

# The epidemiology of infantile hypertrophic pyloric stenosis in Sweden 1987–96

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## Abstract

**Aims**—To find out whether the incidence of infantile hypertrophic pyloric stenosis (IHPS) has changed over the past decade, and if so, to investigate possible contributory factors.

**Methods**—All infants undergoing pyloromyotomy for IHPS in Sweden between 1987 and 1996 were studied. Using the national patient registers the yearly incidence was determined and evaluated in relation to sex, latitude, urbanisation, and type of surroundings by use of a Poisson model.

**Results**—There was a substantial decline from 2.7/1000 to 0.85/1000 over the time period. The incidence in the south was almost three times greater than in the north.

**Conclusion**—The declining incidence and geographical difference suggest that environmental factors are of importance in this disorder.

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Keywords: pyloric stenosis; incidence; geographical variation; pyloromyotomy

For some years, we have had an impression that there has been a decline in the incidence of infantile hypertrophic pyloric stenosis (IHPS). This study was performed to investigate this observation, and if a decline has taken place, to investigate factors that might have contributed to it. Changes in the incidence of IHPS, both upwards<sup>1–6</sup> and downwards,<sup>7–9</sup> have previously been reported.

## Patients and methods

All patients cared for as in-patients at medical facilities in Sweden are registered with the National Patient Registry which is maintained by the Swedish National Board of Health and Welfare. Using this registry, we identified all patients with a diagnosis of IHPS (No. 750F, ICD-9)<sup>10</sup> during the years 1987–96. The

patient series studied consisted of those individuals who were reported to have undergone pyloromyotomy (No. 4410, Classification of Surgical Interventions).<sup>11</sup> For reasons of patient confidentiality, the registry did not allow determination of the precise age at surgery; however, all patients were less than 1 year old. The inclusion date of a patient was the date of arrival at the hospital before surgery. No one was included in the patient series more than once.

In each case patients were registered with respect to date of arrival at the hospital, sex, county, and local district of residence. The total number of patients treated each year was determined as was the total number of births each year, together with their sex and geographical location.<sup>12</sup> Sweden consists of 24 counties subdivided into 288 local districts.

The probability (F) of a child undergoing pyloromyotomy for IHPS during the first year of life was estimated using a Poisson model<sup>13</sup> incorporating the following factors: sex (X), time as year and date (Y), and latitude (Z), so that:

$$F = \exp(\beta_0 + \beta_1 X + \beta_2 Y + \beta_3 Z) \quad (1)$$

where  $\beta_0$  is a constant, X = 0 for boys, and X = 1 for girls, Y is the number of days after 31 December 1986, and Z is the latitude (in degrees) of the main town or city of the county in question. The  $\beta$  coefficients, their standard errors (SE), and their two sided p values were estimated according to the maximum likelihood method.

Equation 1 was modified by adding  $\beta_4 Y \cdot Z$ , an interaction factor between time and latitude, so that:

$$F = \exp(\beta_0 + \beta_2 Y + \beta_3 Z + \beta_4 Y \cdot Z) \quad (2)$$

Using equation 2 allowed the investigation of time trends in relation to latitude. In this modified function, all  $\beta$  coefficients were estimated separately for boys and girls instead of using  $\beta_1 X$ .

A second modification was performed by adding  $\beta_5 U$  and  $\beta_6 V$ , where U and V are factors considering other geographical differences:

$$F = \exp(\beta_0 + \beta_2 Y + \beta_3 Z + \beta_5 U + \beta_6 V) \quad (3)$$

As in equation 2, all  $\beta$  coefficients were estimated separately for boys and girls instead of using  $\beta_1 X$ . U is defined as follows: 1 = cities with >200 000 inhabitants; 2 = suburbs around these cities; 3 = cities with >100 000 inhabitants; 4, 5, 6, and 7 = town districts with >60 000, >30 000, >15 000, and >10 000 inhabitants, respectively; 8 = villages of <10 000 inhabitants; 9 = very sparsely inhabited districts. V is defined as: 1 = coastal

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Table 1 Numbers of male and female infants with IHPS, total number of live births, and yearly incidence of IHPS in Sweden during the years 1987–96

