A trend analysis of major congenital anomalies in Penang, Malaysia

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Background: This study examined the trend of major congenital anomalies (CA) in the state of Penang using the ICD 10 database from 1999 to 2004. The data was collected from various health centres and hospitals. The aim was to study the magnitude of the problem for congenital anomalies in the state of Penang in terms of trends and also to calculate the incidence rate by districts. If a trend was noticed, this in turn will determine whether to carry out further in-depth studies in the future and to find out the linkages to the environment if any.

Methods: This was a retrospective study of congenital anomalies that were registered in the state of Penang and the data was obtained from the ICD10 database from 1999 to 2004. Under ICD 10, congenital anomalies are coded as "Q". Only major congenital anomalies coded as "Q" from Q1 to Q11 were extracted and analysed. Only new cases were analysed, double and repeat entries were excluded. Trend analysis was than carried out according to districts in Penang.

Results: Incidence rate per 1000 birth was calculated to determine the common congenital anomalies. It was found that there was an increasing trend in the incidence of CA for all the five districts studied; topping the list was Barat Daya while Seberang Perai Selatan had the lowest incidence rate. It is noteworthy to mention that Barat Daya is an industrialised district while Seberang Perai Selatan is mainly an agricultural and residential area. This preliminary study however did not look into the reasons or causative factors for the high or low incidence in the respective districts. In terms of the types of congenital anomalies, the highest was that from malformation of circulatory system while the lowest from respiratory system. The congenital anomalies with the incidence rate at least 3 per 1000 births were malformations from the nervous system, circulatory system, digestive system, genital organs, malformation/ deformation of musculoskeletal system and cleft lip and cleft palate.

Conclusion: This study showed a rising trend in congenital anomalies in all districts in the state of Penang and a high incidence was observed in the district of Barat Daya, where a number of factories are located in the Bayan Lepas Industrial Zone. However further studies need to be carried out to determine the causative factors and their linkage to the environment. The limitation of this study was that the data analysed was only from notified cases to the Penang State Health Department.

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Introduction

Congenital anomalies are disorders that may be present at birth or in some cases after birth, depending on the causative factors and the severity. Those that are structural are usually obvious at birth. The exact causes of most of the disorders are not known or remain obscure, but there is sufficient evidence to link these disorders to various risk factors, such as genetics and the environment of the embryo.[1] The cause of these disorders can be multi factorial due to a combined influence of genetic and environmental factors affecting normal development of the embryo. Stevenson (1993) has shown that about 40-60% of the cases are due to unexplained causes, followed by multi factorial inheritance (20-25%), genetic conditions (15 to 25%) and environmental factors (8 to12%).[2] The risk identification for exposure to such factors is of great importance as this form of birth defects can be prevented to a large extent if appropriate caution is taken.

Awareness of congenital anomalies arose after the thalidomide tragedy from 1958-1962. Since then a number of surveillance programmes and registries have been set up to monitor the incidence of congenital anomalies in the developed countries. The purpose of these surveillance programmes was to identify new teratogens and as well as to take preventive measures.

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In Malaysia we do not have a registry for congenital anomalies or active surveillance systems to study the causative or environmental factors, but babies born with congenital anomalies either in the government sector or private are notified to the health centres and the data are compiled. Congenital anomalies are coded and classified using International Statistical Classification of Diseases and related health problems (ICD 10). Since congenital anomalies are significant contributors of infant morbidity and mortality, it is vital to identify and collect statistics of congenital anomalies to study the epidemiology and to take preventive measures.

This paper attempts to study the trends of congenital anomalies seen in the state of Penang from the data collected from various health centres and hospitals. This preliminary study was carried out to study the magnitude of the problem for congenital anomalies in the state of Penang in terms of trends and also to calculate the incidence rate by districts so as to carry out further in depth studies in future to find out the linkages to the environment if any. This will aid the stakeholders in generating proposals for multidisciplinary team operators to address the problem and make the necessary changes.

