Genetics and Paediatric Health: Section 5

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5.1.1 What Are Congenital Anomalies?

Congenital anomalies, sometimes called birth defects, happen during prenatal development. They include abnormalities of structure, function, or metabolism. They are present at birth but may not be diagnosed until later in life. They can result in physical or mental disability, affect a child’s development, and, in severe cases, can be fatal.¹

Congenital anomalies are a leading cause of death among foetuses and infants² and can greatly influence quality of life. They are costly to both families and the healthcare system.³


5.1.2 Monitoring Congenital Anomalies

The Canadian Congenital Anomalies Surveillance System (CCASS) gathers and collates data from hospital databases and from some provincial congenital anomalies surveillance systems. However, the collection and recording of information regarding congenital anomalies is not standardized across the country. Different provinces test for different conditions, use different sources of data, and assess the presence of congenital anomalies in their populations differently. For example, some include data on fetal anomalies from pregnancies terminated following a prenatal diagnosis, while others do not.\(^1,2\)

The lack of standardization makes it difficult to compare data across provinces and territories. A new initiative to improve the current system by strengthening surveillance at the provincial and territorial level is underway to address the limitations in collection and reporting of data in the future. Congenital anomalies are an important cause of childhood death, chronic illness, and disability. There is a need to develop standardized methods of coding data relating to congenital anomalies, along with better registration and surveillance. Further research about the causes of congenital anomalies is needed.


### 5.1.3 Causes of Congenital Anomalies

<table>
<thead>
<tr>
<th>Recognized genetic conditions:</th>
<th>Environmental factors:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromosome and single gene causes</td>
<td>Maternal-related conditions, drug or chemical exposures</td>
</tr>
<tr>
<td>15% to 25% are due to recognized genetic conditions</td>
<td>8% to 12% are due to environmental factors</td>
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</tbody>
</table>

<table>
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<tr>
<th>Multifactorial inheritance*</th>
<th>Unexplained causes</th>
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<tbody>
<tr>
<td>20% to 25% are due to multifactorial inheritance</td>
<td>40% to 60% are due to unexplained causes</td>
</tr>
</tbody>
</table>

* A congenital anomaly is considered to be multifactorial (or polygenic) in origin when there is a combined influence of (a number of) genes and environmental factors that interfere with normal embryologic development. Multifactorial inheritance is considered when there appears to be a genetic component but there is no clear Mendelian pattern of inheritance. Multifactorial inheritance is the underlying etiology of most of the common congenital anomalies.


Some congenital anomalies are caused by mutations in a single gene or damage to a specific chromosome. Other congenital anomalies are due to exposure to environmental hazards or drugs during pregnancy. Others result from a combination of genetic and environmental influences. However, the cause of most congenital anomalies is unknown. Most children with congenital anomalies are born to mothers with no family history and no known risk factors.
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5.1.4 Prevalence of Congenital Anomalies in Canada

In 2007, 4.1% of all births in Canada, including stillbirths, were affected by one or more congenital anomalies. It is estimated that major congenital anomalies affect an estimated 3% of all births. It is also estimated that this rate increases to 7% by the second year of life.

Children can be born with multiple congenital anomalies that can range from mild to severe to life threatening. Infants born with severe anomalies (e.g., anencephaly, trisomy 13, trisomy 18, or inoperable congenital heart defects) often die. Not all congenital anomalies are serious, and many can be corrected with treatment.


Overall it appears that both the number of babies born with congenital anomalies and the rate per 10,000 total births decreased between 1998 and 2009 in Canada. The rate has decreased from 451.2 per 10,000 total births to 385.2, a decline of approximately 15%. This could be partially due to the decline in some of the common congenital anomalies, such as neural tube defects [view report], but also to inconsistencies in data collection.

It should be noted, however, that some congenital anomalies, such as gastroschisis (where the intestines are outside of the body wall), are increasing in frequency. The precise cause of this is uncertain. The decrease in rates among live births has been noteworthy, leading to birth prevalence below 400 per 10,000 in 2009. On the other hand, the rates of congenital anomalies in stillbirths has increased slightly, primarily because of an increase in the rate among stillbirths of very low birth weight (less than 750 g).[2]


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5.2.1 Rate of Fetal Death ≥ 500 Grams by Cause, Canada (Excluding Ontario*), 2000 to 2008

Congenital anomalies are the second leading cause of fetal death. Between 2000 and 2008, the rate of fetal death due to congenital anomalies showed little change, varying between 4 and 5 per 10,000 total births.

*Ontario was excluded because of data quality concerns.

5.2.2 Causes of Neonatal, Postneonatal, and All Infant Death, Canada (Excluding Ontario*), 2003 to 2007

Congenital anomalies are a leading cause of infant mortality. They are the leading cause of death in the period from 28 days to one year of age (postneonatal period). They are the second leading cause of death during the first 27 days of life (neonatal period).¹

*Ontario was excluded because of data quality concerns.

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5.2.3 Causes of Infant Death, Canada (Excluding Ontario*), 1999, 2004, and 2007

Although congenital anomalies are one of the leading causes of infant death in Canada, the rate is decreasing. The Public Health Agency of Canada stated that the decreasing rate of infant deaths is most likely a result of increasing prenatal diagnosis and termination of pregnancies when congenital anomalies are diagnosed.

*Ontario was excluded because of data quality concerns.