Year	Male infants with IHPS	Female infants with IHPS	All infants with IHPS	Number of live births	Incidence per 1000 births
1987	233	40	273	104 699	2.607
1988	242	58	300	111 086	2.701
1989	234	82	316	114 788	2.753
1990	224	61	285	122 172	2.333
1991	188	49	237	123 142	1.925
1992	195	44	239	122 199	1.956
1993	129	31	160	116 606	1.372
1994	113	24	137	110 570	1.239
1995	110	20	130	101 752	1.278
1996	70	10	80	94 384	0.848
All	1738	419	2157	1 121 398	1.923

Table 2 Variables of equation 1, estimating the probability for an infant of needing treatment for IHPS

	$\beta$ coefficient	SE	p value
$\beta_0$ , constant	+0.88374	0.65640	
X, sex; male = 0, female = 1	-1.37912	0.05421	<0.0001
Y, days after 31 Dec 1986	-0.00013	0.00002	<0.0001
Z, latitude, degrees	-0.11022	0.01119	<0.0001

The value of a  $\beta$  coefficient indicates the degree and direction of the effect of its variable in the function.

Table 3 Variables of equation 2, estimating the probability for a male or female infant of needing treatment for IHPS

	$\beta$ , male	SE	p value	$\beta$ , female	SE	p value
$\beta_0$ , constant	+1.97289	1.35467		+3.36770	2.91945	
Y, days after 31 Dec 1986	+0.00064	0.00074	0.3851	-0.00125	0.00147	0.3944
Z, latitude, degrees	-0.12833	0.02315	<0.0001	-0.17793	0.04999	0.0004
Y·Z, (days) · (latitude)	-0.00001	0.00001	0.2878	+0.00002	0.00003	0.4210

The interaction term, Y·Z, was used in order to specifically investigate whether variation in incidence with time (Y) is related to latitude (Z).

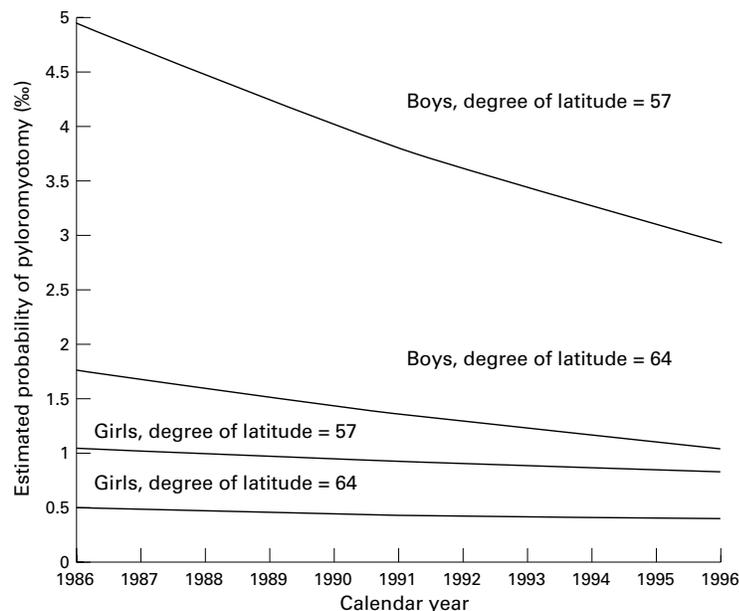


Figure 1 Estimated probability of undergoing pyloromyotomy for a male and female infant during 1987 to 1996 if born in the south of Sweden, in Halmstad, at the latitude of 57°, or if born in the north, in Umeå, at the latitude of 64°.

districts; 2 = inland districts situated more than 100 km from the coast; and 3 = remote districts (mainly mountains and forests).

## Results

Between 1987 and 1996, a total of 2157 infants (1738 boys, 419 girls), underwent pyloromyotomy for IHPS (see table 1). Tables 2, 3, and 4 present the  $\beta$  coefficients with their standard errors and p values for equations 1, 2, and 3, respectively. Figure 1 shows the estimated probability of undergoing pyloromyotomy for a male and female infant during 1987 to 1996 if

born in the south or north of Sweden. The p values of the  $\beta$  coefficients for sex (X), time trend (Y), and latitude (Z) were all significant ( $p < 0.0001$ ). There was an overall decline in the incidence of IHPS during the study period, although when investigated separately the trend of decline for girls was not significant. The decline was not found to be related to latitude (Y·Z). Regarding the geographical factors studied (U and V), there were no significant differences, although there was a trend towards a lower incidence in boys in urban areas.

