

Neural tube defects in Australia

An epidemiological report

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An epidemiological report

**Samanthi Abeywardana
Elizabeth A Sullivan**

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AIHW National Perinatal Statistics Unit
Sydney

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Australian Institute of Health and Welfare

Board Chair

Hon. Peter Collins, AM, QC

Director

Penny Allbon

Any enquiries about or comments on this publication should be directed to:

AIHW National Perinatal Statistics Unit

Sydney Children's Hospital

Level 2 McNevin Dickson Building

Randwick Hospitals Campus

Randwick NSW 2031

AUSTRALIA

Phone: (02) 9382 1014

Email: npsu@unsw.edu.au

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Contents

Acknowledgments	vii
Acronyms and abbreviations	viii
Summary	x
Introduction	1
Background	2
Development and outcomes of neural tube defects	2
Diagnosis of neural tube defects	3
Aetiology	3
Prevention of neural tube defects	4
Mandatory folic acid fortification in Australia	6
Prevalence of neural tube defects in other countries	7
Benefits and risks of folic acid fortification	7
Methods	9
Data sources	9
Analysis	12
Neural tube defects among births	13
Prevalence among births.....	13
Characteristics of births with neural tube defects Australia 1998–2005.....	15
Characteristics of women who gave birth to babies with neural tube defects, Australia, 1998–2005	20
All neural tube defects among births and terminations of pregnancy	24
Prevalence	24
Characteristics of women who had pregnancies affected with neural tube defects	28
Prevalence of neural tube defects among births by individual states	32
Estimated prevalence of NTD based on data from Victoria, South Australia and Western Australia	35
Anencephaly	39
Prevalence	39
Prevalence of anencephaly in other countries/regions	42
Characteristics.....	43
Spina bifida	45
Prevalence	45
Prevalence of spina bifida in other countries	48
Characteristics.....	49

Encephalocele	51
Prevalence	51
Prevalence of encephalocele in other countries/regions.....	54
Characteristics.....	55
Conclusions and recommendations	56
Data development	57
Appendix A: Denominator data	60
Appendix B:	65
National Congenital Anomalies Steering Committee.....	65
State and Territory Implementation Committee for Congenital Anomalies	65
References	66
List of tables	71
List of figures	73

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Acronyms and abbreviations

ABS	Australian Bureau of Statistics
ACAMS	Australian Congenital Anomalies Monitoring System
ACT	Australian Capital Territory
AHMAC	Australian Health Ministers' Advisory Council
AIHW	Australian Institute of Health and Welfare
ASCCSS	Australian Standard Classification of Countries for Social Statistics
ASGC	Australian Statistical Geographical Classification
BPA	British Paediatric Association
CI	confidence interval
FSAG	Folate Scientific Advisory Group
FSANZ	Food Standards Australia New Zealand
g	grams
HDSC	Health Data Standards Committee
ICBDSR	International Clearinghouse for Birth Defects Surveillance and Research
ICD-9-BPA	International Classification of Diseases, 9th Revision, British Paediatric Association Publication
ICD-10-AM	International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification
METeOR	metadata online registry
NCASC	National Congenital Anomalies Steering Committee
NCCH	National Centre for Classification in Health
NHDD	National Health Data Dictionary
NHMRC	National Health and Medical Research Council
NMDS	National Minimum Data Set
NPDC	National Perinatal Data Collection
NPDDC	National Perinatal Data Development Committee
NPSU	National Perinatal Statistics Unit
NSW	New South Wales
NT	Northern Territory
NTD	neural tube defect
PR	prevalence ratio
PRERU	Perinatal and Reproductive Epidemiology Research Unit
Qld	Queensland
RACP	Royal Australian College of Physicians

SA	South Australia
SACC	Standard Australian Classification of Countries
SIMC	Statistical Information Management Committee
STICCA	State and Territory Implementation Committee for Congenital Anomalies
Tas	Tasmania
TOP	Termination of pregnancy
UNSW	University of New South Wales
Vic	Victoria
WA	Western Australia
WHO	World Health Organization
n.p.	not published
..	not applicable

Summary

About this report

This report describes the current prevalence of neural tube defects (NTD) and the trends during the past decade. Characteristics and outcomes of the births and demographic and pregnancy characteristics of the mothers are presented for the period 1998–2005. Information on terminations of pregnancy before 20 weeks gestation is also presented for four jurisdictions where such data are available: New South Wales, Victoria, South Australia and Western Australia.

Among other things, this report provides baseline prevalence data for NTD in Australia, prior to the implementation of mandatory folic acid fortification of bread flour in September 2009. It is expected that the information provided will assist in evaluating the effect of mandatory folic acid fortification in the future.

This report was compiled at the request of the Statistical Information Management Committee (SIMC) of the Australian Health Ministers Advisory Council, using the data collected by the Australian Congenital Anomalies Monitoring System (ACAMS), which is the national data collection of congenital anomalies. State and territory birth defect registries and perinatal data collections provide data on congenital anomalies to ACAMS.

What are neural tube defects?

Neural tube defects are major congenital anomalies that result from very early disruption in the development of the brain and spinal cord. There are three distinct forms of neural tube defects described in this report: *anencephaly*, which is the absence of a major part of the brain, skull and scalp; *encephalocele*, which is a protrusion of brain tissue and/or its covering membranes through a defect in the skull; and *spina bifida*, in which the vertebrae that cover the spinal cord have one or more openings in the middle, allowing exposure and/or protrusion of nervous tissue and coverings with various degrees of damage to nerves.

How is folic acid connected with NTD?

Since the 1960s there has been mounting evidence of a decreased prevalence of NTD with increased intake of folic acid during the period around conception. Folic acid and folate (the anionic form) are forms of Vitamin B. Folic acid and folate occur naturally in food; folic acid may be added to some foods and can also be taken as a supplement. Folate is necessary for the production and maintenance of new cells, which is especially important during periods of rapid cell division and growth such as infancy and pregnancy.

Over the past decade Australian governments have actively promoted folic acid intake around the time of conception in an attempt to reduce the prevalence of NTD. From September 2009 onwards, Australia will join many other developed countries in having mandatory folic acid fortification of flour for bread making, in an attempt to further reduce the prevalence of NTD.

How many NTD are there in Australia?

This report presents the prevalence and trends of births with NTD for all jurisdictions in Australia, except Northern Territory, from 1998–2005. Main findings include:

- There were a total of 944 births over this period affected by NTD. Of these births, 523 were live births and 421 were fetal deaths (still births and terminations after 20 weeks gestation). This equates to a prevalence of neural tube defects (NTD) among births of 4.6 per 10,000.
- There was no significant decrease in NTD among births during the period 1998–2005, despite early diagnosis, health education and health promotion programs and voluntary fortification of food with folic acid.
- While there has been little change in the prevalence of NTD amongst births, there has been a decrease in the overall prevalence of NTD (taking into account births as described above as well as pregnancies that may have been terminated before 20 weeks gestations due to early detection of an NTD). Results from the four states that include these data indicate that during 1998–2005 there were a total of 1,657 pregnancies affected by NTD. However, the prevalence based on four states is likely to be an underestimate. Of these pregnancies, 903 were terminated prior to 20 weeks gestation. The overall prevalence of NTD in these four states, including early terminations, was more than twofold higher (10.1 per 10,000 pregnancies in 2005) than the prevalence at birth. This represents a 32.7% decrease over the 14 years between 1992 and 2005.
- Data from the four states for the period 1998–2005 reveal that more than 77% of pregnancies affected with NTD were fetal deaths or were managed by pregnancy terminations.

Other findings include:

- Younger women are more likely to have NTD-affected pregnancies than older women: teenage women had the highest rate and women aged 30–34 years the lowest.
- The rate of pregnancies affected with NTD was higher for women living in remote areas than for women living in major cities.
- Multiple pregnancies were more likely to have NTD than singleton pregnancies.
- Indigenous women had a higher rate of NTD-affected pregnancies than non-Indigenous women.
- The prevalence of NTD in Australia was similar to or slightly higher than other developed countries.

What is needed for future reporting?

As at least 50% of the pregnancies with NTD were terminated before 20 weeks gestation, collection of data on early terminations is critical in reporting the accurate prevalence of NTD.

A program of national data development is underway with the aim of developing a national minimum data set (NMDS) for congenital anomalies, with the expectation of providing high quality national data on congenital anomalies.

This will be vital for evaluating the effectiveness and outcomes of mandatory folic acid fortification of bread making flour.

Introduction

Neural tube defects (NTD) are common major congenital anomalies that result from very early disruption in the development of the brain and spinal cord. Details of three distinct forms of neural tube defects are described in this report: *anencephaly* which is the absence of a major part of the brain, skull and scalp; *encephalocele* which is a protrusion of brain tissue and/or its covering membranes through a defect in the skull; and *spina bifida* in which the vertebrae that cover the spinal cord have one or more openings in the middle, allowing exposure and/or protrusion of nervous tissue and coverings with various degrees of damage to nerves. Each of these is described in more detail in later sections of the report.

NTD are a significant public health concern in Australia. With advanced medical technology, most NTD are diagnosed early in pregnancy. Many affected women opt for termination of pregnancy while some women may have stillbirths. However termination of pregnancy is not acceptable for some women for cultural, religious or personal reasons. The survivors are known to face frequent morbidity and are at high risk of mortality. Those families who are affected experience considerable emotional and economic difficulties. Hence, primary prevention of neural tube defects is an important health issue.

The mechanisms which cause NTD are still not fully understood, but evidence has shown that increased intake of folic acid during the periconceptional period can decrease the prevalence of NTD. Therefore, many government and non-government organisations have conducted health education and health promotion programs to encourage women contemplating pregnancy to increase their intake of folic acid. Food Standards Australia New Zealand (FSANZ) has allowed voluntary fortification of food with folic acid in Australia since 1995. These initiatives have not decreased the prevalence of NTD to the extent expected, so in June 2007 the Commonwealth Government in partnership with state and territory governments agreed to implement mandatory folic acid fortification of bread flour within a two-year timeframe.

The objective of this report is to provide a baseline prevalence of neural tube defects in Australia, prior to the implementation of mandatory folic acid fortification of bread flour. It is expected that the information provided in this report will assist in evaluating the effect of mandatory folic acid fortification in the future. This report illustrates the current prevalence of NTD and the trends during the past decade. Characteristics and outcomes of the births and demographic and pregnancy characteristics of the mothers are presented for the period, 1998 to 2005. Information on terminations of pregnancy before 20 weeks gestation is also presented for four jurisdictions that include New South Wales, Victoria, South Australia and Western Australia. The Northern Territory data were not available for this report.

This report was compiled at the request of the Statistical Information Management Committee (SIMC) of the Australian Institute of Health and Welfare, using the data collected by the Australian Congenital Anomalies Monitoring System (ACAMS), which is the national data collection of congenital anomalies. State and territory birth defect registries and perinatal data collections provide data on congenital anomalies to the ACAMS. This report is part of the project funded by the Australian Health Ministers' Advisory Council for the development of a national minimum data set for congenital anomalies with the expectation of collecting high quality, consistent congenital anomalies data nationally.

Background

Development and outcomes of neural tube defects

The neural tube, which develops into the human brain and spinal cord, derives from the embryonic dorsal ectoderm that resembles a plate in the early embryo. During the third week of embryonic life the lateral edges of this plate thicken and grow towards each other and fuse along the midline to form a tube by the end of the fourth week. If the neural tube fails to close it affects the development of surrounding tissues resulting in defects of the bones, muscles and skin that cover the neural structures. In open NTD, the nervous tissues are exposed to the amniotic fluid which has a corrosive effect on nervous tissues and further damages the surrounding nerves (Ellenbogen 2006).

The outcome for individuals with NTD depends on the site, the extent of the defect, the type of nerve cells that are involved and the extent of secondary abnormalities. Although most NTD are considered to result from a primary failure of the embryonic neural tube to close, there is some evidence supporting the possibility of a closed neural tube secondarily reopening, resulting in NTD (Campbell & Sohal 1990, Padmanabhan 2006).

The NTD can be open or closed (Lemire 1988). The mildest type of closed NTD is spina bifida occulta which is a benign bony change in one or more vertebrae, but not involving the nerves within the spinal column. This could be more common than the other NTD but prevalence is not known because it may not be obvious and may not show any symptoms. This condition is not counted as an NTD in this report. Open NTD can range from a single small opening in the vertebral canal, to complete lack of closure of the neural tube, which will result in the most severe forms of these defects.

Anencephaly is the most severe form of NTD that results from failure of the closure of the head end of the neural tube and is not compatible with life. A fetus with anencephaly may result in a miscarriage or can be born with a rudimentary brainstem where the baby may die at or within a few days of birth.

Spina bifida results from failure of the closure of the lower end of the neural tube. Babies who survive, usually as a result of extensive medical and surgical care may have mild to severe symptoms depending on the site and extent of nerve exposure or damage (Botto et al. 1999). Surviving infants with spina bifida are likely to have severe life-long disabilities (Date et al. 1999). About 10–15% of cases have spina bifida occulta. The position, extent and types of nerves involved will determine the abnormalities associated with spina bifida. Lower limb paralysis, incontinence, hydrocephalus and learning difficulties can all be present.

An encephalocele results from failure of the surface ectoderm to separate from the neuroectoderm that leads to a bony defect in the skull, allowing herniation of the meninges or of the brain tissue. Some of them survive depending on the severity of the condition.

Survivors of spina bifida and encephalocele may need neonatal intensive care management, surgery, rehabilitation and other specialised management for long periods which require substantial resources. In 2003, the National Center for Birth Defects and Developmental Disabilities (Centers for Disease Control and Prevention, USA) showed that each case of spina bifida prevented saves an estimated US\$500,000 in lifetime costs. The consequences of NTD extend beyond the affected individual to the family for whom there are the emotional and financial costs of caring for a child with disabilities. Society as a whole will carry much of the burden of providing health and social care to affected individuals.

Diagnosis of neural tube defects

The prevalence of NTD at birth depends on the availability of prenatal screening, quality of available methods, and the use of prenatal screening as well as the acceptance of termination of pregnancy as a way of managing affected pregnancies. The option of termination may be unacceptable for some cultures and individuals. This contributes to variations in prevalence at birth and the cost to health care services for surviving children and adults with neural tube defects.

With the availability of technology, most affected pregnancies are diagnosed early and many are managed by termination of pregnancy. The methods used for diagnosis are:

- maternal serum alpha fetoprotein, a screening test that is performed on the blood of pregnant women, at approximately 16–18 weeks of pregnancy
- high-resolution ultrasound
- amniocentesis, a test that samples the amniotic fluid after 15 weeks of pregnancy.

Each of these tests has various risks and benefits. Therefore, a genetic counsellor or other health care provider should be consulted to explain in detail each procedure, their risks and benefits, and other available options. Using these methods, 85–90% of affected pregnancies can be diagnosed. A study in South Australia showed a significant increase in the rate of antenatal detection of NTD through the state-based screening program (ultrasound and/or maternal serum alpha fetoprotein), from 76.3% in 1986 to 95.2% in 2004 (Muller et al. 2007).

Aetiology

The exact aetiology of NTD is poorly understood and is suggested to be multifactorial in origin. Epidemiological studies have established clear variations in the occurrence of NTD among different ethnic groups, different socioeconomic levels and different geographical distributions, and have shown recurrences in families. The NTD are expected to have a significant genetic component in the aetiology that interacts with nutritional factors and a number of environmental factors (Padmanabhan 2006). NTD are not only disorders of embryologic induction but also disorders of cellular migration and include the secondary mechanical complications that occur with an unprotected nervous system (Kashani 2001). Specifically, the amniotic fluid can have a caustic and destructive effect on the open neural structures (Ellenbogen 2006).

The prevalence of NTD among first and second-degree relatives of affected infants appears to be significantly higher than that reported for the general population. Females and monozygotic twins appear to be particularly prone to NTD (Padmanabhan 2006). Family studies suggest the recurrence risk for first-degree relatives of affected individuals could be approximately 1 in 30. For second-degree relatives (the children of the mother's sisters and brothers) the risk is approximately 1 in 220 (Shurtleff 2004). Despite the declining prevalence of NTD in many parts of the world, NTD recurrence within affected families has not declined (Czeizel & Metneki 1984).

Anencephaly is reported to be particularly more prevalent in certain communities with a high rate of consanguinity (Zlotogora 1997; Al-Gazali et al. 1999). Spontaneous abortions with NTD have a significant association with chromosomal aberrations, suggesting a genetic component to their aetiology (Coerdet et al. 1997; McFadden & Friedman 1997). NTD are a feature of known genetic syndromes, such as trisomy 13, trisomy 18, certain chromosome

rearrangements and Meckel-Gruber syndrome. Spina bifida occurs more frequently in babies with autosomal trisomies.

In humans, carbamazepine and valproic acid have been definitively identified as teratogens. Valproic acid is a known folate antagonist and its association with NTD may be through that action. A woman taking valproic acid during pregnancy has an estimated risk of 1–2% of NTD-affected pregnancy (Lindhout et al. 1992; Duncan et al. 2001). A meta-analysis has shown that maternal hyperthermia during early pregnancy is associated with increased incidence of NTD (odds ratio 1.95), showing that the neural tube is heat sensitive in human embryos (Moretti et al. 2005).

Prevention of neural tube defects

Since the 1960s, observational studies, case control studies and randomised control trials have provided evidence of a decreased prevalence of NTD with increased intake of folic acid during the periconceptual period. After the publication of the results of randomised controlled trials, for example the Medical Research Council Vitamin Study in 1991 which reported a 72% reduction in the recurrence of NTD and the Hungarian study by Czeizel et al. (1992) that showed a 100% reduction in NTD in women who had periconceptual folic acid, some countries initiated the active promotion of the use of periconceptual folic acid for women planning to become pregnant.

The Commonwealth and state and territory governments of Australia have also actively taken steps to promote periconceptual folic acid intake. Experts interested in NTD have made enormous efforts to educate susceptible women, health professionals and the people at risk on the advantages of increased intake of folic acid during the period immediately before pregnancy and in the early weeks of pregnancy. There have been many extensive health promotion programs with the aim of increasing the recognition of the importance of periconceptual folate.