Material and Methods

This is a retrospective study using data from the, ICD10 database (International Classification of Diseases, 10) from 1999 to 2004, registered in the state of Penang. In this database congenital anomalies are coded as "Q". Cases were classified according to the classification defined by the ICD 10. The major congenital anomalies as defined by ICD 10 are malformation of nervous system (Q1); malformation of eye, ear, face and neck (Q2); malformation of circulatory system (Q3); malformation of respiratory system (Q4); malformation of cleft lip and cleft palate (Q5); malformation of digestive system (Q6) ; malformation of genital organs (Q7); malformation of urinary system (Q8); malformation/ deformation of musculoskeletal system (Q9); Other malformation (Q10); and chromosomal abnormalities (Q11). Firstly all the data under "Q" were extracted and grouped according to the number and type of congenital anomalies. The frequency table was constructed and the effective percentage was reported to indicate the severity of the different types of congenital anomalies. Only new cases born from 1999 to 2004 were included and analysed. Repeat cases and double entries were excluded. Based on the effective percentages and total cases registered the incidence of congenital anomalies per 1000 life birth in Penang from 1999 to 2004 were calculated.

The state of Penang is divided into 5 major districts, Seberang Perai Selatan (SPS), Seberang Perai Tengah (SPT), Seberang Perai Utara (SPU), Timur Laut (TL), and Barat Daya (BD). It is an industrialised state with manufacturing as the most important component. Most of the large industries are situated in BD and its high technology industries are located in the Bayan Lepas Free Trade Industrial Zone. The other industrial district is SPT while SPU has a combination of industries and agriculture and in SPS, it is mainly agriculture. TL district has mixed activities such as industries, government agencies and also residential housing.

The cases were grouped according to districts (geographical distribution). The incidence of congenital anomalies by districts in Penang from 1999 to 2004 was computed based on effective percentage. Trend analysis using simple average was performed on major congenital anomalies to identify the pattern and type of cases according to ICD 10 by districts. Since this is an exploratory study, only descriptive statistics were used. This study also does not make any inference to the research population as such neither hypothesis testing nor estimation of confidence interval was carried out.

Results

From 1999 to 2004, a total of 3985 cases of congenital anomalies in all districts were recorded from the ICD 10 database. There was clear indication of an increasing trend in all districts as seen in Table 1. There was an average increase of 797 cases per year for the state.

However there was a slight dip incidence in the year 2000 as seen from the number of cases recorded (494). The highest number of cases (796) was recorded in the year 2004. According to the districts, SPS had the lowest incidence (75.4) of congenital anomalies over the 5-year period. The highest incidence of congenital anomalies was recorded in TL.

Apart from the overall analysis of data to assess the incidences of congenital anomalies in the state of Penang, analysis of data from 5 districts were also carried out separately. The analysis showed an increasing trend for all the five districts (Figure 1) in congenital anomalies. In terms of average incidence per 1,000 birth, BD topped the list with the incidence rate of 47.18% followed by SPT (37.30%), SPU (31.63%), TL (30.27%), and SPS (25.85%) respectively.

Out of the 11 ICD 10 parameters observed for the years 1999 to 2004, it was found that there was an increased incidence for 5 of the 10 parameters. For all the six years, the highest type of congenital anomalies recorded was for malformations of circulatory system while the lowest was malformation of respiratory system. The other parameters were malformation of nervous system (Q1), malformation of circulatory system (Q3), cleft lip and cleft palate (Q5), malformation of digestive system (Q6), malformation of genital organs (Q7) and malformation/deformation of musculoskeletal system (Q9) (Table 2). Q3 was significantly raised during all the years, followed by Q6, Q1, Q5, Q7 and Q9. However cases recorded for year 2003 showed a slightly different pattern in which there were many other types of congenital anomalies registering high numbers of incidence. Further analysis was carried to identify the general pattern of the incidence rate of these congenital anomalies. The analysis showed that the types of malformations with an incidence rate of at least 3 per 1000 life birth were as follows, Q1 from 2002 to 2004, Q3 for all the years, Q5 from 2002 to 2004, Q6 for all the years except for the year 2003, Q7 for 1999 and Q9 for 2003 (Table 2).

