BIRTH DEFECTS IN A COMMUNITY LOCATED NEAR A VINYL CHLORIDE PLANT

The mutagenic capacity of vinyl chloride monomer and its metabolites has been confirmed in vitro within recent months (1-4). The presence of chromosomal aberrations at abnormally high levels in the lymphocytes of vinyl chloride monomer workers has also been reported (5-7).

Studies showing the presence of birth defects in humans following exposure to vinyl chloride monomer are, however, much less convincing. The rate of fetal mortality and abortion has been noted to be higher than expected in the wives of vinyl chloride monomer workers (8). However, this rate was established using questionnaires filled out by the workers themselves thus attenuating the strength of any conclusion.

A recent study (9), concerning the oncogenic and mutagenic risks of residents in communities where there are vinyl chloride producing plants, suggests the existence of an association between the presence of such plants in a population and elevated rates of malformations in the population. Using data from Ohio State's Birth Registry (congenital malformations have been reported since 1968), the author compared the rate of birth defects in three cities where vinyl chloride polymerization plants are located, with rates observed in other cities of the same State. The study shows that the rate of birth defects is higher in these three cities than in the rest of the State. The difference was particularly marked for malformations of the central nervous system, upper digestive system and the feet (club-feet).

Using data from a different source (Center for Disease Control's Hospital-based Birth Defects Monitoring Program) other authors confirm that the rate of defects of the central nervous system is higher in Painsville Ohio where a vinyl chloride plant [10] is located. They show, however, that the mothers of the malformed children were less exposed to vinyl chloride than the control mothers and thus conclude that the high rate of defects is not related to exposure to vinyl chloride. Moreover, in another city where a vinyl chloride plant was located, the rate of birth defects was not higher than predicted.

The aim of this study is to confirm the presence of an increase in the frequency of congenital malformations in a community located next to a vinyl chloride polymerization plant by comparing birth defects in such a community (Shawinigan) with those of a control community (Drummondville).

It is a pilot study. Had it shown no excess of birth defects in the studied community, there would have been no reason to pursuit the research; on the other hand, should any excess be found, it will be necessary to go ahead with more studies before stating that an association between vinyl chloride monomer and birth defects does exist in man.

METHOD

There has been a vinyl chloride polimerization plant in Shawinigan since 1943 which has had a workforce of 250 men on average. Production has fluctuated with the times. At the moment, the amount of vinyl chloride monomer released into the atmosphere is estimated at approximately 200 ppm. No data is available to estimate the quantity of vinyl chloride monomer released into the air in the past; it is doubtful it was any lower than today. Ten workers of the plant were found to have died of angiosarcoma of the liver [11]. The plant is surrounded by other heavy industries such as an aluminum refinery plant, a carbide plant, a chemical factory and a pulp and paper mill. As the city is located in a hollow between hills and predominant winds blow from the industries toward the residential zone, the community has been exposed to relatively high concentrations of atmospheric pollutants.

Drummondville is also an industrialised city. Its population (31,000) shows an age and sex structure similar to Shawinigan (29,000). Its major industries consist of textile factories, one of which handles synthetic fibers, a lamp factory and many small businesses. It is located fifty miles south west of Shawinigan.

DATA SOURCES

Data concerning birth defects were obtained from the files of hospitals where the women residing in the two cities give birth. For geographic reasons, Shawinigan data were obtained from six regional hospitals while Drummondville data were acquired at the city's only hospital. In both cases, more than 96% of all records were retrieved.

Malformed children were ascertained through the following sources: the mother's file, the newborn's file, the obstretric room's daybook and the autopsy reports.

DEFINITION OF A BIRTH DEFECT

Birth defects included in this study were those either apparent at birth, or discovered by an X-Ray or a laboratory examination (this excludes heart defects) or described in autopsy reports.