In 1994, the National Health and Medical Research Council (NHMRC) of Australia recommended that women who are at low risk and are planning to become pregnant should take 0.5 mg of folic acid daily and women who are at high risk should take 5 mg of folic acid daily around the periconceptual period. The NHMRC also recommended that food should be fortified with folic acid. However, adherence to the recommendations of the NHMRC would be expected to decrease but not eliminate the prevalence of neural tube defects.

Food Standards Australia and New Zealand has allowed voluntary fortification of food with folic acid since 1996. Since then many food items have been fortified with folic acid throughout Australia. Following all these initiatives, there was a reduction of NTD in Australia (Chan et al. 2001, Halliday & Riley 2000, and Bower et al. 2002). However, this reduction was not seen among all ethnic groups and all socioeconomic groups. In Western Australia, there has been a 30% fall in NTD among the non-Indigenous population, but no change has been seen in the Indigenous population (Bower et al. 2004^c). A series of surveys in Western Australia between mid-1992 and March 1995 in relation to training and health promotion activities showed that women who had education up to year 12 or less were not as well informed as women with a tertiary education. Those study participants were asked if they would take folic acid if they plan to become pregnant. Only about two-thirds of those women stated that they would take supplementary folate if they plan to become pregnant. The main barrier to take folate supplements as noted in this study was an unwillingness to take tablets and a preference for a dietary increase of folate (Bower et al. 1997).

A survey in South Australia found that only 30% of women achieved full compliance of recommended folate levels. This survey showed that some supplements on the market had lower levels of folic acid than the recommended level for pregnancy. Only 18% of the survey participants knew the daily recommended dosage of folic acid during pregnancy. Generally consumers rely on the manufacturer to include an adequate amount of folic acid and do not expect low vitamin levels in supplements (Conlin et al. 2006). Under these circumstances, women who consumed supplements expect that they have had enough folic acid to prevent NTD, but in reality they may not have consumed the adequate amounts.

In 2006, Watson et al. reported that the folic acid supplement intake among women prior to conception and in the first three months of pregnancy in Victoria was 36% and in New South Wales was 46%. In 2006, the Queensland Healthy Food Access Basket Survey found that prices for fruit, vegetables and legumes which are major sources of dietary folate, were commonly 21–30% higher in remote areas of Queensland compared with prices in major cities. Therefore consumption of these foods rich in folic acid by the target population in remote areas could be lower than in cities.

In the United States, a March of Dimes survey in 2005 found that many women of reproductive age were unaware of the importance of having folic acid in the period prior to the pregnancy and there is poor compliance among women who opt to take folic acid supplements. Significant levels of public health resources are required to support the implementation and ongoing promotion of dietary education and supplement use. Maintenance of the knowledge gained by health promotion campaigns is difficult, especially because the target population is constantly changing. The provision of health promotional and educational materials only in English language also makes it difficult for non-English speaking women to absorb the message about folic acid. It has been shown that people with higher socioeconomic and educational levels benefit most from dietary education and promotion of supplement use, making these strategies inequitable (Bower et al. 2005).

The *Interim evaluation of the voluntary folate fortification policy* by Abraham and Webb (2001) showed that the criterion for effectiveness defined by the NHMRC Expert Panel, i.e. at least 70% of women consuming more than 400 µg of folate per day, has not been met under voluntary fortification. By November 1998, voluntary fortification had resulted in only a small increase in mean folate intake (11%) among the target population.

As many pregnancies could be unplanned and terminations of pregnancy are not acceptable for some women, intake of folic acid throughout the reproductive age will assist in achieving maximum prevention of NTD. Under these circumstances, fortification of staple food with folic acid is an effective method of increasing folic acid intake in the target group during the periconceptual period.

In 2005, the National Institute of Clinical Studies has also identified mandatory folate fortification of flour as a key issue.

Mandatory folic acid fortification in Australia

The move to implement mandatory folic acid fortification in Australia has been driven by overwhelming evidence from Australian and international research studies. In May 2004, the Australia and New Zealand Food Regulation Ministerial Council requested Food Standards Australia New Zealand (FSANZ) to investigate mandatory fortification of food with folic acid with the expectation of reducing the incidence of NTD. FSANZ established the Folate Scientific Advisory Group (FSAG) to provide scientific advice in relation to 'Proposal P295 Consideration of mandatory fortification with folic acid'. Members of the FSAG are primarily academia from Australia and New Zealand and collectively have researched and published widely on the benefits and risks of folic acid in public health and clinical medicine.

In developing the mandatory folic acid fortification standard, FSANZ comprehensively assessed the potential health benefits and risks from increasing folic acid intake within the population. The overall effects of mandatory fortification on consumers, industry and government enforcement agencies were also assessed.

These safety assessments demonstrated that the increased intake at the expected level of fortification is harmless for the general population. FSANZ selected bread-making flour as the food vehicle for mandatory folic acid fortification in Australia.

The Australian and New Zealand Food Regulation Ministerial Council approved the mandatory fortification of wheat flour with folic acid in Australia, at the recommendation of the FSANZ in June 2007. The draft standard requires the mandatory addition of folic acid to wheat flour for bread making within the prescribed range of 200–300 µg per 100 grams of flour. This level of fortification is expected to prevent between 14 and 49 neural tube defects per year, when combined with existing voluntary fortification permissions and current levels of supplemental use. The standards allow the food industry two years to prepare for folic acid fortification which will become legally enforceable in September 2009. In adopting the new standard, the Ministerial Council has exempted organic wheat flour used for bread making from fortification.

An extensive monitoring system is being finalised to determine the effects of mandatory folic acid fortification. A comprehensive independent review of the mandatory fortification will be initiated two years after implementation of the standard. The review will consider health effects and the general effectiveness of the initiative.

However, FSANZ identified a need to establish a national monitoring and surveillance system, prior to the implementation of mandatory fortification which will assist in assessing the impact of mandatory fortification. FSANZ stated that the responsibility for establishing and funding a monitoring system would require the concomitant involvement of health and regulatory agencies at the Commonwealth and the state and territory levels.

At its June 2005 meeting, the Australian Health Ministers Advisory Council (AHMAC) agreed to recommend to Health Ministers that any decision on mandatory fortification should be accompanied by a national monitoring system for NTD. As a result, the AHMAC funded the development of a national minimum data set for congenital anomalies and this report on NTD.

Prevalence of neural tube defects in other countries

A decreasing trend of NTD has been noted in many developed countries during the last three decades (Olney 2002). The introduction of prenatal screening for NTD, an understanding of the relationship between folic acid intake and NTD, establishment of prevention programs and the fortification of food with folic acid could have contributed to this decreasing trend.

In the United Kingdom and Ireland, yearly prevalence of NTD declined from 45 per 10,000 births in 1980 to 10–15 per 10,000 in the 1990s. This decline was noted before any periconceptional folic acid supplementation policy initiatives. The prevalence in the United Kingdom and Ireland fell by 32% continuing a stronger pre-existing trend and remains slightly higher than overall European levels (Botto et al. 2005).

In the United States, prior to 1998, spina bifida and anencephaly together affected approximately 4,000 pregnancies resulting in 2,500 to 3,000 US births annually. In 1992, the US Public Health Service issued a recommendation that all US reproductive-age women who are capable of becoming pregnant should consume 400 µg of folic acid daily. In 1998, a survey indicated that only 29% of US women were following this recommendation. The US Food and Drug Administration authorised the addition of folic acid to enriched grain products in March 1996 and made compliance mandatory by January 1998. The level of fortification was expected to add approximately 100 µg of folic acid to the daily diet of the average person and to result in approximately 50% of all reproductive-age women receiving 400 µg of folate from all sources. Following this initiative, a 19% reduction in NTD was reported in the USA in 1999 compared with 1996. The spina bifida prevalence declined by 23% (Honein 2001).

After implementation of mandatory folic acid fortification, Canada reported a 46% reduction in NTD (De Wals et al. 2007). More than 40 other countries have implemented mandatory folic acid fortification subsequent to the US and Canada (Maberly & Stanley 2005).

In Northern China there was a 79% reduction observed in NTD after the addition of folic acid supplements to women's diets (Berry et al. 1999).

Benefits and risks of folic acid fortification

Increased folate consumption has been shown to decrease the prevalence of neural tube defects by about 40–70%. Mandatory fortification of bread flour with folic acid will allow all women who become pregnant to have increased blood folate levels and eliminate the need to take supplements. Women who are not aware of the importance of folic acid, who cannot afford it, who do not like or forget to take pills and women who have unplanned pregnancies, will all benefit from increased blood folate levels resulting from folic acid fortification.

There is a concern that folic acid fortification may mask vitamin B₁₂ deficiency, mainly in the elderly. However, severe vitamin B₁₂ deficiency is uncommon and folic acid does not prevent the neurologic consequences of vitamin B₁₂ deficiency (Malouf et al. 2003). It was suggested that people with deficiency will present with early neurological symptoms and available serological tests can easily detect this condition. Nevertheless, the anticipated fortification level is not expected to mask anaemia. A study in NSW (Flood 2001) has shown that it is unlikely to have a large increase in number of older people consuming folic acid more than the upper safety level.

Elevated total homocysteine levels have shown to cause increased risk of arteriosclerotic vascular diseases (Boushey et al. 1995). Some studies have shown lowered homocysteine levels after fortification of food with folic acid (Boushey et al. 1995; Jacques et al. 1999). A study conducted in Western Australia from 1995 to 2001 also has shown a decrease in total homocysteine levels in blood, after voluntary fortification of food with folic acid (Hickling et al. 2005). Therefore, it is anticipated that increased blood folate may lower the rates of heart disease and stroke. Malinow et al. (1998) have suggested that folic acid fortification at levels higher than that recommended for fortification is required to reduce total homocysteine levels. Hence further studies are required to determine whether folic acid fortification may prevent vascular disease.

There may be similar protective effects of folic acid on other congenital anomalies such as oral clefts, limb reduction defects and congenital heart defects. Findings of studies so far have not confirmed whether there are any protective effects.

Some studies suggested that folate can increase twinning rates independently of the use of assisted reproductive technology (Signore et al 2005, Waller et al 2003). However, findings from a large, population-based cohort study in China found that consumption of folic acid supplements during pregnancy was not associated with an increased occurrence of multiple births (Li et al. 2001). A systematic review of the recent literature suggests that well designed, long-term follow-up studies be carried out in places where fortification with folic acid has been introduced, focusing on dose response and obtaining accurate data on infertility treatment (Muggli & Halliday 2007).

Folate is a key component of DNA synthesis and repair, and it is biologically plausible that folate can both protect against the initiation of, and enhance the progression of, cancer (Duthie 1999; Kim 2004). Folate deficiency has an inhibitory effect whereas folate supplementation has a promoting effect on the progression of established neoplasms. In contrast, folate deficiency in normal epithelial tissues appears to predispose them to neoplastic transformation, and modest levels of folate supplements suppress the development of tumours in normal tissues (Kim 2003). Some studies could not show an increased or decreased risk of breast or colorectal cancer with increased use of folic acid (Stolzenburg-Solomon et al. 2006; Tjonneland et al. 2006; Charles et al. 2004; Fuchs et al. 2002). A meta-analysis of observational and genetic association studies of folate intake and breast cancer risk concluded that there was no evidence of increased folate intake protecting against breast cancer (Lewis et al. 2006).

Some studies have shown that folic acid supplementation has been associated with a 15% increase in spontaneous abortions (Cziezel 1992; MRC 1991). However, in a large study conducted in China, Gindler et al. (2001) found no evidence that the daily consumption of 400 µg of folic acid during the periconceptual period influenced the risk for spontaneous abortion.

Anticonvulsants reduce serum folate levels, and treatment with folic acid can result in reductions in circulating levels of the anticonvulsant. This can subsequently lead to an increased numbers of seizures in patients who take anticonvulsants.

Methods

Data sources

The Australian Congenital Anomalies Monitoring System (ACAMS) collates data submitted from state and territory birth defect and perinatal data collections in each of the jurisdictions with the exception of the Northern Territory. Since 1998 the data have been obtained in a standardised format. The ACAMS currently includes congenital anomaly information for births occurring in the years up to 2003. Additional data for births with NTD in 2004 and 2005 were requested from the states and territories specifically for this report. The ACAMS data have been checked for completeness and validity. Records with missing or improbable data values were queried with the relevant providers, who were in most cases, able to correct and resubmit the records.

Queensland, Tasmania and the Australian Capital Territory rely solely on information reported in their perinatal data collections for information about congenital anomalies and only abnormalities diagnosed prior to discharge from hospital can be included. New South Wales, Victoria, Western Australia and South Australia have Birth Defect Registers with multiple sources of ascertainment. In these states the data about congenital anomalies are supplemented by information from other hospitals, cytogenetic laboratories, perinatal death certificates, general practitioners or other doctors, autopsy reports and notifications of terminations of pregnancy. The notification period varies: Victoria collects data on children up to 15 years of age; Western Australia up to 6 years of age; South Australia up to 5 years of age; and New South Wales up to 1 year of age.

South Australia has legislation for mandatory reporting of congenital anomalies data irrespective of gestational age. Therefore, data from the South Australian Birth Defect Register provide almost complete data on congenital anomalies. Western Australia has statutory notification of termination of pregnancy since 1998 and data is expected to be near complete. A study on the completeness of data has shown that the Western Australian Birth Defects Register has been collecting near complete data since prior to 1998 (Bower et al. 2001). The Victorian Birth Defect Register also actively collects data and a study has shown that the data on NTD are almost complete (Riley et al. 2004). The Birth Defect Register in New South Wales relies on voluntary reporting of information about congenital anomalies. Hence in New South Wales the reporting of NTD is not considered to be complete. In particular, there may be data missing on terminations of pregnancy carried out in the private sector.

Differences in ascertainment of congenital anomalies in the states and territories are not likely to substantially affect estimates of the prevalence of NTD at birth. NTD, with a few exceptions, are obvious at birth. Those that are diagnosed later or missed will be those with very minor degrees of spina bifida or the rare cases of spina bifida occulta. Spina bifida occulta is not considered as an NTD for this report.

In all jurisdictions, perinatal data collections gather information about live births and stillbirths (fetal deaths of at least 20 weeks of gestation or at least 400g birthweight). Stillbirths in all states and territories include termination of pregnancy carried out at 20 weeks gestation or thereafter or resulting in the delivery of a fetus weighing 400g or more. Some states are able to distinguish these late terminations of pregnancy from still births, but some states cannot differentiate them. Therefore terminations of pregnancy with at least 20 weeks gestation and stillbirths are included as births and identified as fetal deaths in this report.

Information about NTD in the period 1992–1997 is available for four states. For this period, the Victorian data were obtained from data available in the National Congenital Malformations and Birth Defects Data Collection which preceded ACAMS. Western Australia and South Australia resubmitted data for these years. Information for New South Wales was obtained from published reports; New South Wales mothers and babies 1998 (DOH 2000) and New South Wales mothers and babies 2000 (DOH 2001).

Denominators to compute rates are based on the state or territory of occurrence of births and were obtained from the National Perinatal Data Collection.

Definitions

Anencephaly

A congenital anomaly characterised by the total or partial absence of the cranial vault, the covering skin, and the brain. The brain could be reduced to a small mass. Anencephaly includes infants with craniorachischisis, iniencephaly and other neural tube defects such as encephalocele or open spina bifida, when associated with anencephaly. This excludes acephaly, that is, absence of the head observed in amorphous acardiac twins.

The following codes were used to classify this condition:

ICD-9-BPA codes: 740.00–740.29 or ICD-10-AM codes: Q00.0–Q00.2

Spina bifida

A family of congenital anomalies due to failure in the closure of the spinal column characterised by herniation or exposure of the spinal cord and/or meninges through an incompletely closed spine. Spina bifida in this report includes meningocele, meningomyelocele, myelocele, myelomeningocele and rachischisis. Spina bifida is not counted when present with anencephaly. This excludes spina bifida occulta and sacrococcygeal teratoma without dysraphism.

The following codes were used to classify these conditions:

ICD-9-BPA codes: 741.00–741.99 or ICD-10-AM codes: Q05.0–Q 05.9

Encephalocele

A congenital anomaly characterised by herniation of the brain and/or meninges through a defect in the skull. Encephalocele is not counted when present with spina bifida or anencephaly.

The following codes were used to classify this condition:

ICD-9-BPA codes: 742.00–742.09 or ICD-10-AM codes: Q01.0- Q01.2, Q01.8, Q01.9

Data elements

Sex

Data on the sex of each baby were reported as male, female, indeterminate or not stated.

Gestational age

The estimated gestational age of the baby is given in completed weeks. This may be calculated from the first day of the last menstrual period, ultrasound findings and/or be determined by clinical assessment.

Birthweight

Birthweight is the first weight of the liveborn or stillborn baby obtained after birth, or the weight of the neonate or infant on the date admitted if this is different from the date of birth.

Maternal age

Mother's age was calculated by subtracting their date of birth from the date of birth of their baby. Some states provided maternal age, not the maternal date of birth. Maternal age is presented by five-year age groups.

Indigenous status

Only the Indigenous status of the mother was reported to the ACAMS. In this report, the Indigenous women include mothers who were in the categories of Aboriginal but not Torres Strait Islander origin, Torres Strait Islander but not Aboriginal origin, or Aboriginal and Torres Strait Islander origin. The category reported as non-Indigenous was of neither Aboriginal nor Torres Strait Islander origin.

Remoteness of area of usual residence

The postcode was provided by states and territories for all records. The remoteness of area of usual residence was assigned using postcodes provided to the NPSU. This classification is based on the Australian Standard Geographical Classification (ASGC) remoteness structure (ABS 2001). Because of the small numbers in the data presented, the Remoteness Areas of usual residence categories in this report are presented under three headings: Major Cities, Regional and Remote. (Inner regional and Outer regional are reported as Regional; Remote and Very remote are reported as Remote.)

Plurality

Plurality refers to the number of babies resulting from a single pregnancy. In this report, the plurality category is 'singleton' for single births, and multiple for twins, triplets, quadruplets, quintuplets and other.

Analysis

Two prevalence rates have been calculated: the prevalence rate of NTD amongst births; and the prevalence rate of NTD amongst births and terminations of pregnancy (TOP). The prevalence rate of NTD in births is calculated as the proportion of total births with NTD.