Implications

It is important to monitor congenital anomalies for possible associations with environmental factors, as the human genome responds to the environment in a very dynamic fashion. In an effort to facilitate health service planning, methods for collecting information regarding congenital anomalies in Canada could be improved for more accessible and reliable data.

5.3.1 Three Common Congenital Anomalies

- Down Syndrome
- Neural Tube Defects
- Congenital Heart Defects

There are many congenital anomalies. The module contains some more detailed information on three of the most common congenital anomalies: Down syndrome, neural tube defects, and congenital heart defects.
Most children with Down syndrome have an extra copy of the 21st chromosome, meaning that instead of two of these chromosomes, they have three, which is referred to as Trisomy 21. About 95% of people with Down syndrome have Trisomy 21. People with Down syndrome have wide variations in mental abilities, behaviour, and development, and their symptoms can range from mild to severe.¹

While the chance of having an infant with Down syndrome increases with maternal age, a baby with Down syndrome can be born to women of any age. It is estimated 80% of children with Down syndrome are born to women younger than 35 years of age.¹

There has been no clear trend in the rates of Down syndrome since 1996. In 2007, the rate was 13.0 per 10,000 total births, or approximately 483 babies born with Down syndrome.
When looking at the combined rate of Down syndrome for the years 1998–2007, it is clear that the rate varied greatly between provinces and territories. The rates of Down syndrome ranged from 11.2 per 10,000 total births in Quebec to 24.2 in the Northwest Territories.

These differences may be due to a number of factors, such as differences in maternal age, the availability and use of prenatal screening and diagnosis, and the rate of pregnancy termination.
Neural tube defects are a group of congenital abnormalities of the central nervous system that result when the bony structure that encloses the spinal cord (the vertebra) does not close completely. The causes of neural tube defects are multifactorial and are influenced by geography, ethnicity, genetics, and nutrition.
In 1999, in Canada, six babies were born with neural tube defects per 10,000 total births, a decline from 11.1 per 10,000 births in 1989. Between 1995 and 2007, the rate of neural tube defects in Canada decreased by about half, to 4.1 from 9.2 per 10,000 total births. Most of the decline occurred between 1995 and 2004, and there has not been a clear trend in rates since. Despite this, much of the decline is attributed to policy-making and education initiatives surrounding the role of folic acid in preventing babies from developing neural tube defects.
There are variations in the rates of neural tube defects across Canada, ranging from 3.8 per 10,000 total births in Quebec to 6.5 in Nova Scotia.
Research shows that women can reduce their risks of having a baby with a neural tube defect by taking folic acid, or folate, which is a B vitamin. Folic acid is essential for the development of the baby’s brain and spine. Studies have shown that women who take enough folic acid supplements and eat a healthy diet before they become pregnant and during the early part of their pregnancy are less likely to have a baby with a neural tube defect.1

In 1998, the Canadian government required that white flour, enriched pasta, and cornmeal be fortified with folic acid.2 The Public Health Agency of Canada and Health Canada recommended that all women who could become pregnant take a supplement containing 0.4mg of folic acid and suggested a higher dose for women who are at increased risk of having a baby with a neural tube defect.3

According to the 2009–2010 Canadian Community Health Survey, nearly 60% of women aged 20 to 49 years reported taking folic acid before their last pregnancy. However, access to folic acid and prevention of neural tube defects is not equal for all women. Women aged 30 to 49 years were more likely to take folic acid than were younger women. Two-thirds of women with a post-secondary education took the supplements compared to one-third of those without a high school diploma. Moreover, 84% of women in the highest income households took folic acid compared with only 43% of women in the poorest households.
There are also differences among the provinces and territories with regards to the proportion of women taking folic acid prior to pregnancy. Approximately 49% did so in the territories compared with 68% in British Columbia.
According to the Canadian Maternity Experiences Survey, more than three-quarters of women in the survey knew before their pregnancy that folic acid could help prevent some birth defects. Women who knew that this was the case were more likely to take folic acid before and during their pregnancy.¹

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5.3.12 Common Congenital Anomalies – Congenital Heart Defects

Congenital heart defects – where the heart or the blood vessels near the heart do not develop normally before birth – are the most common congenital anomalies. In Canada, 1 in 100 to 150 babies are born with a congenital heart defect.¹ There has been progress in the early diagnosis and surgical treatment of congenital heart defects that has resulted in a decrease in death and illness. Sixty years ago, less than 20% of infants born with complex heart defects lived to adulthood. Today, more than 90% live to adulthood due largely to surgical procedures, the development of regional cardiac surgical centres, and improved medical care.² Despite this progress, congenital heart defects remain the leading cause of childhood death among congenital anomalies in Canada. Children who suffer from the most serious heart defects require complex medical care and can have a greatly compromised quality of life.¹

In most situations, the cause of congenital heart defects is unknown. Although many congenital heart defects can be genetic, viral infections such as rubella (measles) or drug and/or alcohol use during pregnancy are known to increase risks. Thus, the causes are multifactorial. Babies born with congenital anomalies often have other congenital or chromosomal anomalies, such as Down syndrome, trisomy 13 or 18, or Turner syndrome.²

² Congenital Heart Defects. Heart and Stroke Foundation of Canada http://www.heartandstroke.com/site/c.ik0LcMWJRe/b.3484063/
Both the number and the rate of congenital heart defects (determined up to 30 days of age) have decreased. In 1998, the rate was 107.1 per 10,000 total births. By 2009, that rate had decreased by 21% to 85.1 per 10,000 total births.

*Quebec was excluded because data were not available for all years.