The following abnormalities were not included as such in the study:

a) locomotor apparatus

metatarsus varus
calcaneo valgus and varus
misimplanted toes
internal rotation of the foot
flat-foot

b) genitals

cryptorchidism
hydrocele
undescended testes
phimosis

c) cutaneous-mucus membrane

nevus vasculosus, nevus venosus
mongolian spots
cavernous hemangiomas
pilonidal sinus
begnin teratoma

d) others

pectus excavatum
stenosis of external urethral meatus
thymus hypertrophia
small cleft palate
eyelid ptosis
minor deformity of the thorax
short string of the tongue.

For a child to be considered malformed, the defects had to have been diagnosed at the time of the discharge from hospital.

Still-births comprised only children still-born at or after twenty weeks of pregnancy.

The annual number of live births of parents residing in each city was obtained from the Quebec birth registration file.

RESULTS

Table I gives the distribution of malformed children by parents' place of residence. The Chi square test indicates that the difference is significant between the two cities.

Table II shows the ratio of malformed children per 1,000 live births by type of malformations. All types of defects except those of the endocrine system are higher in the city where the vinyl chloride polymerization plant is located. Although the mean age of the mother at delivery in Shawinigan is often lower than in Drummondville, it is not statistically significant.

Table III shows the distribution of malformed children according to number of defects per year and city of residence. Among malformed children, the proportion with multiple malformations is similar in both cities (Shawinigan 28/124, Drummondville 28/116). It would seem therefore that the higher ratio of malformed children in the city where the vinyl chloride plant (RR. 1.56) is located does not extend to multiple malformations.

Except for the years 1971-72, birth defect ratios are higher in Shawinigan over the nine year period of observation (Figure I). No clear reason could explain this difference in the ratio of defects each year.

Table IV shows that the ratio of still-births per 1,000 live births is somewhat higher in Drummondville. However, the proportion of malformed children among still-borns is higher in Shawinigan (21% versus 18%). This is not statistically significant.

DISCUSSION

The results of the present study concur in part with those of studies carried out in Ohio, where a higher birth defect rate was observed in a city with a vinyl chloride polymerization plant. However, the presence of other atmospheric pollutants in the environment of Shawinigan should be noted. The present study does not permit linking the observed phenomenon to a particular pollutant be it vinyl chloride or any other teratogenical agent.

Congenital defects observed in Shawinigan as well as in Drummondville were higher than those observed in Ohio. Differences could be accounted for by the data collection method. The present study gathered data from hospital records while the Ohio study used birth registers. It is possible that certain cases are not reported to a state register.

It is puzzling to observe that the increase of birth defects is in the same order of magnitude in several organ systems. Usually, particular chemical would produce a specific effect rather than a broad increase in birth defects generally. The explanation for such an observation could be twofold:

1 - The chemical in the Shawinigan environment produces, by itself or in combination with other air pollutants, a broad spectrum of developmental defects. This observation is not in line with previous studies which show a possible association between vinyl chloride in the environment and central nervous system defects [10]. The problems encountered in Shawinigan could be of a different order of magnitude than those seen elsewhere.

2 - Even if careful attention was given to the collection of data and even if more than 96% of all births were reviewed in both cities, the apparent difference between Shawinigan and

Drummondville could result from an artifact such as ignoring defects diagnosed after the hospital discharge, different diagnosis or different reporting criteria used in the seven hospitals contacted or some inherent lack of comparability between the study and control population.

Further studies are needed to support the assertion that vinyl chloride causes birth defects in the community located near a polymerization plant. Should this be the case, stringent emission standards will have to be devised.

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ABSTRACT

Birth defect ratios observed in a community where a vinyl chloride polymerization plant has been located since 1943 (and where ten cases of angiosarcoma of the liver have been diagnosed among vinyl chloride monomer workers) are compared with the birth defect ratios observed in a control city. The frequency of congenital defects is higher in the exposed community. This phenomenon is observed in seven out of the nine years covered by the study. Both sexes are affected equally. These findings concur in part with other previously published studies and should lead to further research.