Prevalence of NTD at birth = number of births with NTD/number of total births

The data from South Australia, Western Australia, Victoria and New South Wales include data on births as well as terminations of pregnancy at all gestational ages. Therefore, these data were used to provide an estimated prevalence for the whole country. However, considering the incompleteness of the data from New South Wales, another estimate was also provided using data from three states: Victoria, South Australia and Western Australia

The estimated prevalence rate of NTD amongst births and TOP is calculated as a ratio of the number of NTD and the number of total births.

Prevalence of NTD in pregnancies = number of pregnancies with NTD/ number of total births

Total births include live births and stillbirths. The number of total births in the relevant years and jurisdictions used as denominators were obtained from the National Perinatal Data Collection. All rates at birth and estimated rates that include terminations of pregnancy are expressed per 10,000 births (live births and fetal deaths of at least 20 weeks gestation or at least 400 grams birthweight).

Statistically significant differences in maternal characteristics were determined by comparing prevalence ratios and the confidence intervals around those ratios. The confidence intervals around prevalence ratios were calculated using a method described by Armitage and Berry, (1994).

Prevalence ratio (PR) = prevalence in exposed/prevalence in unexposed

For data analysis, SPSS 15.1 software was used.

There may be slight variations between data given in this report and state and territory reports because of updates to data in state and territory databases.

Neural tube defects among births

Neural tube defects include: anencephaly, spina bifida and encephalocele.

ICD-9-BPA codes: 740.00–742.09

ICD-10-AM codes: Q00.0–Q00.2, Q05.0–Q05.9, Q01.0–Q01.2, Q01.8, Q01.9

Prevalence among births

In Australia, the average prevalence of NTD among births was 4.6 per 10,000 births for the period 1998–2005. Births in this report include all births and fetal deaths at 20 weeks gestation or later or with a birthweight of at least 400 grams. Fetal deaths include stillbirths and pregnancy terminations of at least 20 weeks gestation.

With the availability of improved technology for early diagnosis and facilities for termination of pregnancy, a decline in NTD has been seen among births in many developed countries. However, in Australia, despite all available facilities, health education and health promotion programs through government and non-government organisations and voluntary fortification of food with folic acid, there seems to be no decrease in NTD among births during the period 1998 to 2005. The prevalence decreased by about 18% from 5.0 per 10,000 births in 1998 to 4.1 per 10,000 births in 2003, but it had returned to 5.0 per 10,000 births in 2004 (Figure 1).

More than half of those births were live births, and the prevalence of live births with NTD was 2.6 per 10,000 births. The fetal death rate was about 2.0 per 10,000 births; this rate has not changed significantly since 1998 (Table 1.1). Of the liveborn babies, about 71% were alive on day 28 (1.8 per 10,000 live births). In 2005, the proportion of babies with NTD who were alive on day 28 had increased to about 76% and the proportion of neonatal deaths had decreased (Table 1.2). With advancing medical knowledge and technology, more babies may survive and live longer, requiring long-term medical care and rehabilitation.

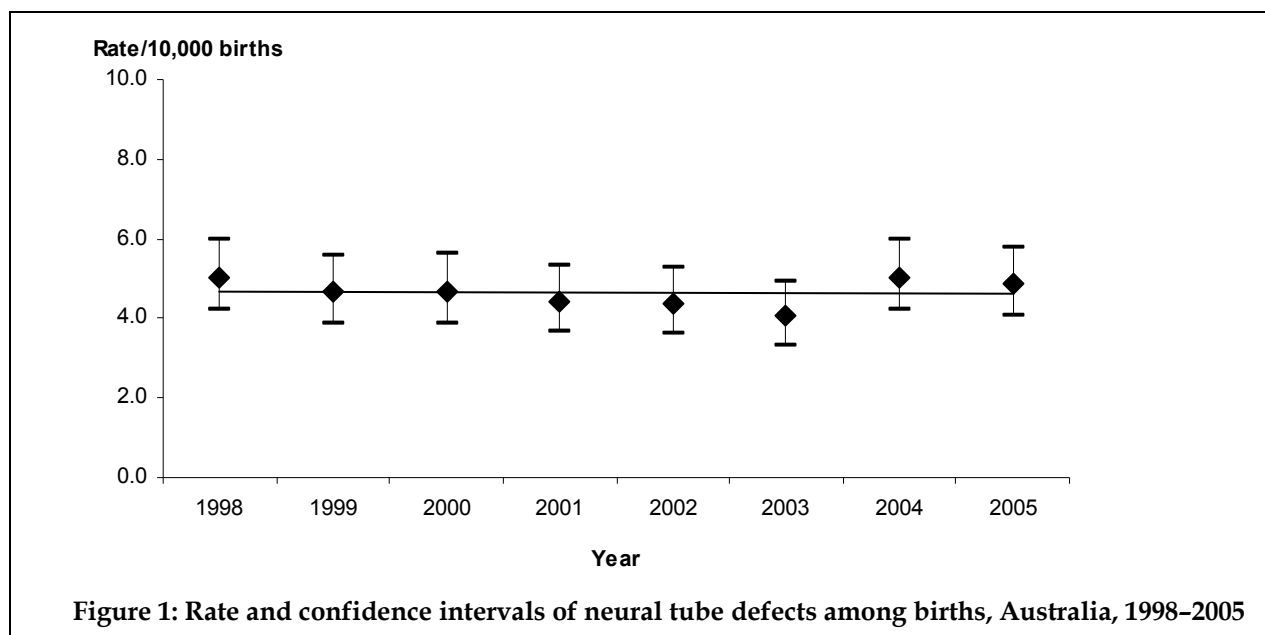


Table 1.1: Number and rates of NTD among births^(a) as reported to the ACAMS, Australia, 1998–2005

Year	Live births			*Fetal deaths			All births	
	Number	Per cent ^(b)	Rate ^(c)	Number	Per cent ^(b)	Rate ^(c)	Number	Rate ^(c)
1998	73	57.9	2.9	53	42.1	2.1	126	5.0
1999	72	61.5	2.8	45	38.5	1.8	117	4.6
2000	74	62.2	2.9	45	37.8	1.8	119	4.7
2001	58	52.3	2.3	53	47.7	2.1	111	4.4
2002	57	51.8	2.3	53	48.2	2.1	110	4.4
2003	48	46.6	1.9	55	53.4	2.1	103	4.1
2004	71	55.9	2.8	56	44.1	2.1	127	5.0
2005	70	53.4	2.6	61	46.6	2.2	131	4.9
1998–2005	523	55.2	2.6	421	44.8	2.0	944	4.6

(a) Includes all live births, stillbirths and pregnancy terminations of at least 20 weeks gestation or at least 400 g birthweight.

(b) Percentage of all births with NTD.

(c) Rates are per 10,000 live births and stillbirths.

* Still births and pregnancy terminations of at least 20 weeks gestation are included in fetal deaths.

Table 1.2: Outcomes of live births with NTD, Australia, 1998–2005

Year	Live births	Alive on day 28		Neonatal deaths			Outcome not stated	
	Number	Number	Per cent ^(a)	Rate ^(b)	Number	Per cent ^(a)		Rate ^(b)
1998	73	49	67.1	2.0	24	32.9	1.0	0
1999	72	53	73.6	2.1	19	26.4	0.8	0
2000	74	56	75.7	2.2	18	24.3	0.7	0
2001	58	42	72.4	1.7	15	25.9	0.6	1
2002	57	39	68.4	1.6	18	31.6	0.7	0
2003	48	32	66.7	1.3	16	33.3	0.6	0
2004	71	48	67.6	1.9	22	31.0	0.9	1
2005	70	53	75.7	2.0	16	22.9	0.6	1
1998–2005	523	372	71.1	1.8	148	28.3	0.7	3

(a) Percentages are per 100 live births each year.

(b) Rates are per 10,000 live births.

The outcome of the live births at the end of the neonatal period was available for all but three babies. The prevalence of NTD among births was lowest in 2003. The live birth rate was also the lowest in this year, but the rates increased again in 2004. The neonatal death rate declined slightly during the period 1998–2005 (Table 1.2). Of all births with NTD, 39.4% survived at least until the end of the neonatal period (28 days).

Characteristics of births with neural tube defects Australia 1998–2005

Sex

On average, the rates of male and female births with NTD were similar between 1998 and 2005, but there were slight fluctuations in some years (Figure 2). The average rates were also similar for both live births and fetal deaths with NTD. However, the neonatal death rate was slightly higher for males than for females, leaving more female babies alive at the end of the neonatal period. There were 52% females and 48% males among the babies who survived at least 28 days. Nevertheless, female predominance among NTD has been shown in other countries. There were 2.4% births with indeterminate sex (Table 1.3).

Table 1.3: Sex of the births with NTD and the outcome, Australia, 1998–2005

Sex		Total births	*Fetal deaths	Live births	Alive on day 28 ^(a)	Neonatal deaths ^(a)
Male	Number	473	212	261	179	81
	Per cent	49.8	50.4	49.9	48.1	54.7
	Rate ^(b)	4.5	2.0	2.5	1.7	0.8
Female	Number	454	198	256	193	63
	Per cent	47.8	47.0	48.9	51.9	42.6
	Rate ^(c)	4.6	2.0	2.6	2.0	0.6
Indeterminate or not stated	Number	17	11	6	0	4
	Per cent	2.4	2.6	1.1	0.0	2.7
Total	Number	944	421	517	372	148
	Per cent	100	100	100	100	100

(a) Rates are per 10,000 live births in each group.

(b) Rates are per 10,000 male births.

(c) Rates are per 10,000 female births.

* Stillbirths and pregnancy terminations of at least 20 weeks gestation are included in fetal deaths.

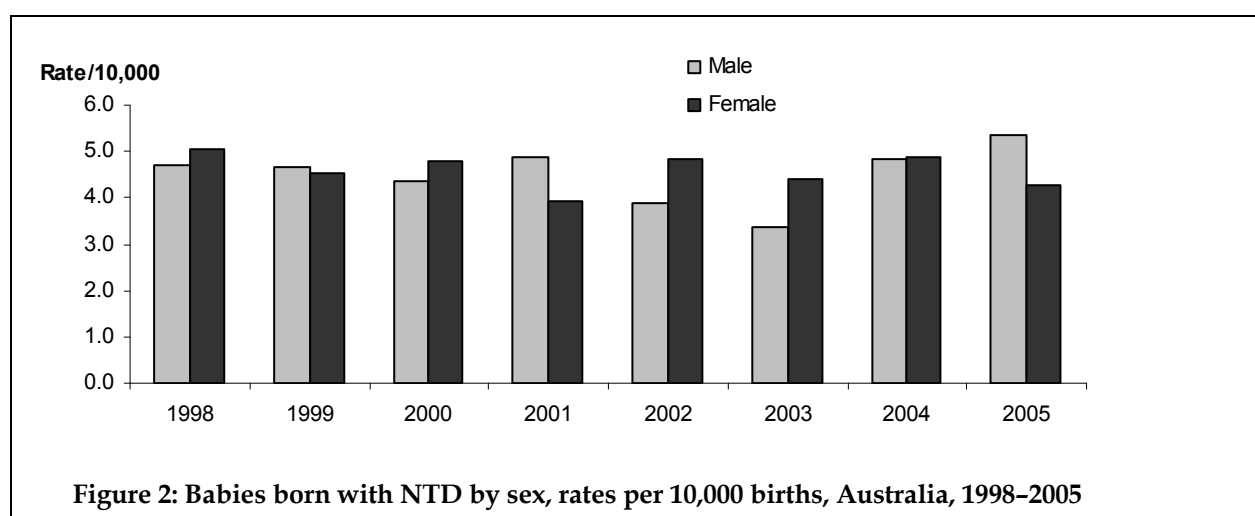


Figure 2: Babies born with NTD by sex, rates per 10,000 births, Australia, 1998–2005

Gestational age

About 47% of the births with NTD occurred at less than 32 weeks gestation, and 82.4% of these were fetal deaths. The large proportion of fetal deaths in this gestational age group indicates a large number of terminations of pregnancy after 20 weeks gestation (Figure 3). Of the remaining 17.6% (n: 78) of live births in this less than 32 weeks gestational age group, only 11.5% (n: 9) survived to the end of the neonatal period. The prevalence of NTD among births that occurred before 32 weeks gestation was 133.6 per 10,000 births, but the prevalence of live births with NTD was 23.5 per 10,000 births. The neonatal death rate among these very preterm babies was 20.8 per 10,000 births (Table 1.4). There were more male births than female births (226 versus 205) in this gestational age group.

Among the births that occurred between 32 and 36 weeks gestation, 79.8% were live births and 54.2% of them were alive on day 28. Of all the babies born before 36 weeks gestation, only 9.9% survived until the end of the neonatal period (Table 1.4).

About 41% (n: 385) of the births with NTD were born at term and 91.9% (n: 354) were live births. By day 28, 88.7% (n: 314) of those babies were still alive (Table 1.4).

As all babies born at less than 32 weeks gestation are treated in level 3 neonatal intensive care units in Australia and some of the other babies born alive with NTD may require assisted ventilation or surgery, a considerable number of babies who survive with NTD may require management in intensive care units.

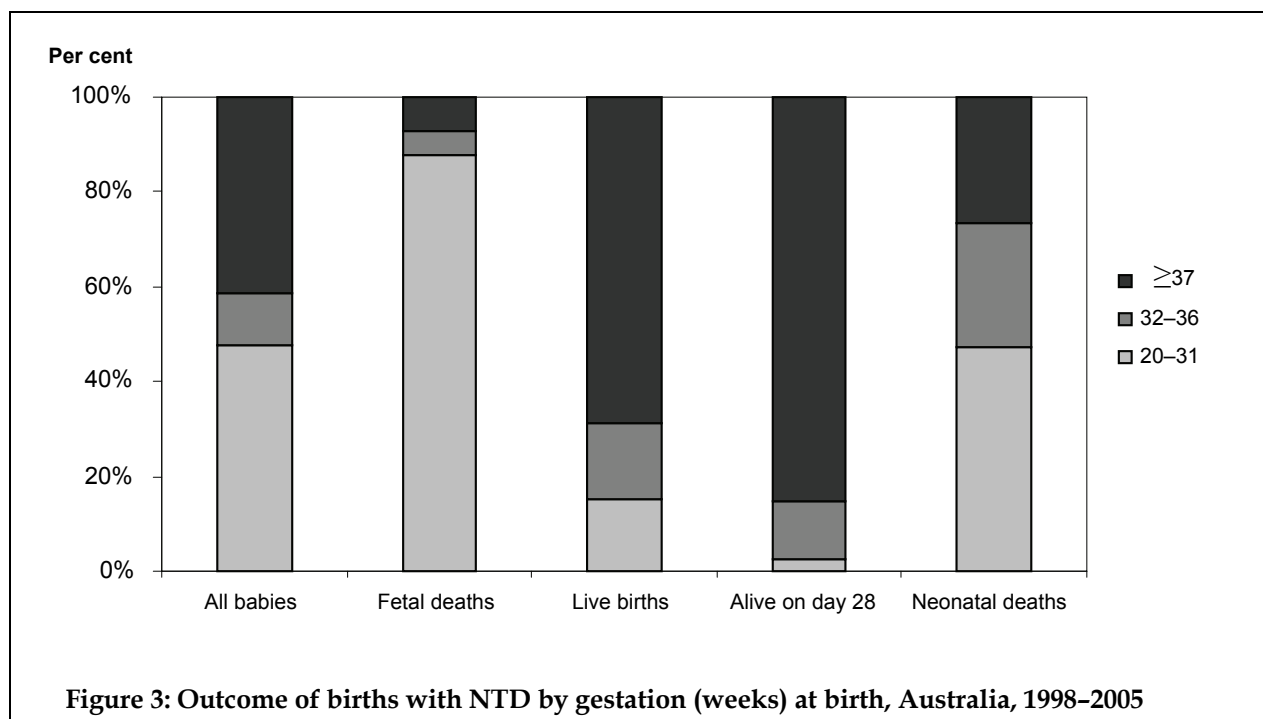


Table 1.4: Gestational age of the births^(a) with NTD and the outcome, Australia, 1998–2005

Gestational age group		Total births	**Fetal deaths	Live births	Alive on day 28	Neonatal deaths
20–31	Number	443	365	78	9	69
	Per cent	46.9	86.7	14.9	2.4	46.6
	Rate ^(b)	133.6	110.0	23.5	*2.7	*20.8
32–36	Number	104	21	83	45	38
	Per cent	11.0	5.0	15.9	12.1	25.7
	Rate ^(c)	8.3	1.7	6.6	*3.6	*2.9
≥ 37	Number	385	31	354	314	39
	Per cent	40.8	7.3	67.7	84.4	26.3
	Rate ^(d)	2.1	0.2	1.9	*1.7	*0.2
Unknown	Number	12	4	8	4	2
	Per cent	1.3	1.0	1.5	1.1	1.4
Total	Number	944	421	523	372	148
	Per cent	100	100	100	100	100

(a) Includes all births and pregnancy terminations with at least 20 weeks gestation or at least 400 g birthweight.

(b) Rates are per 10,000 of all births at less than 32 weeks gestation.

(c) Rates are per 10,000 of all births between 32 and 36 weeks gestation.

(d) Rates are per 10,000 of all births at term.

* Rates are per 10,000 live births.

** Fetal deaths include still births and pregnancy terminations with at least 20 weeks gestation.

Birthweight

Birthweight was available for about 75% of births. More than 85% of the births for which birthweights were not recorded occurred at less than 25 weeks gestation, indicating these could be terminations of pregnancy.

Birthweight was less than 1500 grams for 21% (n: 198) of all births with NTD and only 28.3% (n: 56) of these were live births. The highest neonatal death rate was seen in this birthweight group. Only 10 of those very low birthweight babies survived more than 28 days (Table 1.5).

Of the babies who had a birthweight of 1,500–2,499 grams, 79.8% were born alive and more than half (52.7%) of them lived at least 28 days.

About 38% of babies who were born with NTD were at least 2,500 grams birthweight. Of those babies, 94.7% were live births and about 92% of them survived until the end of the neonatal period (Table 1.5).

