupation if neither parent was involved in agricultural work and recording an unknown occupation if the occupation of both parents was unknown.

^b Percentage of the total number of subjects in parentheses.

Description of data

The distribution of maternal and infant characteristics for all singleton births (N = 2 463) was compared within categories of parental occupation. Parental occupation was categorized into three divisions — agricultural (either or both parent(s) involved in an agricultural occupation), nonagricultural (neither parent involved in an agricultural occupation), and unknown (occupation of both parents not known). An occupational history was obtained on at least one of the parents in 95.6 % of the cases. The agricultural subgroup accounted for 990 births or 40.2 % of all singleton births (table 1). Malformations were classified according to severity (minor and major) and type as outlined in the classification scheme developed for the Birth Defect Monitoring Program at the Centers for Disease Control (3). All cases of limb reduction defects were confirmed by a review of the perinatal radiographs. Malformation-specific rate ratios (RR) are presented for comparison of the agricultural to nonagricultural occupational groups.

Results

The demographic and medical characteristics of the women participating in this study are presented in table 2. The agricultural parents tended more often to be older, to have a Spanish surname, to reside in a rural part of the county, and to receive public-supported prenatal care. The personal maternal habits and medical histories were similar between the two occupational

Table 2. Percentages of demographic characteristics, maternal habits, and maternal medical history categorized by parental occupation.

	Parental occupation		
	Agricultural (N = 990)	Nonagricultural (N = 1 365)	Unknown (N = 108)
Demographic characteristics			
Maternal age ≥ 35 years	10.0	5.1	1.9
Paternal age ≥ 35 years	19.4	10.5	8.3
Spanish surname	84.0	63.9	47.2
Rural residence	30.6	20.3	14.8
No prenatal care	4.1	2.7	7.4
Public-supported prenatal care	54.0	29.2	10.2
Habits			
Smoked ≥ 1 cigarettes per day at delivery	3.7	4.2	0.9
Alcohol in first trimester (any)	1.7	2.3	0.9
≥ 2 medications during pregnancy	13.1	13.8	8.3
Medical history			
Diabetes mellitus	1.5	1.3	0.9
Irregular menses	6.6	8.1	7.4
Fertility problems	0.4	0.3	0.0
Gravidity > 1	69.9	58.5	34.3
Parity > 1	42.4	25.3	15.7
Previous miscarriage(s)	16.2	11.4	10.2
Previous induced abortion(s)	1.7	3.4	0.9
Previous stillbirth(s)	2.5	1.0	0.0
Previous child with birth defect	1.7	0.3	0.0

subgroups except that pregnant women with an agricultural background were more often multiparous and reported more previous miscarriages, stillbirths, and children with birth defects.

Pregnancy events, delivery characteristics, and infant outcomes are reported in table 3. The agricultural and nonagricultural groups displayed similar rates of adverse birth-related events. The progeny of both occupational groups was similar with regard to sex ratio, prevalence of low birth-weight infants, stillbirth rate, minor and major malformation rates, and prevalence of neonatal deaths.

Specific malformations categorized by parental occupation are presented in table 4. The prevalence of all major birth defects was similar between the agricultural (36.5/1 000 live births) and nonagricultural (34.7/1 000 live births) offspring and was consistent with rates observed in the Birth Defect Monitoring Program (3) and the Collaborative Perinatal Project (9). With the exception of limb reduction defects, the prevalence of specific malformations was also similar between the progeny of agricultural and nonagricultural parents, and these malformation-specific rates were consistent with observed rates in the national defect monitoring programs.

Limb reduction defects were observed to occur more frequently among the offspring of agricultural workers (RR = 2.3) and at rates that were in excess of nationally established norms. Although five of eight children with limb reduction defects had at least one

Table 3. Percentages of pregnancy events, delivery characteristics, and infant outcomes categorized by parental occupation.

	Parental occupation		
	Agricultural (N = 986)	Nonagricultural (N = 1 354)	Unknown (N = 103)
Pregnancy events			
Bleeding			
First trimester	1.4	2.5	0.0
Second trimester	1.8	1.3	1.0
Third trimester	1.5	1.5	0.0
Delivery characteristics			
Fetal distress	4.6	4.6	3.9
Breech presentation	3.3	2.1	6.8
Caesarian section	13.7	14.5	18.4
Infant outcomes			
Male infant	51.3	50.6	51.5
1-minute APGAR ^a			
score < 6	11.8	9.5	13.6
Birth weight < 2 500 g	2.4	3.8	8.7
Gestation < 37 weeks	4.1	4.1	12.6
Stillbirth	0.4	0.8	4.9
Minor malformations	5.9	5.3	4.9
Major malformations	3.7	3.5	2.9
Neonatal death	0.9	0.5	0.9