As the highest incidence of congenital anomalies recorded was in BD (47.18%) followed by SPT (37.30%), and the lowest in SPS, the economic activities in relation to industrialization was studied. Penang is an industrialised state with manufacturing (electronics and electrical) as the most important industry followed by paper and chemical/ fertiliser industries. Most of these medium sized and small industries are located in SPT while the large ones are in BD. There were 343 industries in SPT and 139 in BD with electrical and electronic industries being the highest in both districts followed by the chemical and fertiliser industries in SPT at the time of the study. The distribution of the industries by districts is shown in Table 3.

Discussion

Congenital anomalies or birth defects is an abnormal condition that is present either at birth or detected later in life. It is of great concern for it is one of the leading causes of infant mortality. Congenital anomalies that are seen in children at birth may be due to errors in structural formation and damage on formed structures due to external forces.[3] These abnormalities which can be anatomical, functional or metabolic may be seen at birth or may appear later resulting in physical or mental disability and sometimes can be fatal.[4]

The exact causative factors for most of the disorders are not known or remain obscure. About 60% of these birth defects of unknown aetiology are due to occupation related environmental agents.[5] Scientists believe most birth defects are caused by a complex mixture of factors such as genetic predisposition, environmental exposure and lifestyle choices. Although the cause of most birth defects is still not determined, scientists do know that ingestion of or exposure to certain compounds can affect developing foetuses. According to Dr Hines, environmental causes alone are thought to be linked to between 2% and 3% of birth defects and there is sufficient evidence to link these disorders to various risk factors. It is often reported to be due to many factors like genetic or environment exposures or an interplay

between the two.[4] The risk identification for exposure to such factors is of great importance as this form of birth defects can be prevented to a large extent if appropriate caution is taken.

The incidence of congenital anomalies as seen in Figure 1, clearly showed an increasing trend in all the 5 districts. Thus there is a problem of congenital anomalies and the question arises as to which district and why the increasing trend. Hence the economic activities and the land use pattern was studied and the highest incidence was recorded in BD (47.18) which is an industrialized district with manufacturing (electronics and electrical) as the most important industry while the lowest incidence rate was in SPS (37.30) which is mainly an agricultural district with minimum manufacturing activities.

As for the types of anomalies, there were 11 and the highest 5 malformations were those of the nervous system, circulatory system, cleft lip and cleft palate, digestive system, and genital organs.

There is no national registry for congenital anomalies in Malaysia. There is incomplete collection of data; abortions and still births that may be due to congenital anomalies either at home or hospitals are sometimes not accounted for or notified. Individual records are prepared and kept at various levels in the government or private hospitals when the patient seeks medical treatment either as an outpatient or inpatient record. Inpatients with congenital anomalies upon discharge are coded accordingly to ICD 10 (Q) for congenital anomalies and this data is available in the record office as well as at the national level in the Ministry of Health. Outpatient records are kept in the clinics under various disciplines and are not compiled unless notified. Some data are also published through reports by the Ministry of Health, but there is a lag period of a couple of years before they are published, thus they are not current. Therefore the analyses of data for this study were carried out using only the notified data but in spite of under reporting, there was still an increasing trend of congenital anomalies.

Some studies have been carried out on congenital anomalies by individuals and groups. One such study is the "Maternal Screening for Congenital Anomalies" by the Health Technology Assessment Unit, Ministry of Health.[6] This study was carried out in Hospital Kuala Lumpur in 1996. There were 15,535 life births and the incidence of congenital anomalies was 0.91%, while a similar study conducted in Hospital Alor Star, State of Kedah stated that out of 14,123 life births from 1984-1987, the incidence was 1.52% birth defects. Another study carried out at the University Hospital, Kuala Lumpur in 1970 on 1404 life births showed an incidence rate of 4.7%. When aggregated national data was taken into consideration it showed that 17.9% of still births and neonatal deaths were due to congenital anomalies (MOH Report). Analysis of national data from 1996-1998 showed that incidence of spina bifida and hydrocephalus ranged from 5.12% (1996), 5.83% (1997) to 5.5% (1998) of all congenital anomalies. In 1999 there were 225 cases of neural tube defects among 1055 congenital anomalies. This report also stated that the estimated incidence for birth defects is about 1 in 600 to 700 births but the actual prevalence may be higher for some of the spontaneous abortions due to congenital anomalies not reported or recorded especially if it occurs at home or in private sectors.