Table 1.5: Birthweight of the babies born with NTD and the outcome, Australia, 1998–2005

Birthweight		*All births	Fetal deaths	Live births	Alive on day 28	Neonatal deaths
<1,500 g	Number	198	142	56	10	46
	Per cent	21.0	33.7	10.7	2.7	31.1
	Rate ^(a)	65.5	46.9	18.5	3.3	15.2
1,500–2,499 g	Number	114	23	91	48	42
	Per cent	12.1	5.5	17.4	12.9	28.4
	Rate ^(b)	10.6	2.1	8.5	4.5	3.9
≥2,500 g	Number	357	19	338	311	27
	Per cent	37.8	4.5	64.6	83.6	18.2
	Rate ^(c)	1.9	0.1	1.8	1.6	0.1
Unknown	Number	275	237	38	3	33
	Per cent	29.1	56.3	7.3	0.8	22.3
Total	Number	944	421	523	372	148
	Per cent	100	100	100	100	100

(a) Rate is per 10,000 of all births with less than 1500 g birthweight.

(b) Rate is per 10,000 of all births with 1500–2499 g birthweight.

(c) Rate is per 10,000 of all births with at least 2500 g birthweight.

* All live births and fetal deaths including terminations of pregnancy with at least 20 weeks gestation or at least 400 g birthweight.

Plurality

The rate of NTD was more than five times higher among multiple births compared with singleton births (23.7 per 10,000 versus 4.4 per 10,000 births). This difference was statistically significant (PR=5.4, 95% CI 4.3–6.8). More singletons were alive at birth than multiple births. About 68% of multiple births were fetal deaths.

More singleton babies who were born alive survived at least to the end of their neonatal period compared with babies from multiple births (89% versus 80%). The risk of neonatal death was higher in multiple births affected with NTD than in singleton births.

In 2004 and 2005, the number of women who had affected multiple births was lower than in the period 1998–2003, whereas the number of women who had affected singleton births increased during this period. The prevalence of affected multiple births declined from average 26.8 per 10,000 in 1998–2003, to 12.6 per 10,000 multiple births in 2004–2005.

Table 1.6: Outcome of births with NTD by plurality, Australia, 1998–2005

Outcome		Singleton	Multiple
*Total births	Number	866	78
	Rate ^(a)	4.4	23.7
Live births	Number	396	25
	Per cent ^(b)	45.7	32.1
	Rate ^(a)	2.0	7.6
**Fetal deaths	Number	470	53
	Per cent ^(b)	54.3	67.9
	Rate ^(a)	2.4	16.1
Alive on day 28	Number	352	20
	Per cent ^(c)	88.9	80.0
	Rate ^(d)	1.8	0.1

(a) Rates are per 10,000 live births and stillbirths of at least 20 weeks gestation or at least 400 g birthweight in each group.

(b) Percentage of all births.

(c) Percentage of all live births.

(d) Rates are per 10,000 live births.

* Total births include live births, stillbirths and terminations of pregnancy with at least 20weeks gestation or at least 400 g birthweight.

** Fetal deaths include stillbirths and terminations of pregnancy with at least 20 weeks gestation.

Characteristics of women who gave birth to babies with neural tube defects, Australia, 1998–2005

The births in this report include live births, stillbirths and terminations of pregnancy of at least 20 weeks gestation or at least 400 grams birthweight.

From 1998 to 2005, there were 944 women who gave birth or terminated a pregnancy affected with a NTD (rate 4.7 per 10,000 women who gave birth) of at least 20 weeks gestation or at least 400 grams birthweight (Table 1.7). The number of women who had a live birth with an NTD was 523 (rate 2.6 per 10,000 women who gave birth). This is equivalent to 55% of women who had affected births (Table 1.8). There was a slight reduction in the rate of affected women until 2003, but the rate increased again in 2004 (Table 1.7). The rate of fetal deaths among affected women did not change during this period.

Women's age

A higher rate of pregnancies affected with NTD was seen among younger women compared with older women. About 83% of the affected births were seen in women less than 35 years of age (Table 1.7).

There was a reduction in NTD-affected birth rates in teenage women from 1999 to 2003, but the rate increased again in 2004. Women in the 20–24 year age group had a lower rate only in 2002. The rates did not change markedly for women of other age groups (Table 1.7).

However, the average rate was higher for women less than 30 years of age than for women aged 30 years or more (5.3 per 10,000 versus 4.0 per 10,000). This difference was statistically significant (PR=1.3, 95% CI 1.1–1.5).

Table 1.7: Number of women who gave birth^(a) at 20 weeks gestation or later by age group and year of birth, Australia, 1998–2005

Women's age	1998	1999	2000	2001	2002	2003	2004	2005	Total
<20	8	11	7	7	5	3	10	6	57
20–24	23	22	33	29	14	19	26	30	196
25–29	55	35	24	32	30	30	34	32	272
30–34	25	29	31	25	42	32	33	38	255
≥35	14	18	23	17	17	18	21	24	152
Not stated	1	2	1	1	1	0	3	1	10
Total	126	117	119	111	110	103	127	131	944
^(b)Rate / 10,000 births									
<20	6.4	9.1	5.8	5.9	4.3	2.8	9.0	5.3	6.1
20–24	5.6	5.6	8.6	7.6	3.8	5.2	7.2	7.8	6.4
25–29	6.8	4.4	3.1	4.3	4.2	4.3	5.0	4.5	4.6
30–34	3.4	3.8	4.0	3.1	5.1	3.8	3.9	4.2	3.9
≥35	3.6	4.2	5.4	3.9	3.8	3.8	4.3	4.4	4.2
All women	5.1	4.7	4.8	4.5	4.3	4.0	5.0	4.8	4.7

(a) Births include all live births and stillbirths and pregnancy terminations of at least 20 weeks gestation or at least 400 g birthweight.

(b) Rates are per 10,000 women who gave birth.

Women aged less than 30 years had a higher rate of NTD-affected live births than older women, and more babies born to women of this age group survived at least until the end of the neonatal period. The neonatal death rate was highest among births to teenage women. Women aged 40 years or more had the lowest rate of babies alive at the end of neonatal period. The neonatal death rate for women aged 40 years or more was similar to women younger than 25 years of age (Table 1.8).

Table 1.8: Outcome of live births^(a) with NTD by women's age group, Australia, 1998–2005

Women's age (years)	Live births		Alive on day 28			Neonatal deaths		
	Number	Rate ^(b)	Number	Per cent	Rate ^(b)	Number	Per cent	Rate ^(b)
<20	29	3.1	19	65.5	2.0	10	34.5	1.1
20–24	105	3.4	76	72.4	2.5	29	27.6	1.0
25–29	155	2.6	112	72.3	1.9	42	27.1	0.7
30–34	142	2.2	102	71.8	1.6	40	28.2	0.6
35–39	74	2.4	56	75.7	1.8	18	24.3	0.6
≥40	13	2.2	7	53.8	1.2	6	46.2	1.0
Not known	5	..	0	..	..	0	..	..
Total	523	2.6	372	71.1	1.9	148	28.3	0.7

(a) Includes all live births of at least 20 weeks gestation or at least 400 g birthweight.

(b) Rates are per 10,000 women in each age group who gave birth.

Many women with NTD-affected pregnancies delivered before 32 weeks of gestational age (46.9%). About 56% of the women who gave birth before 32 weeks were less than 30 years of age (Table 1.9). The rate of delivery at less than 32 weeks was high for all age groups of women. The number of teenage women who gave birth at 32–36 weeks was very small and not presented in the table. As terminations of pregnancy at or later than 20 weeks were included as births, some of these births could be late terminations. Of the 40.8% (n: 385) women who gave birth at term, 53.0% were less than 30 years of age (Table 1.9). Poor antenatal care, lack of awareness on periconceptional folate use and unplanned pregnancy could be some reasons for higher rates of NTD and late terminations in younger women.

The rate of NTD among multiple births was higher than the NTD rate among singleton births for each age group. Among multiple births the rate was highest in the 20–24 year age group.

Table 1.9: Women who had NTD-affected births^(a) by age group and gestation at delivery

Women's age (years)	<32 weeks		32–36 weeks		≥37 weeks		Gestation not stated
	Number	Rate ^(b)	Number	Rate ^(b)	Number	Rate ^(b)	
<20	34	151.0	n.p.	3.2	20	2.4	1
20–24	96	192.2	29	16.0	70	2.5	1
25–29	120	155.9	35	10.9	114	2.0	3
30–34	115	138.1	26	7.6	112	1.8	2
≥35	75	126.4	12	5.3	66	2.0	1
Not known	3	..	0	..	3	..	4

(a) All live births and fetal deaths including terminations of pregnancy with at least 20 weeks gestation or at least 400 g birthweight.

(b) Rates are per 10,000 women in each age group who gave birth.

Indigenous status

Indigenous women were at higher risk of births affected with NTD than non-Indigenous women (9.1 versus 4.4). This difference was statistically significant (PR=2.1, 95% CI 2.0–2.2). About 56% of births among both groups were live births. Indigenous babies with NTD are more likely to be alive on day 28, but also have two-fold higher risk of neonatal death than non-Indigenous babies (Table 1.10). About 75% of Indigenous women who had NTD-affected births were less than 30 years old, whereas only about 54% of affected non-Indigenous women were in this age group. The risk of having an NTD-affected pregnancy was similar among teenage women, but the risk increased more than two-fold with increasing maternal age in Indigenous women. Non-Indigenous women had a decreasing risk with increasing age (Table 1.10).

Table 1.10: Characteristics of women who gave birth^(a) by Indigenous status, 1998–2005, Australia

	Indigenous			Non-Indigenous			Unknown	Total
	Number	Per cent ^(b)	Rate ^(c)	Number	Per cent ^(b)	Rate ^(c)	Number	Number
Status of the baby								
Live births	36	56.3	5.1	482	55.9	2.5	5	523
**Fetal deaths	28	43.8	4.0	381	44.1	1.9	12	421
*Total births	64	100.0	9.1	863	100.0	4.4	17	944
Outcome of the baby								
Alive on day 28	24	66.7	3.4	345	71.6	1.8	3	372
Neonatal deaths	12	42.9	1.7	134	27.8	0.7	2	148
Not stated	0	..	..	4	0.6	..	0	4
Women's age (years)								
<20	8	12.5	5.1	48	5.6	6.1	1	57
20–24	23	35.9	10.5	169	19.6	6.0	4	196
25–29	17	26.6	9.7	250	29.0	4.4	5	272
30–34	10	15.6	9.5	243	28.2	3.8	2	255
≥35	6	9.4	12.1	145	16.8	4.1	3	154
Not stated	0	..	..	8	0.9	..	2	10
Gestational age at delivery (weeks)								
<32	31	48.4	128.2	403	46.7	131.9	9	443
32–36	13	20.3	16.2	88	10.2	7.5	3	103
≥37	19	29.7	3.1	362	41.9	2.0	4	385
Not stated	1	1.6	..	10	1.2	..	1	12
Plurality								
Singleton	56	87.5	8.0	796	92.2	4.2	13	866
Multiple	8	12.5	99.1	67	7.8	21.1	3	78

(a) Includes all live births, stillbirths and pregnancy terminations of at least 20 weeks gestation or at least 400 g birthweight.

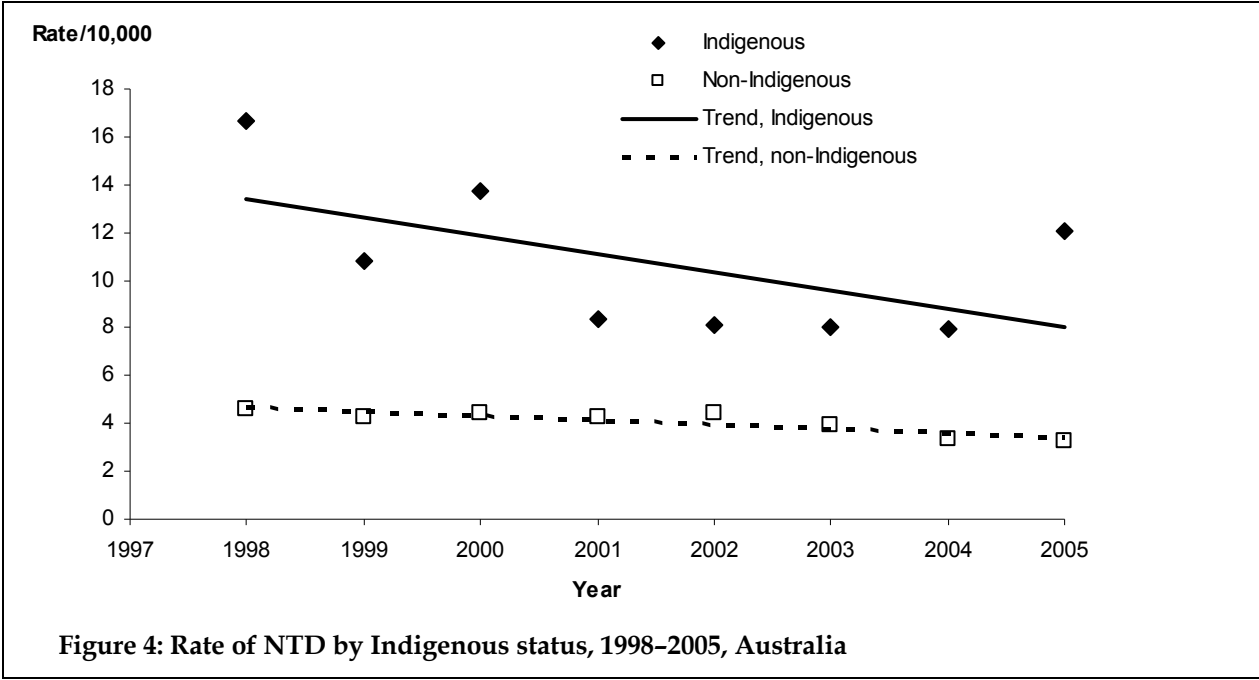
(b) Percentages are per 100 women who gave birth in each group by Indigenous status.

(c) Rates are per 10,000 women who gave birth in each group by Indigenous status.

* Total births include live births, stillbirths and terminations of pregnancy with at least 20weeks gestation or at least 400 g birthweight.

** Fetal deaths include stillbirths and terminations of pregnancy with at least 20 weeks gestation.

Indigenous women were more likely to give birth after 31 weeks gestation compared with non-Indigenous women. Indigenous women who had multiple births had a higher rate of NTD-affected births compared with non-Indigenous women who had multiple births. These data show a decreasing trend of NTD-affected births among Indigenous women, but this could be due to under-reporting of Indigenous status from some states and territories (Figure 4).



Remoteness of the women’s residence

Table 1.11: Remoteness of the residence of women who had NTD-affected births^(a), 1998–2005, Australia

Area of Remoteness	Number	Per cent	Rate ^(b)
Major cities	565	66.6	4.3
Regional areas	245	28.9	4.3
Remote areas	38	4.5	7.7

(a) Includes all live births, stillbirths and pregnancy terminations of at least 20 weeks gestation or at least 400 g birthweight.

(b) Rate is per 10,000 women who gave birth in each area of remoteness.

The remoteness of the area of residence of women who gave birth to a baby with NTD was available for 848 women (89.8% affected women). Two-thirds of the women who gave birth to a baby with an NTD lived in major cities. The proportion of women who lived in remote areas and had a birth with NTD was very small. Nevertheless, these women were more likely to have a birth affected with NTD (Table 1.11). The difference between women who lived in major cities and remote areas and the difference between women who lived in regional areas and remote areas were statistically significant (PR = 1.8, 95% CI 1.6–2.0).

All neural tube defects among births and terminations of pregnancy

These data were provided from birth defect registers of New South Wales, Victoria, South Australia and Western Australia. The data include early terminations of pregnancy (gestational age less than 20 weeks), late terminations of pregnancy of at least 20 weeks gestation and all births including live births and stillbirths. These states collect data from multiple sources, and the duration of collection differs from state to state; Victoria collects data up to the age of 15 years; Western Australia up to the age of 6 years; South Australia up to the age of 5 years and New South Wales up to 1 year. Because most neural tube defects are obvious at birth, the numbers of defects at birth from these four states are expected to be almost complete. Spina bifida occulta, which is a mild form of NTD and not obvious at birth is not included in this report. However, there may be some missing data on terminations of pregnancy before 20 weeks gestation. The largest proportion of missing data is expected to be from New South Wales where the largest number of births occurs, which is equivalent to one-third of births in Australia.

Every year, more than 75% of the births in Australia occur in these four states, and the states cover a wide range of geographical areas, all ethnic groups living in Australia, different socioeconomic status and various environments. Studies have shown evidence of the relationship between these factors and the occurrence of NTD. Therefore, an estimated overall prevalence rate for NTD was calculated on the data provided by these four states. All rates given in this section include live births, stillbirths and terminations of pregnancy at all gestations. The denominators include only live births and fetal deaths from these four states, because the total number of terminations is not known. Detailed data for NTD were not available for the period 1992–1997 for all four states. Therefore, only the number and prevalence up to 1998 are presented in this report.

Prevalence

In 1992 the overall estimated NTD rate based on the data from four states was 15.0 per 10,000 pregnancies. This rate slightly decreased in 1993 and 1994, but increased again in 1995. The highest prevalence between 1992 and 2005 was seen in 1995 and the lowest prevalence was in 2003. The decline in the rate of NTD-affected pregnancies from 1995 to 2003 was 37.4%. Between 1992 and 2005, there was a 32.7% decline in the estimated prevalence of NTD in these four states. However the decline between 1998 and 2005 was only 10.6%. A major decline occurred until 1998 (Figure 5, Table 2.1).