^a The APGAR score is based on the assessment of the heart rate, respiratory effort, muscle tone, reflex irritability, and color and ranges from a low of 0 to a high of 10.

parent involved in agriculture, only three of these children had an agricultural worker for a mother. The Birth Defect Monitoring Program reported United States rates of limb reduction defects to be 0.36/1 000 total births for the year 1979 (3) and the Collaborative Perinatal Project observed a rate of 1.65/1 000 total births (9). In our study, agricultural workers were found to have children with limb reduction deformities at a rate of 5.07/1 000 live births or 5.05/1 000 total births, while the rate observed among the progeny of nonagricultural workers was 2.22/1 000 live births or 2.19/1 000 total births. Differences in case ascertainment confound a direct comparison between our findings and reported national rates.

To assess confounding, we compared parental characteristics of progeny born with limb reduction defects to those born without this malformation. Parents of children born with limb reduction defects were more often found to be engaged in an agriculture-related occupation and either not receive prenatal care or receive public-supported prenatal care. Other characteristics found to be associated with parental involvement in agriculture (table 2), such as older parental age, Spanish surname, rural residence, and multiparity, were not seen more frequently among parents with offspring having limb reduction defects.

Discussion

Findings from our study suggest that agricultural communities and, in particular, agricultural workers may be at excess risk of producing a child with a limb reduction defect.

Table 4. Prevalence^a of specific malformations by parental occupation.

	Agricultural (N = 986)	Nonagricultural (N = 1 354)	RR ^b
Central nervous system			
Anencephaly	0.0	0.7	..
Spina bifida	0.0	0.7	..
Hydrocephalus	0.0	1.5	..
Microcephaly	1.0	1.5	0.7
Craniofacial			
Cleft palate	1.0	0.0	..
Anotia	0.0	0.7	..
Cardiovascular			
Ventricular septal defect	2.0	3.0	0.7
Patent ductus arteriosus	2.0	3.0	0.7
Multiple defects	2.0	1.5	1.3
Gastrointestinal			
Tracheoesophageal atresias	1.0	0.0	..
Small bowel atresias	1.0	0.0	..
Genitourinary			
Hypospadias	4.0	5.9	0.7
Kidney dysplasia	1.0	0.0	..
Musculoskeletal			
Clubfoot	3.0	3.0	1.0
Reduction deformity	5.1	2.2	2.3
Polydactyly	3.0	0.0	..
Syndactyly	0.0	0.7	..
Other skeletal	0.0	1.5	..
Dislocated hips	1.0	1.5	0.7
Chromosomal			
Down syndrome	2.0	3.0	0.7
Trisomy 18	1.0	0.0	..
Multiple malformations			
Total cases	6.1	4.4	1.4
Total major malformations	36.5	34.7	1.1

^a Cases per 1 000 live births, hypospadias for males only.

^b Rate ratios (agricultural/nonagricultural malformation rates).

If this conclusion is valid, several distinguishing features that could be responsible exist within this community and among agricultural workers. Imperial County is largely a desert habitat that has been converted to agriculturally productive land through the use of intensive irrigation, fertilization, and the utilization of insecticides. In 1976 this county ranked first in the state of California for the use of restricted insecticides (over 60 000 kg), primarily organophosphates, carbamates, and chlorophenoxy herbicides (4). Pesticide residues have been found in human fetal tissue (5), and, if administered in sufficiently high doses, all three classes of these insecticides have been shown to cause skeletal anomalies in laboratory animals (2, 12, 18, 19). Although several human case reports assert a causal connection between gestational insecticide exposure and congenital malformations (7, 14, 15), previous human studies have failed to confirm this association conclusively (1, 6, 8, 10, 16). Moreover, unique environmental exposures, such as organic fertilizers, specific pollens, imported water supply, and extreme climatic conditions, may individually or collectively be responsible for the observed excess number of limb re-

duction defects. Lastly, several factors unrelated to occupation distinguish farm workers from their nonagricultural counterparts. Prior use of birth control pills was unfortunately not recorded in our review and may be acting as a true confounder (11). In our study, parents with an agricultural background tended more often to be older, to be of Spanish descent, to live in a rural part of the county, and to make more use of public-supported prenatal care. Furthermore, pregnant women with an agricultural background were more often multiparous and reported more previous miscarriages, stillbirths, and children with birth defects. Of these parental characteristics, only public-supported prenatal care was associated with limb reduction defects. Thus, in addition to occupational and environmental exposures, medical and economic factors may explain the observed excess of limb reduction defects within this agricultural community and among agricultural workers.