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TABLE I - Distribution of malformed children / 1,000 live births by parents' place of residence 1966-1974.

	Shawinigan	Drummondville
Number of malformed children	124	116
Ratio malformed children per 1,000 live births	30.8	19.7

$X^2 = 12{,}359$, d.l. 1 , $p < 0.001$

TABLE II

Distribution of malformed children/1,000 live births, relative risk and mean age of mother at delivery time, by type of malformations and city, 1966-1974.

	Ratio for both sexes		Relative Risk Sh./Dr.	Mean age of mother	
	Shawinigan	Drummondville		Shawinigan	Drummondville
	(4,022)*	(5,875)*		27.2	27.5
Central Nervous System	(21)** 5.2	(24) 4.1	1.27	24.6	28.7
Eye, Ear, Face	(13) 3.2	(8) 1.4	2.29	22.7	23.0
Cardio-vascular	(28) 7.0	(26) 4.4	1.59	26.7	28.8
Respiratory	(9) 2.2	(3) 0.5	4.40	24.2	23.8
Digestive	(12) 3.0	(10) 1.7	1.76	24.7	29.7
Genital	(15) 3.7	(18) 3.1	1.19	25.6	24.6
Urinary	(8) 2.0	(6) 1.0	2.0	22.8	21.7
Locomotor	(49) 12.2	(43) 7.3	1.67	27.0	29.2
Chromosomal	(6) 1.5	(8) 1.4	1.07	28.5	36.2
Endocrine	(0) -	(2) 0.3	0	-	26.4

* Number of live-births

** Number of children with that defect.

TABLE III

Distribution of malformed children by year and parent's city of residence according to number of defects (1966-1974)*.

of efects	1966		1967		1968		1969		1970		1971		1972		1973		1974		T O T A L	
	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	Shawinigan	Drummondvil
	(610)**	(761)	(510)	(689)	(454)	(681)	(466)	(677)	(438)	(648)	(396)	(636)	(372)	(583)	(368)	(540)	(408)	(660)	(4022)	(5875)
1	14	8	10	7	9	7	6	7	16	10	3	9	6	11	18	13	14	16	96	88
2	2	2	2	1	2	2			1	1	1	4	2	5	1	2	2	4	13	21
3	3		2		1				1		1	1		1		1			8	3
4		1					1				1								2	1
5									1				1					1	2	1
6			1																1	
7																				
8			1					1											1	1
9																				
10																	1		1	
11				1																1
otal	19	11	16	9	12	9	7	8	19	11	6	14	9	17	19	16	17	21	124	116
	(31.1)***	(14.5)	(31.4)	(13.1)	(26.4)	(13.2)	(15.0)	(11.8)	(43.4)	(17.0)	(15.2)	(22.8)	(24.2)	(29.2)	(51.6)	(29.6)	(41.7)	(31.8)	(30.8)	(19 7)