In this study a high incidence was also noted among the malformations of the nervous system. The others are those of circulatory system, cleft lip and cleft palate, digestive system, and genital organs. From the literature review it is known that most of these defects are due to exposure to some agent that affects the early embryonic developmental stages of the fetus.[9] In the case of toxicological effects of environmental pollutants on the fetus, the timing of exposure and the gestational age is important as evidenced by anomalies such as neural tube defect, cleft lip and cleft palate.[7,8]

Several epidemiological studies were reviewed to see if there was any link between industrial activity and congenital anomalies. It is interesting to note that some environmental contaminants and occupations

(maternal and paternal exposures) are related to or said to be causative factors for congenital anomalies. For environmental contaminants, three of them have been scientifically proven to be teratogenic and they are ionising radiation,[9] mercury,[10] and lead.[11,12] As for maternal and paternal exposures, most of the studies focus on maternal exposures[5] but paternal exposure was also found to be a causative factor for congenital anomalies.[13] Paternal exposure to radiation and chemicals causes either genetic damage to germ cells or the teratogenic substances in the seminal fluid affects embryonic development.[14] Other causes may be occupational exposure of both the mother and father to chemicals (pesticides, organic solvents, vinyl chloride, polychlorinated biphenyls [PCBs] and dioxins), heavy metals (mercury and lead) and other pollutants, such as ionising radiation.[9,10,11,15,16] A review of several epidemiological studies have suggested that some common paternal occupations like janitors, painters, printers, fire fighters, laboratory workers have been associated with congenital anomalies.[16] Environmental insults can come from landfills which are known to pollute air, water and soil.[17] Studies on agricultural chemicals and birth defects also show an association between pesticide exposures and congenital anomalies[12,18] especially in children of agricultural workers.[19,20]

Conclusion

This study showed a rising trend in congenital anomalies in all districts in the state of Penang. However we cannot consider the results to be indicative of a true picture for Malaysia as the data from other states were not available for comparison. There were also limitations in the study as the available data was only from notified cases. More studies are needed to determine if there is any link between environmental factors and congenital anomalies. As the study only looked at the incidence of congenital anomalies and not the causative factors of it, the high incidence in BD cannot be conclusively linked with the industrial activities and related pollutants but there is a possibility that it may be linked.

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Figure 1: Incidence of congenital anomalies by districts in Penang from 1999 to 2004.

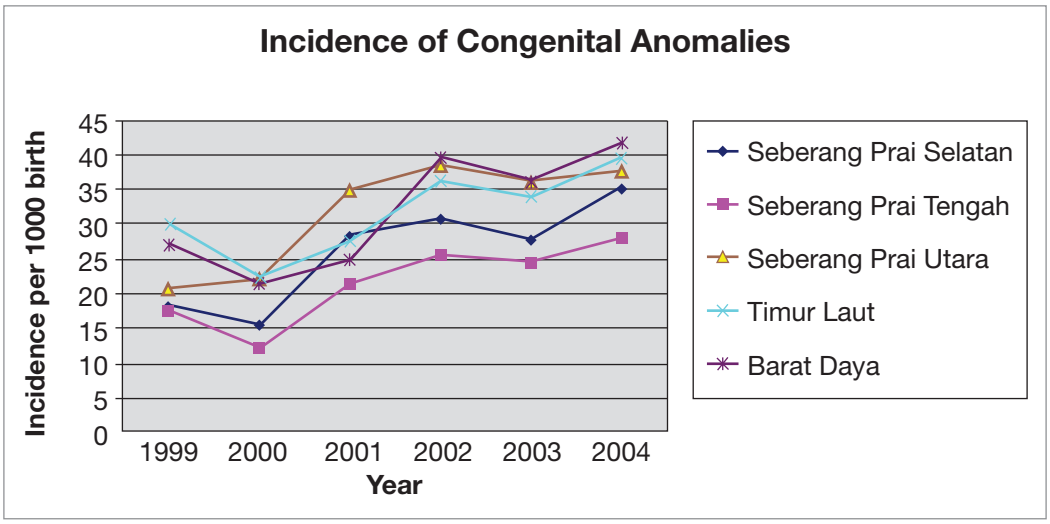

Table 1 : Number of cases and incidence of congenital anomalies by districts in Penang State from 1999 to 2004.