Several problems exist within the design of this study. As with all cross-sectional studies, it is difficult to explore a temporal relationship between exposure (parental occupation) and disease (birth outcome). The size of our sample and the small absolute number of limb reduction defects ($N = 8$) limited the application of a meaningful statistical analysis. Furthermore, the large number of outcome variables examined raises the possibility that the excess of limb reduction defects within this population is nothing more than a chance observation. Observer bias was not a problem in this study since the parental occupations were recorded prior to knowledge of birth outcome and the observed excess outcome (ie, limb reduction defects) was confirmed by a review of the perinatal radiographs.

No definite conclusions can be drawn from this study. The observed excess of limb reduction defects may or may not be generalizable to other agricultural communities. Even if these differences are applicable to other farming communities, factors other than occupational involvement in agriculture may be responsible for their occurrence. Our results, however, support the need for further investigation of this association.

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References

1. American Association for the Advancement of Science. Herbicide assessment report. Congr rec 118 (1972) 6806—6813.
2. Bage G, Cekanova E, Larsson KS. Teratogenic and embryotoxic effects of the herbicides di- and trichlorophenoxyacetic acids (2,4-D and 2,4,5-T). *Acta Pharmacol Toxicol* 32 (1973) 408—416.
3. Centers for Disease Control. Congenital malformations surveillance report. Atlanta, GA 1979.
4. Department of Food and Agriculture. Report on environmental assessment of pesticide regulatory programs: Imperial County component. Sacramento, CA 1978.
5. D'Ercole AJ, Arthur RD, Cain JD, Barrentine BF. Insecticide exposure of mothers and newborn in a rural agricultural area. *Pediatrics* 57 (1976) 869—874.
6. Gordon JE, Shy CM. Agricultural chemical use and congenital cleft lip and/or palate. *Arch Environ Health* 36 (1981) 213—221.
7. Hall JG, McLaughlin JF, Stamm S. Coarctation of the aorta in male cousins with similar maternal environmental exposure to insect repellent and insecticides. *Pediatrics* 55 (1975) 425—427.
8. Hemminki K, Mutanen P, Luoma K, Saloniemi I. Congenital malformations by the parental occupation in Finland. *Int Arch Occup Environ Health* 46 (1980) 93—98.
9. Heinonen OP, Slone D, Shapiro S. Birth defects and drugs in pregnancy. Publishing Sciences Group, Littleton, MA 1977.
10. Hunt VR. Reproductive toxicology. Presented at the Conference on Pesticides and Human Health, Washington, DC 1978.
11. Janerich DT, Piper JM, Glebatis DM. Oral contraceptives and congenital limb-reduction defects. *N Engl J Med* 291 (1974) 697—700.
12. Larsson KS, Arnander C, Cekanova E, Kjellberg M. Studies of teratogenic effects of the dithiocarbamates maneb, mancozeb and propineb. *Teratology* 14 (1976) 171—183.
13. Levin SM. Problems and pitfalls in conducting epidemiological research in the area of reproductive toxicology. *Am J Ind Med* 4 (1983) 349—364.
14. Matthies F. The triad of anotia, facial paralysis, and cardiac anomaly not due to thalidomide. *J Am Med Assoc* 195 (1966) 695—696.
15. Rasche-Gonzales E. Teratogen may be implicated in lethal congenital syndrome. *J Am Med Assoc* 242 (1979) 1119—1120.
16. Roan CC, Matanoski GE, McInay CQ, Olds KL, Py-lant F, Trout JR, Wheeler P, Morgan DP. Spontaneous abortions, stillbirths and birth defects in families of agricultural pilots. *Arch Environ Health* 39 (1984) 56—60.
17. Selevan SG. Design considerations in pregnancy outcome studies of occupational populations. *Scand J Work Environ Health* 7 (1981): suppl 4, 76—82.
18. Staples RE, Kellan RG, Haseman JK. Developmental toxicity in the rat after ingestion or gavage of organophosphate pesticides during pregnancy. *Environ Health Perspect* 13 (1976) 133—140.
19. Weis P, Weis JS. Abnormal locomotion associated with skeletal malformations in the Sheepshead Minnow, *Cyprinodon variegatus*, exposed to malathion. *Environ Res* 12 (1976) 196—200.
20. Wilson JG. Environmental chemicals. In: Wilson JG, Fraser FC, ed. Handbook of teratology. Volume 1. Plenum Press, New York and London 1977, pp 304—355.

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