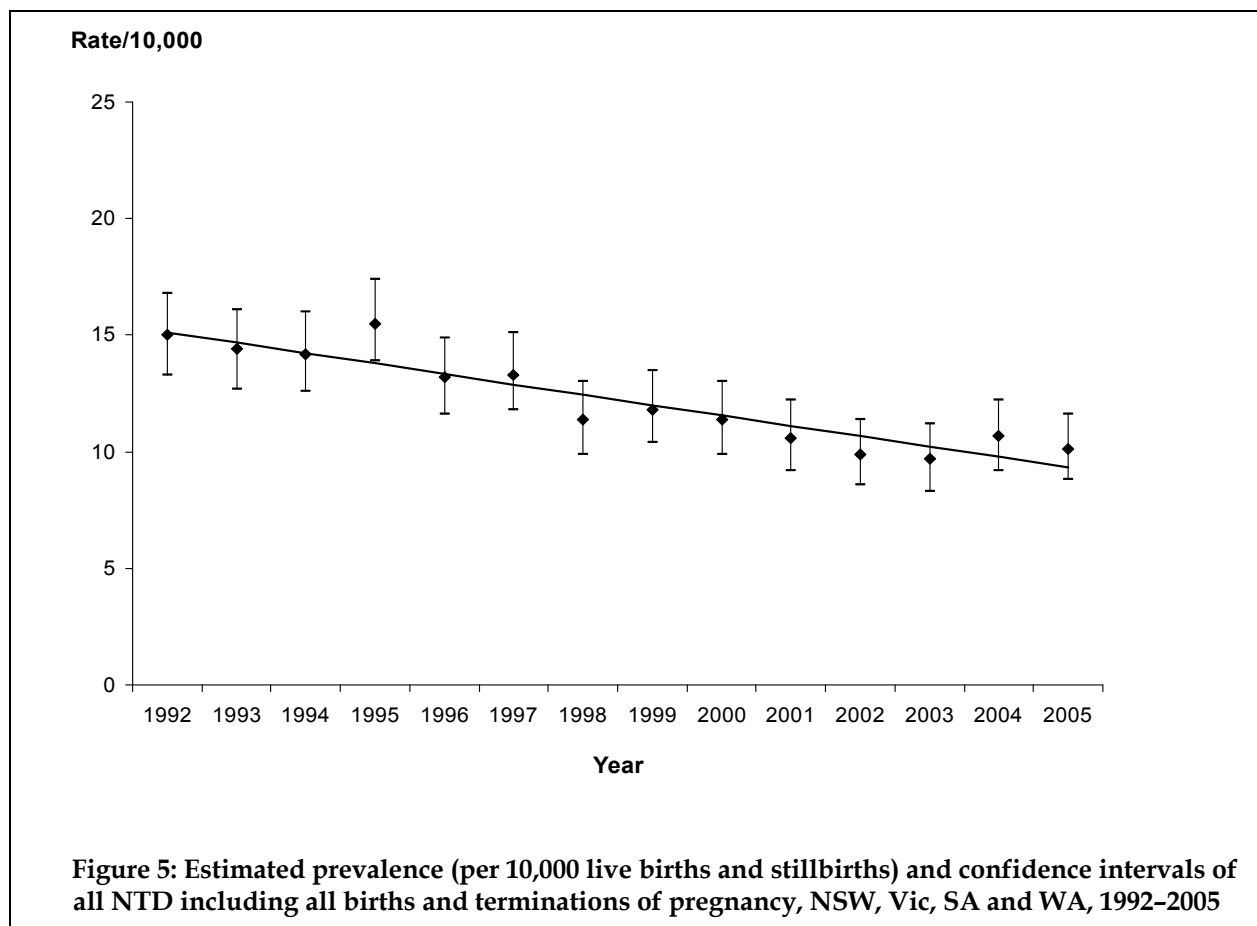


Table 2.1: Total number of NTD^(a) by year of pregnancy, NSW, Vic, SA and WA, 1992–2005

Year	Number	Rate ^(b)	95% CI
1992	301	15.0	13.3–16.8
1993	284	14.4	12.7–16.1
1994	281	14.2	12.6–16.0
1995	305	15.5	13.9–17.4
1996	256	13.2	11.6–14.9
1997	259	13.3	11.8–15.1
1998	218	11.3	9.9–13.0
1999	230	11.8	10.4–13.5
2000	220	11.4	9.9–13.0
2001	204	10.7	9.2–12.2
2002	190	9.9	8.6–11.4
2003	186	9.7	8.3–11.2
2004	205	10.7	9.2–12.2
2005	205	10.1	8.8–11.6

(a) Includes live births, stillbirths and terminations of pregnancy at all gestational ages.

(b) Rates are per 10,000 live births and stillbirths.

Outcomes of the pregnancies and available characteristics of women who had pregnancies affected with NTD were provided by four states for the period 1998–2005.

Each year, during the period 1998–2005, at least 50% of pregnancies with NTD were terminated before 20 weeks gestation. This demonstrates that the collection of termination of pregnancy data for all gestations is essential to estimate the accurate prevalence of NTD. From 1998 to 2005, more than 77% of pregnancies with NTD were managed by terminations or resulted in stillbirths. The lowest NTD-affected live birth rate was in 2003 and has increased again in 2004. However, the fetal death rate increased by 17.9% from 1998 to 2005, probably due to increased terminations of pregnancy after 20 weeks of gestation. A decline (22.2%) in terminations of pregnancies before 20 weeks gestation was seen during the period 1998 to 2005. The lowest overall estimated NTD prevalence was seen in 2003 (Table 2.2).

Between 1998 and 2005, 23% of the NTD-affected pregnancies were live births and 71% of those babies were alive on day 28 (rate 1.8 per 10,000 pregnancies). The proportion of babies alive by the end of the neonatal period decreased until 2002 and increased again in 2003. The neonatal death rate has not changed markedly since 1998 (Table 2.3).

Table 2.2: All pregnancies affected with NTD by outcome, NSW, Vic, SA, and WA, 1998–2005

Year	Live births		**Fetal deaths		TOP <20 weeks		All NTD	
	Number	Rate ^(a)	Number	Rate ^(a)	Number	Rate ^(a)	Number	Rate ^(a)
1998	51	2.6	45	2.3	122	6.3	218	11.4
1999	50	2.6	40	2.1	140	7.2	230	11.8
2000	54	2.8	39	2.0	127	6.6	220	11.4
2001	46	2.4	49	2.6	109	5.7	203	10.6
2002	43	2.2	46	2.4	101	5.3	190	9.9
2003	37	1.9	47	2.4	102	5.3	186	9.7
2004	53	2.8	50	2.6	102	5.3	205	10.7
2005	48	2.4	57	2.8	100	4.9	205	10.1

(a) Rates are per 10,000 live births and stillbirths.

** Fetal deaths include stillbirths and pregnancy terminations of at least 20 weeks gestation.

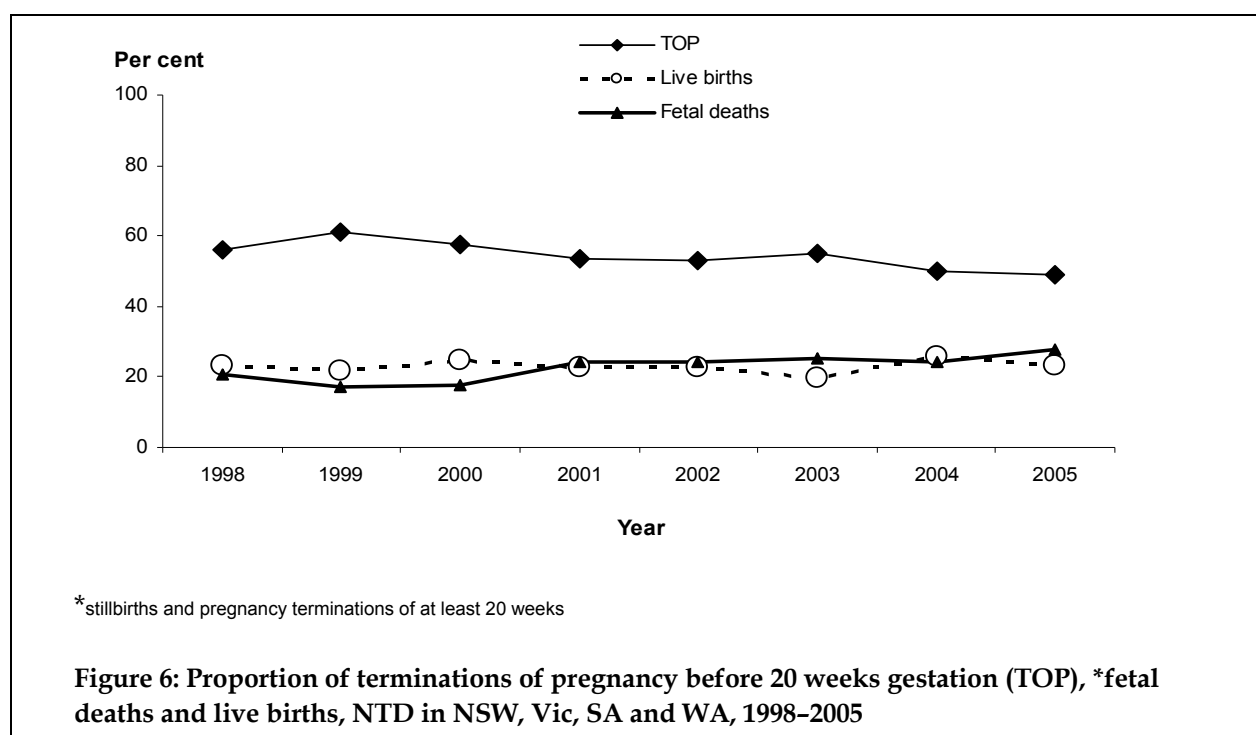
Table 2.3: Outcomes of the live births with NTD by year of birth, NSW, Vic, SA, and WA, 1998–2005

Year	Live births		Alive on day 28			Neonatal deaths		
	Number	Rate ^(a)	Number	Per cent	Rate ^(b)	Number	Per cent	Rate ^(b)
1998	51	2.6	37	72.5	1.9	14	27.5	0.7
1999	50	2.6	37	74.0	1.9	13	26.0	0.7
2000	54	2.8	41	75.9	2.1	13	24.1	0.7
2001	46	2.4	31	67.4	1.6	15	32.6	0.8
2002	43	2.2	27	62.8	1.4	16	37.2	0.8
2003	37	1.9	25	67.6	1.3	12	32.4	0.6
2004	53	2.8	36	67.9	1.9	17	32.1	0.9
2005	48	2.4	36	75.0	1.8	12	25.0	0.6
1998–2005	382	2.5	270	70.7	1.8	112	29.3	0.7

(a) Rates are per 10,000 live births and stillbirths.

(b) Rates are per 10,000 live births.

The proportion of terminations of pregnancy before 20 weeks gestation was nearly three-fold higher than the fetal deaths and live births during the period 1998 to 2005. However, the proportion of early pregnancy terminations showed a mild reduction more recently (Figure 6).



Plurality

Plurality status was available for 95.5% of the data. The rate of NTD-affected singleton pregnancies has not changed significantly during the eight year period. However the rate of NTD-affected multiple pregnancies had declined. The lowest rate for multiple pregnancies was seen in 2001 (Table 2.4). The data show that the multiple pregnancies had approximately three times higher rate than the singleton pregnancies. This difference was statistically significant (PR=2.7, 95% CI 2.5-2.9).

Table 2.4: Plurality and year of pregnancy NSW, Vic, SA, and WA, 1998-2005

Year	Singleton	Rate ^(a)	Multiple	Rate ^(b)	Prevalence ratio
1998	209	8.9	8	22.5	2.5
1999	214	9.1	16	43.3	4.8
2000	208	8.8	12	31.1	3.5
2001	200	8.6	4	10.2	1.2
2002	180	7.7	10	24.8	3.2
2003	175	7.5	11	27.3	3.7
2004	200	8.5	5	12.5	1.5
2005	198	8.0	6	13.9	1.8
1998-2005	1584	8.4	72	22.9	2.7

(a) Rates are per 10,000 women who gave birth to singleton pregnancies and year of birth.

(b) Rates are per 10,000 women who gave birth to 10,000 multiple pregnancies and year of birth.

Characteristics of women who had pregnancies affected with neural tube defects

Age

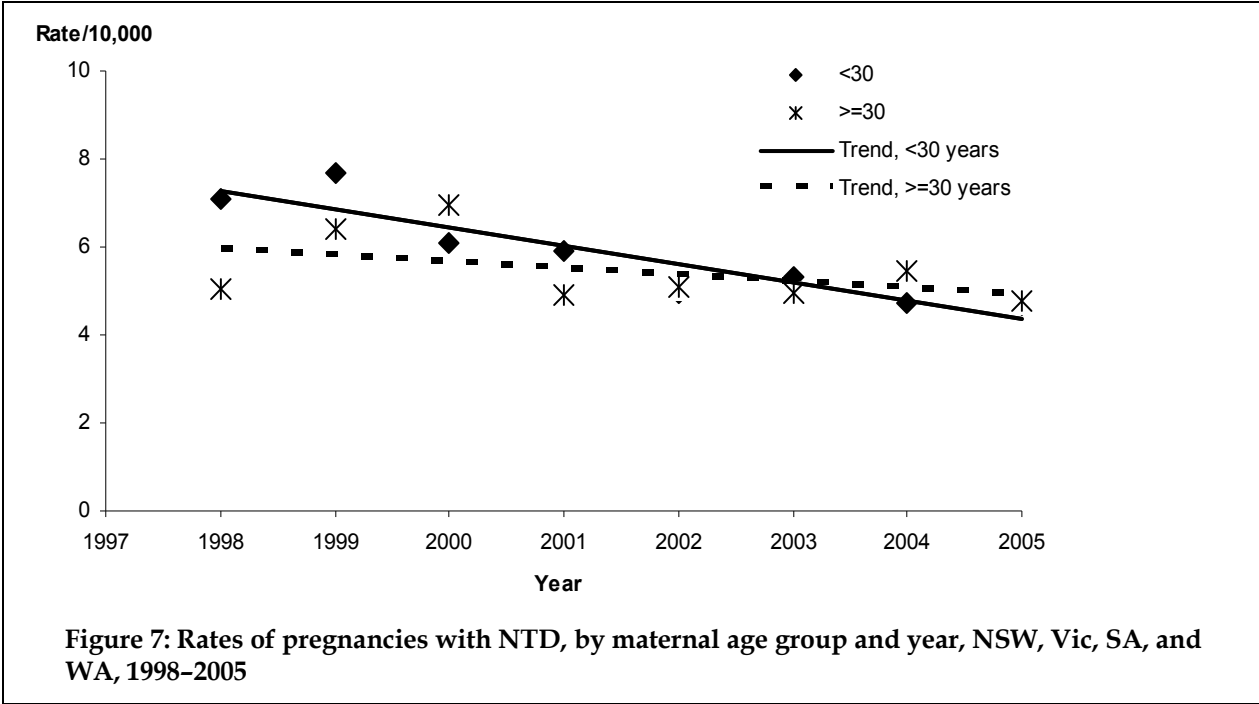
Age of the women was available for 99.5% who had a pregnancy affected with NTD in the four states. Although there were fluctuations in the rates, women less than 30 years of age had a higher rate of NTD-affected pregnancies than women aged 30 years or more. On average, teenage women had the highest rate. The rate of affected pregnancies decreased with increased age of women. However, the lowest rate was seen in women aged 30–34 years.

Table 2.5: All NTD, women's age group by year of pregnancy, NSW, Vic, SA and WA, 1998–2005

Women's age	1998	1999	2000	2001	2002	2003	2004	2005	Total
<20	14	14	8	14	4	5	13	10	82
20–24	32	38	49	35	23	22	26	33	258
25–29	90	77	56	64	57	58	59	48	509
30–34	50	56	62	48	67	62	59	60	464
≥35	25	38	41	34	33	34	42	48	295
Not stated	7	7	4	9	6	5	6	6	50
Total	218	230	220	204	190	186	205	205	1658
Rate^(a)/10,000 births									
<20	16.2	16.2	9.7	17.3	5.0	6.7	17.3	13.0	12.7
20–24	10.8	13.1	17.6	12.8	8.6	8.3	10.1	12.2	11.7
25–29	14.5	12.6	9.4	11.5	10.6	11.1	11.6	9.1	11.4
30–34	8.6	9.4	10.2	7.8	10.4	9.4	8.9	8.7	9.2
≥35	8.0	11.7	12.1	10.0	9.3	9.2	10.9	11.3	10.3

(a) Rates are per 10,000 women who gave birth each year by maternal age group.

In recent years, women less than 30 years of age had a decreasing rate of affected pregnancies, while the rate for older women did not decline markedly (Table 2.5, figure 7). The average rate for women less than 30 years of age was 11.6/10,000 while the average rate for women aged 30 years or more was 9.5/10,000. The difference in two age groups was statistically significant (PR=1.2, CI 1.1-1.3).



Remoteness of the women’s residence

Approximately 83% of the records of women who had a pregnancy affected with NTD had data on remoteness of the area of residence. Of those women, 96.8% lived in major cities or regional areas (Table 2.6). Only a small proportion of affected women lived in remote areas, but they had a higher rate of NTD-affected pregnancies than the women living in cities or regional areas. The difference was statistically significant (PR=1.5, 95% CI 1.4-1.7). This suggests that women living in remote areas are more likely to have a pregnancy affected with NTD.

Table 2.6: Remoteness of residence of women who had NTD-affected pregnancies NSW, Vic, SA, and WA, 1998-2005

Area of remoteness	Number	Per cent	Rate ^(a)
Major cities	998	72.5	8.8
Regional areas	334	24.3	8.7
Remote areas	44	3.2	13.5

(a) Rates are per 10,000 women who gave birth.

Indigenous status

Indigenous status of the women was available for 98% of the births in these four states, but only 35.3% of the women who had terminations of pregnancy before 20 weeks had Indigenous status reported. Therefore, overall proportion of women who had their Indigenous status recorded was 64% (n: 1059).

According to the available data, Indigenous women were 2.4 times more likely to have a NTD-affected pregnancy than the non-Indigenous women (PR =2.4, 95% CI 2.2–2.6). These data show that less than one-fifth of the Indigenous women had a termination of pregnancy before 20 weeks gestation if the fetus had a NTD, whereas almost one-third of non-Indigenous women had early terminations if they had an NTD-affected pregnancy. Over 80% of affected Indigenous women either had delivered a baby or had terminations at or after 20 weeks of gestation. Nearly half of Indigenous women had given birth between 20 and 31 weeks of gestation, which could include late terminations of pregnancy. Indigenous women were more likely to give birth at term than non-Indigenous women (Table 2.7).

About 74% of the affected Indigenous women were less than 30 years of age, whereas only about 53% of the non-Indigenous women were younger than 30 years. However, the rates were similar for teenage women in both groups. With advancing age, the rates were decreasing in non-Indigenous women, while the rates did not change markedly in Indigenous women (Table 2.7).