Year (Total Cases)	District					Total	Average Incidence per 1000 birth (%)
	SPS	SPT	SPU	TL	BD		
1999	**45**	**110**	**101**	**195**	**103**	554	23.26
	18.29	*17.56*	*20.97*	*30.0*	*27.28*		
2000	**41**	**85**	**122**	**158**	**88**	494	18.90
	15.50	*12.22*	*22.28*	*22.55*	*21.73*		
2001	**65**	**137**	**173**	**171**	**92**	638	27.23
	28.38	*21.53*	*35.11*	*27.72*	*25.01*		
2002	**72**	**171**	**186**	**215**	**139**	783	33.70
	30.97	*25.65*	*38.56*	*36.28*	*39.81*		
2003	**67**	**156**	**173**	**200**	**124**	720	31.60
	27.85	*24.62*	*36.29*	*34.14*	*36.32*		
2004	**87**	**163**	**181**	**223**	**142**	796	36.10
	35.42	*28.10*	*37.87*	*39.67*	*41.86*		
Total	377	822	936	1162	688	3985	
Average cases per year	75.4	164.4	187.2	232.4	137.6	797	
Average Incidence per 1000 birth	25.85	37.70	31.63	30.27	47.18	28.17	

Bold – Cases of CA
Italics – Incidence/1000 birth
Seberang Perai Selatan (SPS), Seberang Perai Tengah (SPT), Seberang Perai Utara (SPU), Timur Laut (TL), and Barat Daya (BD)

Table 2: Incidence of congenital anomalies by ICD 10 per 1000 life births in Penang from 1999 to 2004

ICD10	1999	2000	2001	2002	2003	2004
Q1	2.39	1.72	2.39	3.66	3.12	3.22
Q2	1.09	0.99	1.71	2.15	1.93	2.63
Q3	5.54	4.36	6.70	9.08	7.64	9.07
Q4	0.21	0.11	0.43	0.52	0.66	0.86
Q5	1.85	1.88	2.95	3.57	3.29	4.54
Q6	3.82	3.02	3.20	3.27	2.90	4.08
Q7	3.15	2.60	2.18	2.80	2.06	2.36
Q8	0.63	0.73	1.54	2.32	2.94	2.81
Q9	1.76	1.19	2.01	2.67	3.29	2.68
Q10	1.47	1.15	1.96	2.02	2.77	2.45
Q11	0.97	1.11	2.05	1.46	0.92	1.41

Malformation of Nervous System (Q1); Malformation of eye, ear, face and neck (Q2); Malformation of circulatory system (Q3); Malformation of respiratory system (Q4); Cleft lip and cleft palate (Q5); Malformation of digestive system (Q6); Malformation of genital organs (Q7); Malformation of urinary system (Q8); Malformation/deformation of musculoskeletal system (Q9); Other malformation (Q10); and Chromosomal abnormalities (Q11).

Table 3: Distribution of Industries by Districts in Penang State.

Type of Industry	District						Total
	BD	SP	SPS	SPT	SPU	TL	
Chemical/Fertilizer	9	0	0	46	9	1	65
Electronics/Electrical	70	0	0	84	4	8	166
Fabricated Metal Products	12	0	0	42	1	4	59
Feed meal	0	0	0	5	2	0	7
Food Processing/Canning	6	0	1	23	17	3	50
Machinery	15	1	0	24	1	4	45
Non-Metalic Mineral	0	0	0	6	2	0	8
Paper	7	0	0	47	8	11	73
Processing of Agricultural Products	0	0	0	8	5	0	13
Professional, Scientific, Measuring & Controlling Equipment & Optical Goods	8	0	0	12	0	2	22
Rubber-Based Industry	6	0	0	14	3	2	25
Textile and Garments	5	0	0	14	4	2	25
Timber Based/Wood Products	0	0	0	5	8	0	13
Transport Equipment	1	0	0	13	1	0	15
Total	139	1	1	343	65	37	586

Seberang Perai Selatan (SPS), Seberang Perai Tengah (SPT), Seberang Perai Utara (SPU), Timur Laut (TL), and Barat Daya (BD)