* Sill born defectives included

** Number of live births

*** Ratio malformed children/1,000 live-births

S = Shawinigan

D = Drummondville

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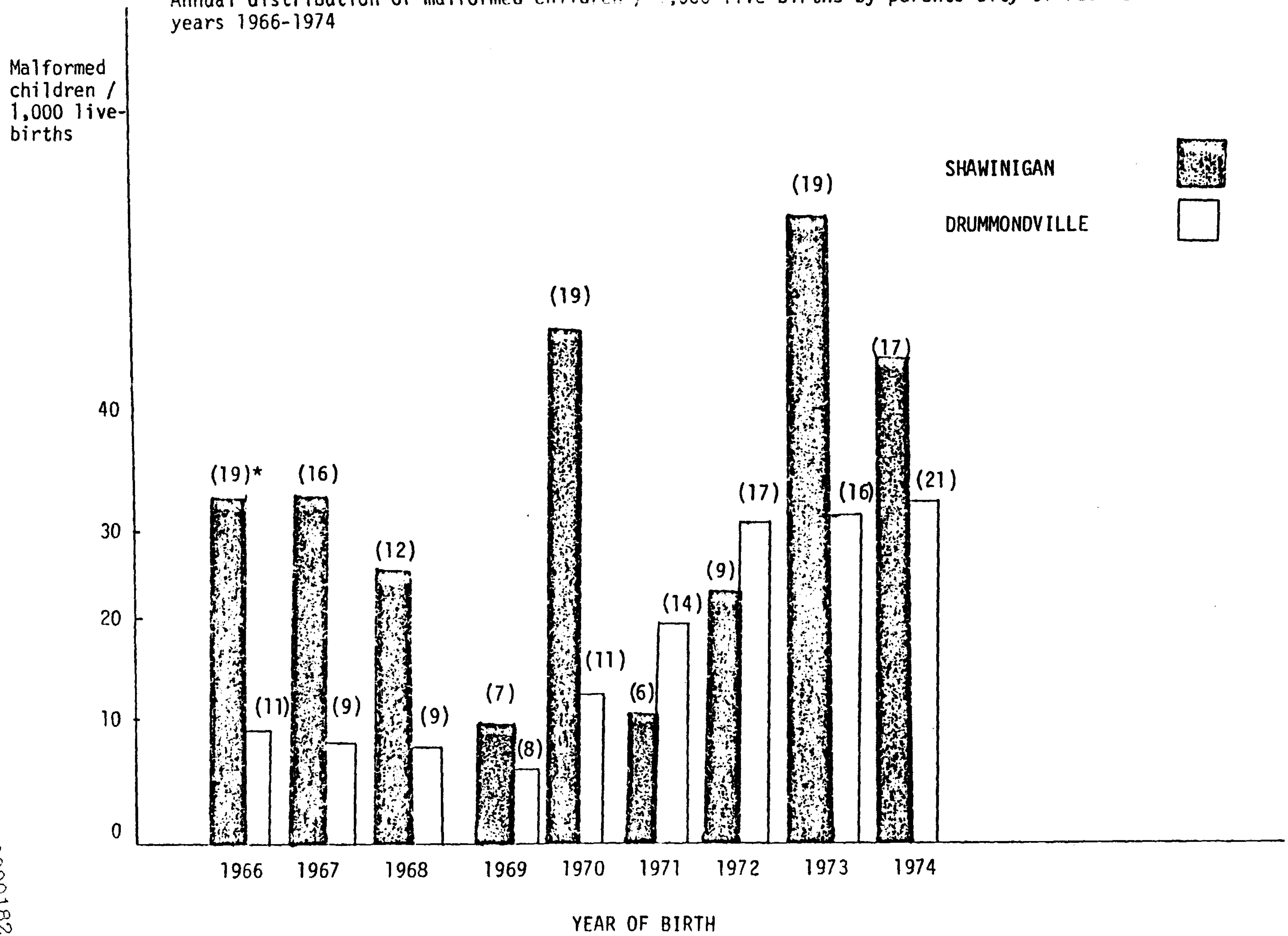
FIGURE I

Annual distribution of malformed children / 1,000 live-births by parents city of residence for the years 1966-1974



* Number of children

TABLE IV

Distribution of still births/1,000 live births by parents place of residence, category of still births and mean age of the mother 1966-1974

	SHAWINIGAN	DRUMMONDVILLE	MEAN AGE OF THE MOTHER	
			Shawinigan	Drummondville
Still birth without malformation	(37)* 9.2	(64) 10.89	28.3	28.8
Still birth with malformation	(10) 2.49	(14) 2.38	26.1	29.3
TOTAL still-births ratio per 1,000 live births	(47) 11.69	(78) 13.27	27.2	29.1

$X^2 = 0.21$, d.l. 1, n.s.

* number of cases.