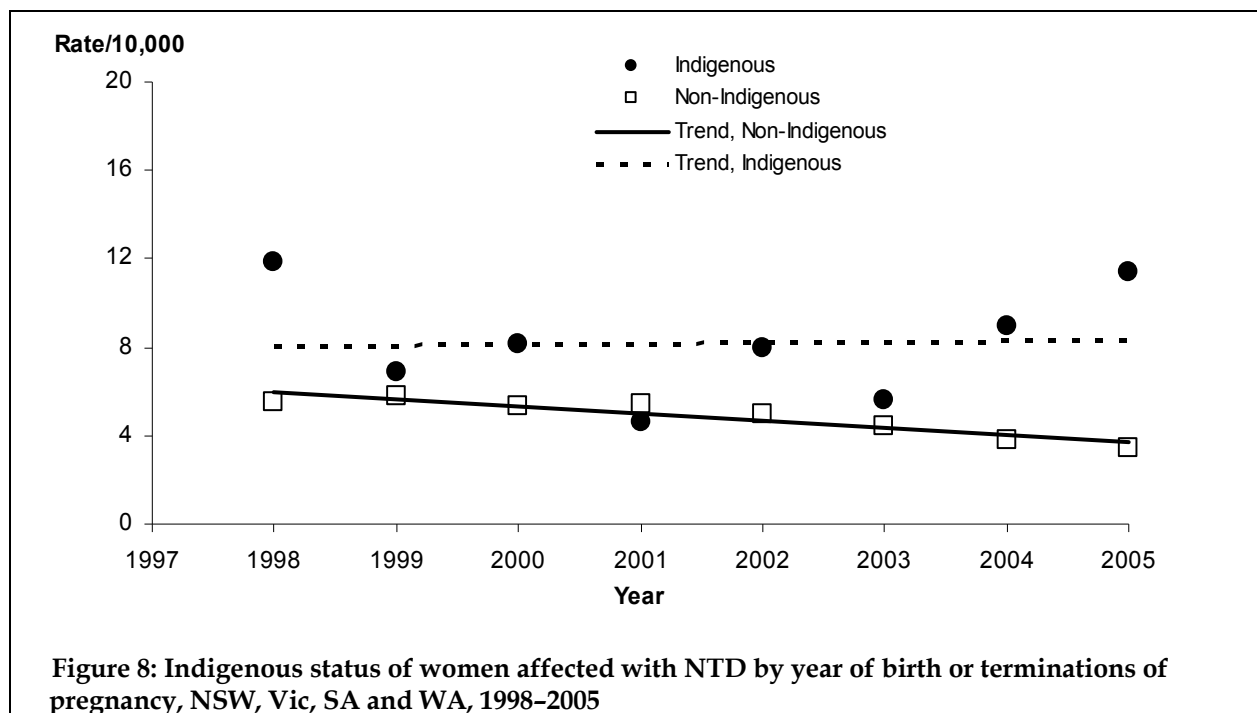
Table 2.7: Characteristics of women who had pregnancies affected with NTD by Indigenous status, NSW, Vic, SA, and WA, 1998–2005

	Indigenous			Non-Indigenous		
	Number	Per cent ^(a)	Rate ^(b)	Number	Per cent ^(a)	Rate ^(b)
Outcomes						
*TOP <20	10	17.2	2.7	310	31.0	2.1
Live births	24	41.4	6.6	354	35.4	2.4
Fetal Deaths	24	41.4	6.6	337	33.7	2.3
Total	58	100.0	15.9	1001	100.0	6.7
Gestational age (weeks)						
<20	10	17.2	..	310	31.0	..
20–31	25	43.1	215.3	351	35.1	172.7
32–36	9	15.5	24.5	65	6.5	8.2
≥37	13	22.4	4.1	270	27.0	0.1
Not known	1	1.7	..	5	0.5	..
Women's age group (years)						
<20	7	12.1	8.6	51	5.1	9.1
20–24	19	32.8	16.6	172	17.2	8.2
25–29	17	29.3	18.8	309	30.9	7.0
30–34	10	17.2	18.2	287	28.7	5.7
≥35	4	6.9	15.3	168	16.8	5.9
Not known	1	1.7	..	14	1.4	..

(a) Percentages are per 100 women in each group.

(b) Rates are per 10,000 all births in each group.

* Termination of pregnancy at less than 20 weeks gestation.



The data show that the decreasing trend of NTD is only seen among non-Indigenous women; there is no change among Indigenous women (Figure 8).

A study in Western Australia has shown a widening gap and disparity among Indigenous and non-Indigenous infants who were affected with NTD (Bower et al. 2004^c). According to this study, the prevalence of NTD has declined by 30% among non-Indigenous women, but there was no decline among Indigenous women.

About 60% of the data on Indigenous women who had a pregnancy affected with NTD among the four states are from Western Australia, while none or few affected pregnancies were reported from other states. Therefore it may not be appropriate to apply the above finding across the country because of a large number of missing data on Indigenous status.

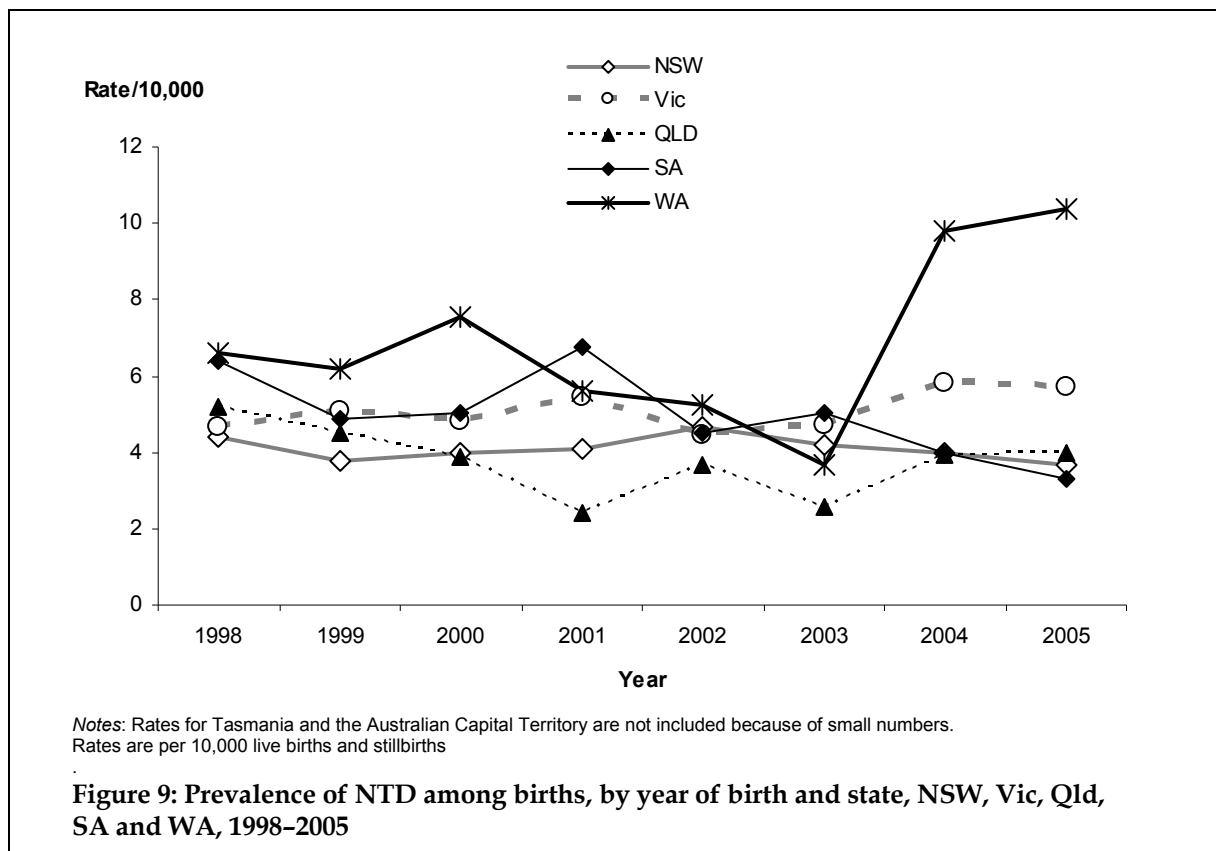
Nevertheless, rates among births showed a decreasing trend of NTD in Indigenous women (Figure 4). Those data represent 55% Indigenous NTD-affected births from states other than Western Australia. The early terminations are low among Indigenous people. Therefore birth rates may be more representative of prevalence of NTD among Indigenous women (Figure 4).

The availability of data from Northern Territory, termination of pregnancy data from all states and the paternal Indigenous status would provide more accurate information on NTD in the Indigenous population.

Prevalence of neural tube defects among births by individual states

The national data show that the birth prevalence is not equivalent across all states. Western Australia, South Australia and Victoria, where data ascertainment is near complete, have higher rates of NTD than the other states. These three states and New South Wales collect data from multiple sources and continue to collect data after the birth episode, with New South Wales collecting for the shortest duration, which is at least up to one year. South Australia showed a marked decline in the NTD prevalence in recent years, while Western Australia showed a sudden increase in births with NTD in 2004, probably due to increased termination of pregnancy after 20 weeks gestation. New South Wales has the largest proportion of births in Australia, but has lower rates of NTD-affected births than expected for each year. This may show an incomplete ascertainment of data.

Queensland, where data were collected only during the birth episode, had the lowest prevalence. The data on some late terminations due to NTD and mild forms of spina bifida may be missing as a result of collecting data only during the birth episode. In 2004 and 2005, the rates in Queensland have increased, which could be partly due to better ascertainment of data. Tasmania and the Australian Capital Territory also collect data only during the birth episode and have only a small number of NTD-affected births.



Overall prevalence of NTD in four states providing information including termination of pregnancy

New South Wales, Victoria, South Australia and Western Australia have shown an obvious decline in the prevalence of all NTD, including live births, stillbirths and terminations of pregnancy at all gestational ages, since 1992 (Figure 10).

Reporting data on all congenital anomalies, including terminations of pregnancy at less than 20 weeks gestation is mandatory in South Australia. Although there were mild fluctuations, South Australian data show a gradual decline in the estimated prevalence during the period 1992 to 2005. There was a sudden increase in the prevalence in 2000, but it gradually decreased again from 2001. South Australia showed a 33% decrease in NTD from 1992 to 2005 (Table 3.3).

Western Australia had the highest prevalence of NTD between 1992 and 1995. There was a 43% decrease in the prevalence between 1995 and 1996. From 1996 to 2003 the rates were similar to other states, but increased again in 2004. In 2004 and 2005, Western Australia had the highest prevalence among the four states. The decrease in prevalence between 1992 and 2005 was 15.5% (Table 3.4).

In Victoria, between 1992 and 2005, the highest prevalence of NTD was seen between 1995 and 1997. From 1997 to 2005, there was a 36.3% decline in the prevalence. The decline from 1992 to 2005 was 20% (Table 3.2).

Available data from New South Wales also show a gradual decrease in prevalence, but the prevalence is lower than expected, when compared with the other three states (Table 3.1). New South Wales usually has the highest rate of births in Australia and has a high population of Indigenous people as well as people with low socio-economic background. Therefore, the prevalence in New South Wales would be expected to be higher than the observed rates. This may suggest missing data from this state, in particular, terminations at less than 20 weeks.

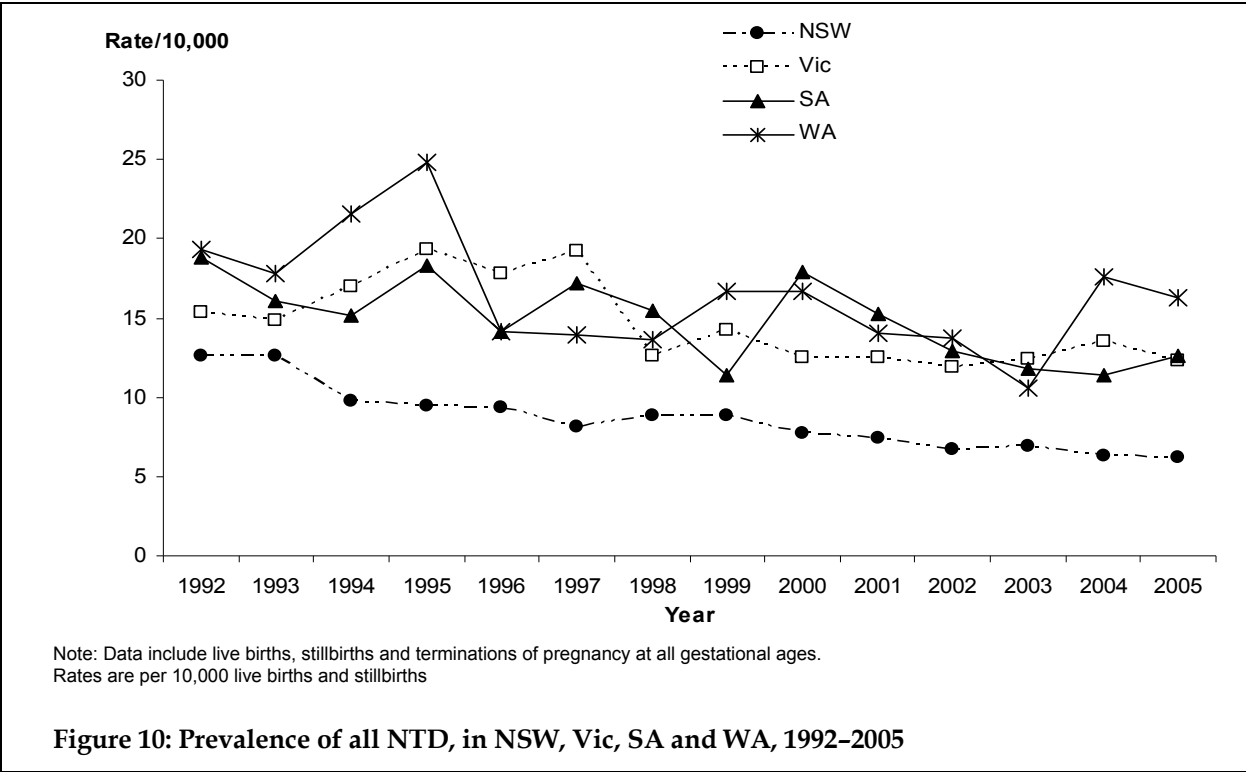


Table 3.1: Number and estimated rate of all NTD, New South Wales, 1992–2005

NSW	Number	Rate ^(a)	95% CI
1992	112	12.6	10.4–15.1
1993	111	12.7	10.4–15.2
1994	86	9.8	7.8–12.1
1995	83	9.5	7.6–11.8
1996	81	9.4	7.4–11.7
1997	72	8.2	6.4–10.3
1998	76	8.8	6.9–11.0
1999	77	8.8	7.0–11.0
2000	68	7.7	6.0–9.8
2001	64	7.5	5.7–9.5
2002	58	6.7	5.1–8.7
2003	60	6.9	5.3–8.9
2004	54	6.3	4.7–8.2
2005	56	6.2	4.7–8.0

(a) Rates are per 10,000 live births and stillbirths in NSW.

Table 3.2: Number and estimated rate of all NTD, Victoria, 1992–2005

VIC	Number	Rate ^(a)	95% CI
1992	102	15.4	12.5–18.6
1993	96	14.8	12.0–18.1
1994	110	16.9	13.9–20.4
1995	123	19.3	16.0–23.0
1996	112	17.8	14.7–21.4
1997	120	19.3	16.0–23.0
1998	78	12.6	9.9–15.7
1999	89	14.2	11.4–17.5
2000	78	12.5	9.9–15.6
2001	78	12.6	9.9–15.7
2002	75	11.9	9.3–14.9
2003	79	12.4	9.8–15.5
2004	86	13.5	10.8–16.7
2005	82	12.3	9.8–15.3

(a) Rates are per 10,000 live births and stillbirths in Vic.

Table 3.3: Number and estimated rate of all NTD, South Australia, 1992–2005

SA	Number	Rate ^(a)	95% CI
1992	38	18.9	13.3–25.9
1993	32	16.0	11.1–22.6
1994	30	15.2	10.2–21.6
1995	37	18.9	12.9–25.4
1996	27	14.1	9.3–20.5
1997	32	17.1	11.7–24.2
1998	29	15.5	10.4–22.2
1999	21	11.3	7.0–17.3
2000	32	17.9	12.3–25.3
2001	27	15.3	10.1–22.2
2002	23	13.0	8.2–19.4
2003	21	11.8	7.3–18.0
2004	20	11.4	7.0–17.6
2005	23	12.6	8.0–19.0

(a) Rates are per 10,000 live births and stillbirths in SA.