## Discussion

This study provides clear evidence of a decline in the incidence of IHPS between 1987 and 1996 in Sweden. The incidence of IHPS was almost three times higher in the south of Sweden than in the north. The registers employed for this study provide complete and reliable data: all medical facilities in Sweden are required to submit data on inpatients, their diagnoses, and surgical interventions; data submission is virtually complete for the past several years. This is possible because Swedish medical care is highly centralised in one nationwide organisation. The validity of the registers of the National Board of Health and Welfare has been confirmed in previous studies.<sup>14</sup> Furthermore, the fact that the patients identified from the National Patient Registry coincided closely with those who were identified as having undergone pyloromyotomy supports the validity of the registers used. Only one discrepancy was found—an adult patient with incorrect diagnosis of IHPS. The reporting procedures in paediatric and surgical clinics did not change during the study period. Therefore the change in incidence could not be explained by registration procedures.

Previous epidemiological studies have shown various different trends. No change was identified in three studies—in Denmark from 1950 to 1984,<sup>15</sup> in British Columbia during the 1970s,<sup>16</sup> and in Western Australia from 1971 to 1984.<sup>17</sup> An increasing incidence was found in Minnesota from 1950 to 1984,<sup>1</sup> in central Scotland and other parts of UK,<sup>2-5</sup> and in Germany during the 1970s and 1980s.<sup>6</sup> Three previous studies showed a decline like ours—in Northern Ireland before 1970,<sup>7</sup> in Saskatchewan from 1970 to 1985,<sup>8</sup> and in New York State from 1983 to 1990.<sup>9</sup> The latter study was by far the largest, including 4063 cases, and showed a fall in incidence from 2.4 to 1.7/1000 births. White race and male gender were associated with an increasing incidence of IHPS; low birth weight, increased maternal age, and high birth order were associated with a reduced

Table 4 Variables of equation 3, estimating the probability for a male or female infant of needing treatment for IHPS

	$\beta$ , male	SE	p value	$\beta$ , female	SE	p value
$\beta_0$ , constant	+3.52717	0.76298		-0.61042	1.527605	
Y, days after 31 Dec 1986	-0.00015	0.00002	<0.0001	-0.00007	0.00005	0.1665
Z, latitude, degrees	-0.15599	0.01322	<0.0001	-0.10999	0.02639	<0.0001
U, urbanisation, rated 1-9	+0.02076	0.01191	0.0814	-0.01816	0.02457	0.4598
V, geographical location, rated 1-3	-0.01202	0.03697	0.7451	+0.04351	0.07163	0.5600

The value of a  $\beta$  coefficient indicates the degree and direction of the effect of its variable in the function. Urbanisation was rated from 1 to 9, with low values for urban areas. Geographical location was rated from 1 to 3, with 1 for coast and 3 for inland areas.

incidence. A study from California on 1963 cases of IHPS during 1983 to 1988 showed no clear decline, although some other findings were confirmed: the incidence among white infants was 2.4 and among Hispanic infants 1.8/1000 births while it was 0.7 and 0.6/1000 births among black and Asian infants, respectively.<sup>18</sup> The highest incidences have been reported in the UK, ranging from 3.5 to 8.8/1000 births.<sup>1-3</sup> In the Saskatchewan study bottle feeding was 2.9 times more prevalent among the IHPS infants.<sup>8</sup>

From the results of these various studies, it appears that IHPS occurs with a varying frequency over time and in different regions with incidences ranging between 1.7 and 8.8/1000 births. Occurrence depends on genetic factors, gender and race being affected differently, although minor environmental factors like type of feeding also appear to be important.

In our study, the finding that the incidence of IHPS was almost three times higher in the south of Sweden compared to the north could indicate unknown environmental factors of importance. We found that the substantial decline in incidence occurred throughout the whole country during the ten year study period. This change in incidence might be explained if IHPS is being transmitted like an infectious disease, although the low incidence would suggest that individual susceptibility would have to be variable and infrequent. This susceptibility may depend on both hereditary and environmental factors. It is impossible to say whether environmental or genetic factors are most important in determining the difference in incidence between northern and southern Sweden. The only obvious difference between the north and south is the difference in climate. The incidence of IHPS at the end of the study period, especially in northern Sweden, is the lowest reported so far among white infants.

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