Table 3.4: Number and estimated rate of all NTD, Western Australia, 1992–2005

WA	Number	Rate ^(a)	95% CI
1992	49	19.3	14.3–25.6
1993	45	17.8	13.0–23.7
1994	55	21.6	16.3–28.1
1995	63	24.8	19.0–31.7
1996	36	14.1	9.9–19.5
1997	35	13.9	9.6–19.3
1998	35	13.6	9.5–19.0
1999	43	16.7	12.1–22.5
2000	42	16.6	12.0–22.5
2001	35	14.0	9.8–19.5
2002	34	13.7	9.5–19.2
2003	26	10.5	6.9–15.4
2004	45	17.6	12.9–23.6
2005	44	16.3	11.9–21.9

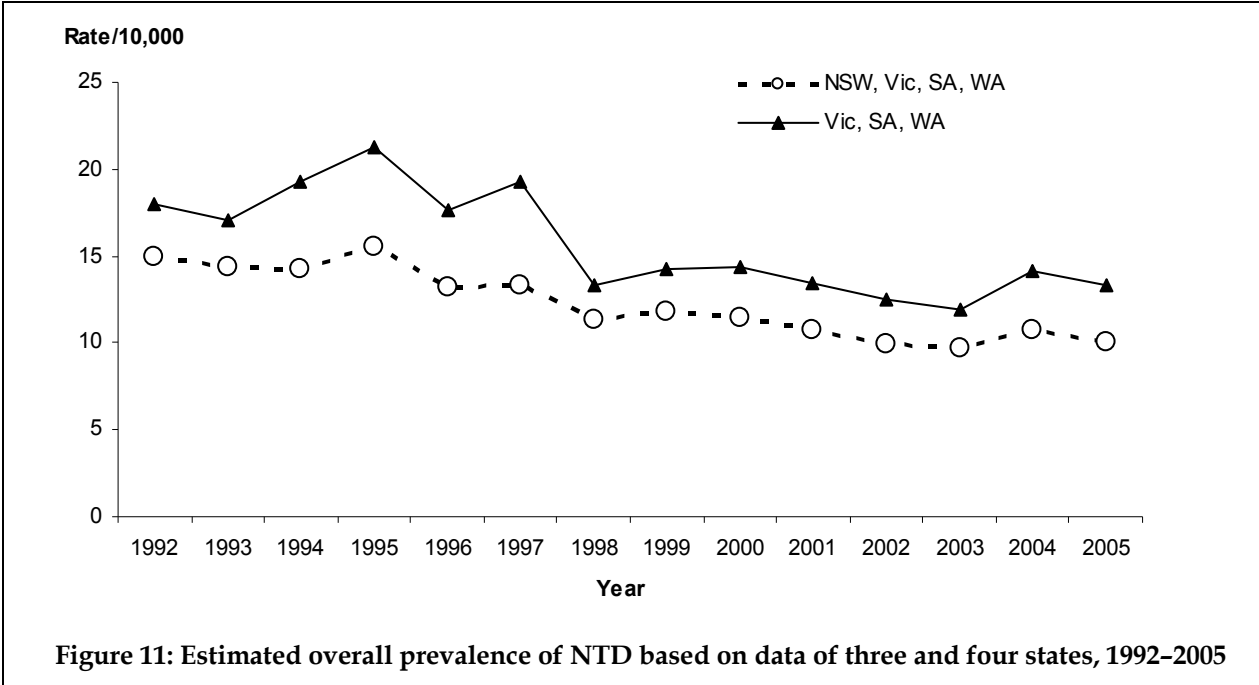
(a) Rates are per 10,000 live births and stillbirths in WA.

Estimated prevalence of NTD based on data from Victoria, South Australia and Western Australia

The data from three states (Victoria, South Australia and Western Australia) that have nearly complete ascertainment, including terminations of pregnancy before 20 weeks of gestation were used to calculate the estimated rate. As shown in Table 3.1 and Figure 10, New South Wales has low rates for all years because of missing data, mainly on some terminations of pregnancy. Therefore, New South Wales data were not used to compute the estimated prevalence.

Prevalence

When overall estimated NTD rates were calculated using data from Victoria, South Australia and Western Australia, these rates were about 3.5 per 10,000 pregnancies higher than the rates observed using the data from four states that include New South Wales (Figure 11). Data from the three states also show an obvious decreasing trend in NTD-affected pregnancies from 1992 to 2005 (Figure 12). Studies have shown that ascertainment of data on NTD are near complete in these three states. Therefore, prevalence based on these three states could be a more accurate baseline of NTD prevalence prior to mandatory fortification of bread flour with folic acid.



The data show a 26% decline in NTD prevalence from 1992 to 2005 (Table 4.1). Since the confirmation from randomised controlled trials in 1991, of the effect of periconceptional folate use in reducing NTD, there have been many health promotion programs in these states to increase the knowledge of women and health professionals. Nevertheless, the highest prevalence was seen in 1995. With the efforts of many health professionals and others interested in NTD, the prevalence has declined by 37.6% from 1995 to 2005. There was a large decline (30.0%) in the prevalence from 1997 to 1998. After that the decline in prevalence was minimal (Table 4.1). The lowest rate was seen in 2003. The prevalence rose again in 2004 and 2005, and this increase have been seen across all three states. Western Australia showed the highest increase.

Table 4.1: All NTD reported from Vic, SA and WA by year of birth or terminations of pregnancy, 1992-2005

Year	Number	Rate ^(a)	95% CI
1992	201	18.0	15.6-20.6
1993	188	17.1	14.7-19.7
1994	213	19.3	16.8-22.1
1995	232	21.3	18.7-24.3
1996	189	17.6	15.1-20.2
1997	205	19.3	16.7-22.1
1998	142	13.3	11.2-15.7
1999	153	14.3	12.1-16.8
2000	152	14.4	12.2-16.9
2001	140	13.4	11.2-15.8
2002	132	12.5	10.5-14.8
2003	126	11.9	9.9-14.1
2004	151	14.1	12.0-16.6
2005	149	13.3	11.3-15.6

(a) Rates are per 10,000 live births and stillbirths.

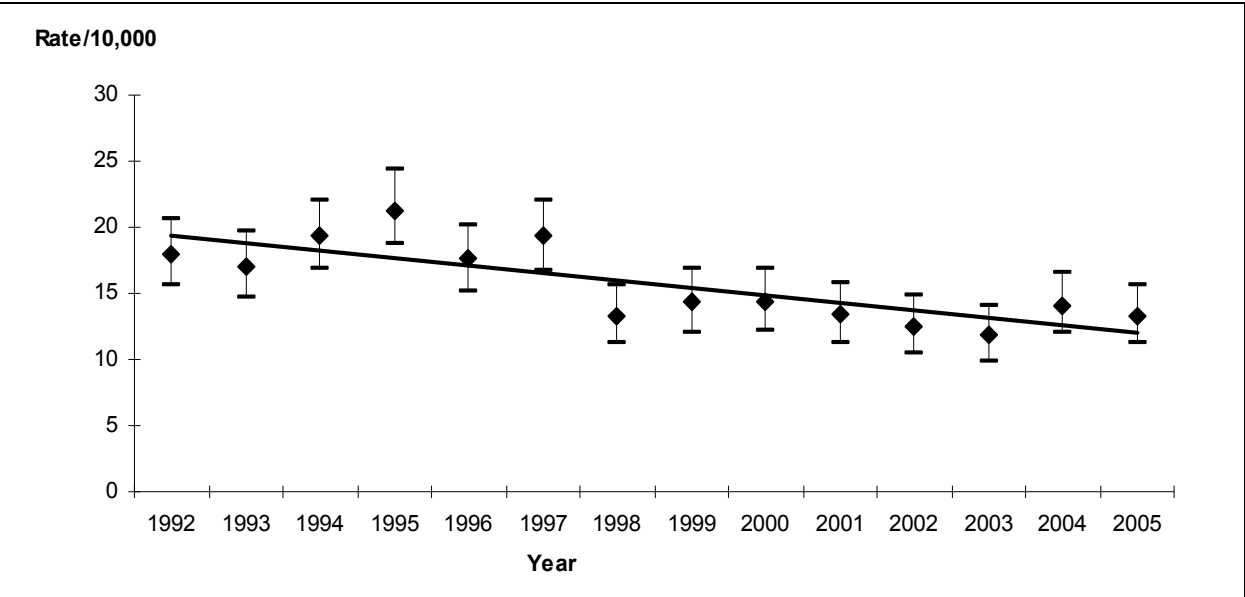


Figure 12: Estimated NTD rates in Australia based on data from Vic, SA and WA, 1992-2005

In these three states, the prevalence of live births gradually decreased from 1998 to 2003, but increased again in 2004 (Table 4.2). More than a quarter of NTD-affected pregnancies were alive at birth. About three quarters of those who were alive at birth survived at least until the end of the neonatal period (Table 4.3). The live birth rates in three states are not significantly higher than the rates observed in four states, except in 1998, suggesting the missing data is mainly among pregnancy terminations before 20 weeks gestation (Table 2.3, Table 4.3).

The neonatal deaths due to NTD in the three states fluctuated during 1998–2005.

The fetal death rate has gradually increased, possibly due to increased late pregnancy terminations. During the eight year period from 1998 to 2005, the highest termination of pregnancy (<20 weeks gestation) rate was seen in 1999. From 1999 to 2005 there was a 23.3% decrease in the rates of early terminations.

Table 4.2: All neural tube defects by outcome, Vic, SA, and WA, 1998–2005

Year	Live births		**Fetal deaths		TOP <20 weeks		All NTD	
	Number	Rate ^(a)	Number	Rate ^(a)	Number	Rate ^(a)	Number	Rate ^(a)
1998	38	3.6	20	1.9	84	7.9	142	13.3
1999	33	3.1	24	2.2	96	9.0	153	14.3
2000	35	3.3	23	2.2	94	8.9	152	14.4
2001	27	2.6	33	3.1	80	7.6	140	13.4
2002	23	2.2	26	2.5	83	7.9	132	12.5
2003	20	1.9	28	2.6	78	7.4	126	11.9
2004	31	2.9	38	3.6	82	7.7	151	14.1
2005	34	3.0	38	3.4	77	6.9	149	13.3

(a) Rates are per 10,000 live births and stillbirths.

** Fetal deaths include stillbirths and pregnancy terminations of at least 20 weeks gestation.

Table 4.3: All live births with neural tube defects by outcome, Vic, SA, and WA, 1998–2005

Year	Live births		Alive on day 28			Neonatal deaths		
	Number	Rate ^(a)	Number	Per cent	Rate ^(b)	Number	Per cent	Rate ^(b)
1998	38	3.6	29	76.3	2.8	9	23.7	0.9
1999	33	3.1	26	78.8	2.5	7	21.2	0.7
2000	35	3.3	27	77.1	2.6	8	22.9	0.8
2001	27	2.6	20	74.1	2.0	7	25.9	0.7
2002	23	2.2	14	60.9	1.4	9	39.1	0.9
2003	20	1.9	14	70.0	1.4	6	30.0	0.6
2004	31	2.9	22	71.0	2.1	9	29.0	0.9
2005	34	3.0	27	79.4	2.5	7	20.6	0.6

(a) Rates are per 10,000 live births and stillbirths.

(b) Rates are per 10,000 live births.

Women's age

A higher rate of NTD-affected pregnancies was seen mainly in younger age groups. However the rates fluctuated each year and the lowest was seen in 2003. The rate of NTD among older women has increased in recent years, probably because of the increasing number of older women becoming pregnant. The lowest rate was seen among women aged between 30 and 34 years. When the data from New South Wales, where data are incomplete were excluded, the rates were about 3.0 per 10,000 higher in each age group than the rates including NSW (Figure 13, Table 2.5, Table 4.4).

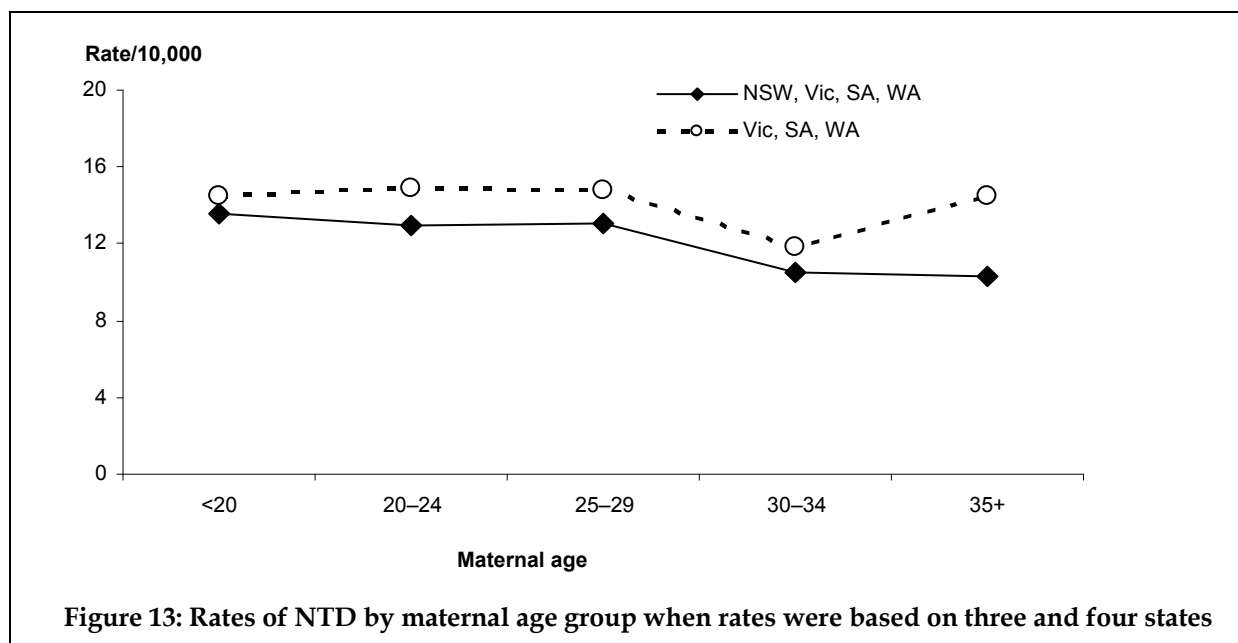


Table 4.4: All NTD, women's age group by year of pregnancy, Vic, SA, and WA, 1998-2005

Women's age	1998	1999	2000	2001	2002	2003	2004	2005	Total
<20	7	8	6	8	3	3	9	6	50
20-24	20	30	31	23	17	18	21	23	183
25-29	58	53	42	46	33	41	39	39	351
30-34	34	35	43	35	49	38	46	40	320
≥35	20	27	30	26	28	26	35	40	232
Not stated	3	0	0	2	2	0	1	1	9
Rate^(a) per 10,000									
<20	15.4	19.6	13.6	18.6	6.9	7.7	21.7	14.1	14.7
20-24	13.0	20.7	21.3	16.0	11.9	13.1	15.3	16.0	15.9
25-29	17.0	16.3	13.1	15.2	11.4	14.6	14.0	13.6	14.5
30-34	10.2	10.1	12.5	9.9	13.4	10.1	12.3	10.4	11.1
≥35	11.5	13.8	16.1	13.8	14.1	12.4	16.1	16.7	14.4

(a) Rates are per 10,000 women who gave birth each year by maternal age group.

Anencephaly

Anencephaly is a congenital anomaly characterised by the total or partial absence of the cranial vault and the covering skin. The brain tissue in affected fetuses may be missing or reduced to a small mass. Anencephaly in this report includes infants with craniorachischisis, iniencephaly and other neural tube defects such as encephalocele or open spina bifida, when associated with anencephaly. Acephaly or absence of head observed in amorphous acardiac twins was excluded.

Anencephaly occurs when the cephalic end of the neural tube fails to close, resulting in the absence of a major part of the brain, skull, and scalp. The remaining brain tissue is often exposed and not covered by bone or skin. This condition is not compatible with life and a baby born with anencephaly is usually blind, deaf, unconscious, and unable to feel pain. Some individuals with anencephaly may be born with a rudimentary brain stem. They may have reflex actions such as breathing and responses to sound or touch. If the anencephaly extends to the neck, exposing a thin and flattened spinal cord, this condition is known as craniorachischisis. If the head of a fetus with anencephaly and spinal defects is bent backwards with the face looking upwards this condition is called iniencephaly. The affected infant tends to be short, with a disproportionately large head.

Prevalence

There were 216 births of at least 20 weeks gestational age or at least 400 grams birthweight diagnosed with anencephaly, reported from all states and territories except Northern Territory from 1998 to 2005. About 64% of those births were stillbirths or terminations of pregnancy at or after 20 weeks gestation. The rate of live births was highest in 1998 and had an average rate of 0.4 per 10,000 births between 1998 and 2005 while the fetal death rate remained 0.7 per 10,000 births (Table 5.1). The average fetal death rate was about 43% higher than the live births. The anencephaly prevalence among births had decreased by 36% from 1998 to 2005. Of the 36% of babies who were born alive, all died early in the neonatal period.

Table 5.1: All anencephaly among births^(a), Australia, 1998–2005

	Live births	Rate ^(b)	*Fetal deaths	Rate ^(b)	All births	Rate ^(b)
1998	17	0.7	18	0.7	35	1.4
1999	8	0.3	15	0.6	23	0.9
2000	9	0.4	18	0.7	27	1.1
2001	7	0.3	17	0.7	24	1.0
2002	12	0.5	21	0.8	33	1.3
2003	9	0.4	14	0.6	23	0.9
2004	10	0.4	17	0.7	27	1.1
2005	6	0.2	18	0.7	24	0.9
1998–2005	78	0.4	138	0.7	216	1.1

(a) Includes all live births, stillbirths and pregnancy terminations of at least 20 weeks gestation or at least 400 g birthweight.

(b) Rates are per 10,000 live births and stillbirths.

* Fetal deaths include stillbirths and terminations of pregnancy with at least 20 weeks gestation.

There were 666 pregnancies affected with anencephaly in the four states including New South Wales, Victoria, South Australia and Western Australia (Table 5.2). These data include anencephaly-affected terminations of pregnancy at less than 20 weeks during 1998 to 2005. About 73% of those pregnancies were managed by early terminations, before 20 weeks gestation. Of all those pregnancies, 91.6% resulted in terminations of pregnancy or fetal deaths. The 8.4% who were born alive did not survive to the end of the neonatal period (Table 5.2).

The rate of termination of pregnancy before 20 weeks gestation due to NTD has declined by 22.2% from 1998 to 2005. During the same period, the estimated rate of all anencephaly in the four states decreased by 21.6%.

Table 5.2: All anencephaly, including terminations of pregnancy, NSW, Vic, SA, and WA, 1998–2005

	Live births		*Fetal deaths		**TOP <20 weeks		All anencephaly	Rate ^(a)
	Number	Rate ^(a)	Number	Rate ^(a)	Number	Rate ^(a)		
1998	9	0.5	16	0.8	73	3.8	98	5.1
1999	5	0.3	12	0.6	65	3.3	82	4.2
2000	7	0.4	18	0.9	59	3.0	84	4.3
2001	5	0.3	15	0.8	65	3.4	85	4.5
2002	10	0.5	19	1.0	54	2.8	83	4.3
2003	8	0.4	13	0.7	53	2.8	74	3.8
2004	7	0.4	15	0.8	57	3.0	79	4.1
2005	5	0.2	18	0.9	58	2.9	81	4.0
1998–2005	56	0.4	126	0.8	484	3.1	666	4.3

(a) Rates are per 10,000 live births and stillbirths.

* Fetal deaths include stillbirths and terminations of pregnancy with at least 20 weeks gestation.

** TOP – Terminations of pregnancy before 20 weeks gestation.

When the data from New South Wales were excluded there were no marked difference in the prevalence of live births and fetal deaths. The difference of prevalence of anencephaly between the four states and three states was seen mainly in terminations of pregnancy before 20 weeks gestation (Table 5.2, Table 5.3). Three states had, on average about 1.5/10,000 higher rate of early terminations than the rates in four states. Although there was a decrease in early termination rates in data from the four states, there was no marked decrease seen when the New South Wales data were excluded. The live birth rate has declined over the years, but fetal deaths have increased during those years indicating increased late terminations. In each year, about 80% of anencephaly-affected pregnancies in the three states were terminated before 20 weeks of gestation.

Table 5.3: All anencephaly, including terminations of pregnancy, Vic, SA, and WA, 1998–2005

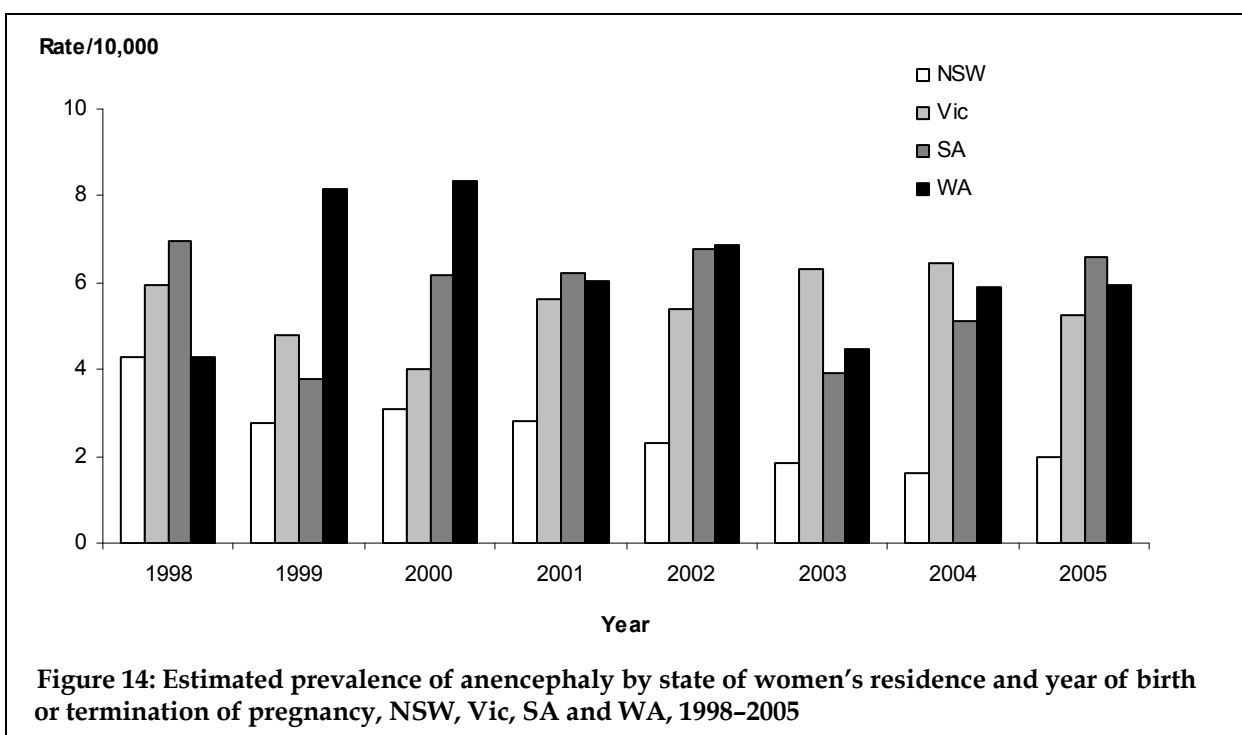
	Live births		*Fetal deaths		**TOP <20 weeks		All Anencephaly	Rate ^(a)
	Number	Rate ^(a)	Number	Rate ^(a)	Number	Rate ^(a)		
1998	5	0.5	6	0.6	50	4.8	61	5.8
1999	2	0.2	10	1.0	46	4.4	58	5.5
2000	4	0.4	11	1.1	42	4.0	57	5.5
2001	2	0.2	9	0.9	50	4.9	61	5.9
2002	4	0.4	11	1.1	48	4.6	63	6.1
2003	4	0.4	6	0.6	48	4.6	58	5.6
2004	5	0.5	10	1.0	50	4.8	65	6.2
2005	2	0.2	11	1.0	50	4.6	63	5.7
Total	28	0.3	74	0.9	384	4.6	486	5.8

(a) Rates are per 10,000 live births and stillbirths.

* Fetal deaths include stillbirths and terminations of pregnancy with at least 20 weeks gestation.

** TOP – Terminations of pregnancy before 20 weeks gestation.

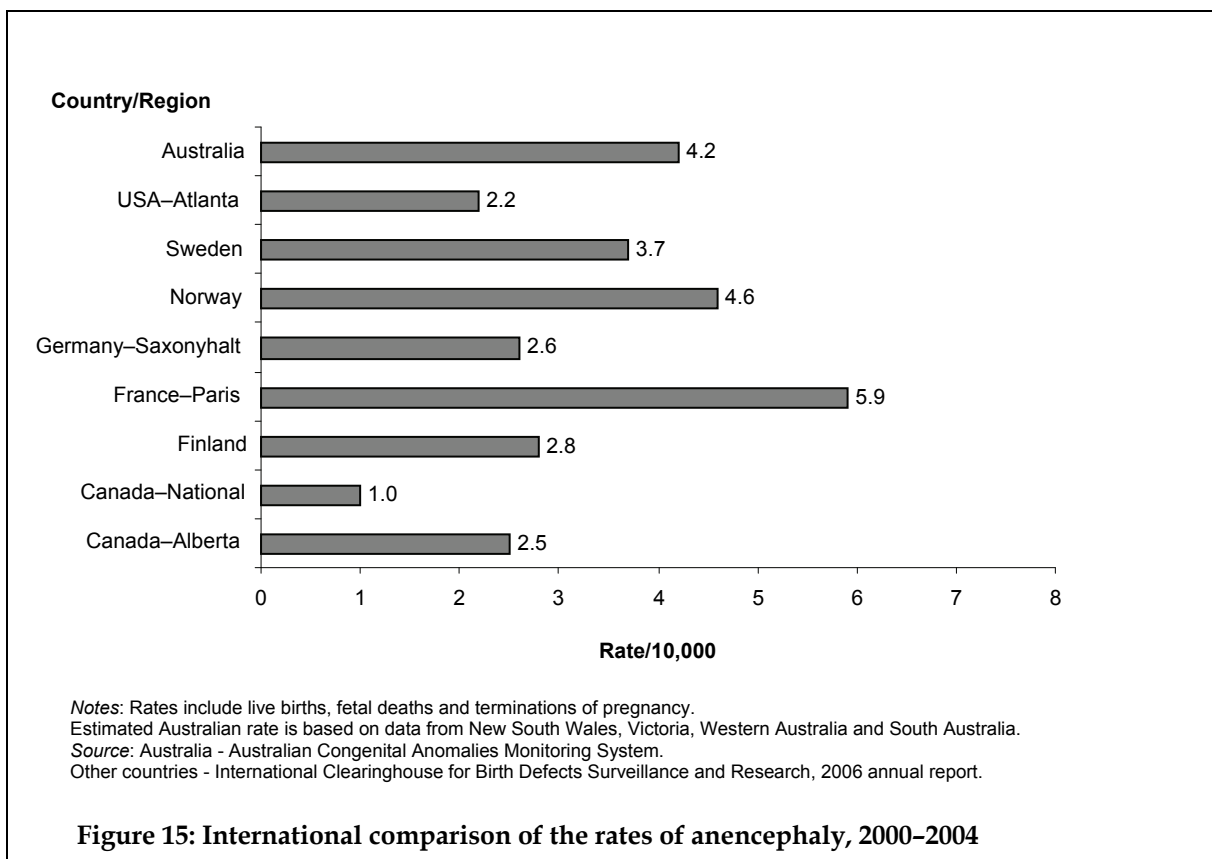
The prevalence of anencephaly largely fluctuated in all states during 1998 to 2005. The anencephaly rate in Victoria was lowest in 2000 and highest in 2004. There was no marked fluctuation in rates over the other years. South Australia had the lowest rates in 1999 and 2003, but the rate increased again after 2003. Western Australia had large fluctuations in rates of anencephaly-affected pregnancies between 4.3 and 8.3 per 10,000 pregnancies. New South Wales had generally lower rates and the rate gradually declined over the years, but this may be due to missing data. The average anencephaly rate in New South Wales was 2.6 per 10,000 pregnancies while the other three states had averages between 5.5 and 6.2 per 10,000 pregnancies (Figure 14).



Prevalence of anencephaly in other countries/regions

The rates given here include live births, stillbirths and terminations of pregnancy at all gestational ages for all countries and states/regions. The Australian rate was calculated using data from New South Wales, Victoria, South Australia and Western Australia. NTD rates for other countries are from the published data in the 2006 annual report of the International Clearinghouse for Birth Defects Surveillance and Research (ICBDSR). ICBDSR receives data from birth defect registers of many countries and regions. This comparison does not include data from countries where information on terminations of pregnancy before 20 weeks was not available. Instead, the data from some regional birth defect registers where terminations of pregnancy before 20 weeks information were presented are included in this section. The prevalence in Australia was similar to other developed countries such as Sweden and Norway. The prevalence reported by some regional birth defect registries showed a lower rate. Among countries who reported total anencephaly rates, Finland had the lowest rate.

If the Australian rate is calculated using the data from Victoria, South Australia and Western Australia, the average rate would be 5.8 per 10,000 pregnancies, which is comparatively higher than some other developed countries. The high rate found from these states may illustrate a better ascertainment of data.



Characteristics

The characteristics in Table 5.4 are based on data from New South Wales, Victoria, South Australia and Western Australia, where details of terminations of pregnancy at less than 20 weeks gestation are also provided. Therefore the women who have had early terminations are also included in this section, but some information was not complete for the early terminations. The number of women whose characteristics were analysed was 666.

Almost all women who had a pregnancy affected with anencephaly had their age reported. Most women who were affected with anencephaly were in younger age groups. About 82% of affected women were younger than 35 years of age. A comparatively large number of teenage women had anencephaly-affected pregnancies. They had the highest rate among all age groups (6.0 per 10,000 pregnancies). Women aged 35 years or more had the lowest rate of pregnancies with anencephaly.

Indigenous status was available for 90% of births, but only 35% of the terminations of pregnancy had Indigenous status recorded. Indigenous women had a nearly two-fold higher rate of births affected with anencephaly than the non-Indigenous women. This difference was statistically significant (PR=1.8, 95% CI 1.5-2.0).

Plurality was reported for almost all affected pregnancies. Almost 6% affected pregnancies were multiple births. Women who had multiple births were more likely to have anencephaly affected births than women who had singleton births (PR=3.7, 95% CI 3.3-4.1).

Data on sex was available only for births and some terminations of pregnancy. Many affected pregnancies were terminated early and sex was not reported. Available data show that there were more females with anencephaly. Of the reported births, about 49% were females and 42% were males. The other 9% were reported as indeterminate sex. The available data show a slightly higher female predominance (Rate 1.3 versus 1.0 per 10,000 pregnancies).

Almost three-quarters of pregnancies were diagnosed early and managed by termination before 20 weeks gestation. Only about 9% of pregnancies continued beyond 31 weeks gestation. However, 4.8% continued the pregnancy until term and 6.3% of them were Indigenous women.

Table 5.4: Characteristics of pregnancies affected with anencephaly, NSW, Vic, SA, and WA, 1998–2005

Characteristics	Number	Per cent	Rate
Women's age group (years)^(a)			
<20	38	5.7	6.0
20–24	93	14.0	4.2
25–29	215	32.3	4.8
30–34	197	29.6	3.9
≥35	109	16.4	3.8
Not stated	14	2.1	..
Indigenous status^(a)			
Indigenous	18	2.7	3.0
Non-Indigenous	314	47.1	1.7
Not stated	334	50.2	..
Plurality^(a)			
Singleton	626	94.0	4.2
Multiple	39	5.9	15.6
Not stated	1	0.2	..
Sex^(b)			
Male	109	16.4	1.0
Female	126	18.9	1.3
Indeterminate	23	3.5	..
Not stated	404	61.3	..
Gestational age^(b)			
<20	484	72.7	..
20–31	119	17.9	35.9
32–36	29	4.4	2.3
≥37	32	4.8	0.2
Not stated	2	0.3	..

(a) Rates are per 10,000 women who gave birth.

(b) Rates are per 10,000 live births and stillbirths.

Spina bifida

Spina bifida includes meningocele, meningomyelocele, myelocele, myelomeningocele and rachischisis. Spina bifida is not counted when present with anencephaly.

Spina bifida occurs when there is a failure of fusion of the posterior vertebral arch, resulting in various clinical manifestations depending on the location and type of defect. Spina bifida can be open or closed. Spina bifida occulta (closed) is the mildest form, and malformed vertebrae are covered by a layer of the skin. The open form includes meningomyelocele, in which the spinal cord and the meninges protrude through the opening in the spine, and meningocele, in which only the meninges protrude through the opening. Babies born with spina bifida may have various degrees of spinal cord and nerve damage. They may have varying degrees of paralysis of the lower limbs, learning disabilities, bowel and bladder complications and hydrocephalus, depending on the location of the malformation. With recent improvements in medical and surgical management, some of these children live into adulthood, but they continue to be at increased risk of morbidity and mortality throughout their life. The mortality rate for children with spina bifida is increased over the general population risk in the first year of life.

The cost of providing medical care for a child with myelomeningocele has been estimated to be over US\$70,000 (adjusted to 2001 US dollars) annually for the first 20 years of life, including the costs associated with an average of five surgeries per year in the first five years of life (20 year lifetime cost is \$1.4 million per case) (Detrait et al. 2005).

The Australian Congenital Anomalies Monitoring System does not collect data on spina bifida occulta and sacrococcygeal teratoma without dysraphism.

Prevalence

There was a 25% decline in the prevalence of births with spina bifida from 1998 to 2003. The lowest rates were seen in 2002 and 2003 and rates increased again in 2004. The lowest live birth rate was in 2003 and the fetal death rate was lowest in 2002 (Table 6.1).

Table 6.1: All spina bifida among births^(a), Australia, 1998–2005

Year	Live births	Rate ^(b)	*Fetal deaths	Rate ^(b)	All spina bifida	Rate ^(b)
1998	46	1.8	34	1.4	80	3.2
1999	52	2.0	28	1.1	80	3.2
2000	59	2.3	25	1.0	84	3.3
2001	42	1.7	31	1.2	73	2.9
2002	36	1.4	25	1.0	61	2.4
2003	30	1.2	31	1.2	61	2.4
2004	51	2.0	36	1.4	87	3.4
2005	54	2.0	38	1.4	92	3.4
1998–2005	370	1.8	248	1.2	618	3.0

(a) Includes all live births, stillbirths and pregnancy terminations of at least 20 weeks gestation or at least 400 g birthweight.

(b) Rates are per 10,000 live births and stillbirths.

* Fetal deaths include stillbirths and terminations of pregnancy with at least 20 weeks gestation.

About 60% of births were live births. More than 83% of them were alive at the end of the neonatal period. The proportion of babies alive on day 28 has not changed markedly during 1998 to 2005. Neonatal death rates varied little throughout this period (Table 6.2).

Table 6.2: Outcomes of the live births with spina bifida, Australia, 1998–2005

Year	Live births	Rate ^(a)	Alive on day 28	Per cent	Rate ^(b)	Neonatal deaths	Per cent	Rate ^(b)
1998	46	1.8	42	91.3	1.7	4	8.7	0.2
1999	52	2.0	44	84.6	1.7	8	15.4	0.3
2000	59	2.3	48	81.4	1.9	11	18.6	0.4
2001	42	1.7	32	76.2	1.3	10	23.8	0.4
2002	36	1.4	29	80.6	1.2	7	19.4	0.3
2003	30	1.2	26	86.7	1.0	4	13.3	0.2
2004	51	2.0	41	80.4	1.6	9	17.6	0.4
2005	54	2.0	46	85.2	1.7	7	13.0	0.3
1998–2005	370	1.8	308	83.2	1.5	60	16.2	0.3

(a) Rates are per 10,000 live births and stillbirths.

(b) Rates are per 10,000 live births.

In New South Wales, Victoria, South Australia and Western Australia where terminations of pregnancy data were available, there was a 13.6% decrease in prevalence from 1998 to 2005. The rates of live births decreased until 2003 and increased again in 2004. The data from these four states had 32.2% live births and 42.3% of early terminations of pregnancy. However, 67.8% of affected pregnancies resulted in fetal deaths or were managed by terminations of pregnancy.

The rates of termination of pregnancy before 20 weeks fluctuated between 1998 and 2005. The rate was highest in 1999 and the lowest was in 2005. Nevertheless, the average termination of pregnancy before 20 weeks had a rate of 2.4 per 10,000 pregnancies (Table 6.3).

Table 6.3: All spina bifida including terminations of pregnancy, NSW, Vic, SA, and WA, 1998–2005

Year	Live births		Fetal deaths		TOP <20 weeks		All spina bifida	Rate ^(a)
	Number	Rate ^(a)	Number	Rate ^(a)	Number	Rate ^(a)		
1998	37	1.9	28	1.5	49	2.5	114	5.9
1999	36	1.9	26	1.3	71	3.7	133	6.8
2000	44	2.3	21	1.1	54	2.8	119	6.1
2001	36	1.9	29	1.5	38	2.0	103	5.4
2002	30	1.6	23	1.2	38	2.0	91	4.7
2003	25	1.3	30	1.6	46	2.4	101	5.2
2004	39	2.0	32	1.7	40	2.1	111	5.8
2005	35	1.7	34	1.7	34	1.7	103	5.1
1998–2005	282	1.8	223	1.4	370	2.4	875	5.6

(a) Rates are per 10,000 live births and stillbirths.

* Fetal deaths include stillbirths and terminations of pregnancy with at least 20 weeks gestation.

** TOP – Terminations of pregnancy before 20 weeks gestation.

Table 6.4: All spina bifida including terminations of pregnancy, Vic, SA, and WA, 1998–2005

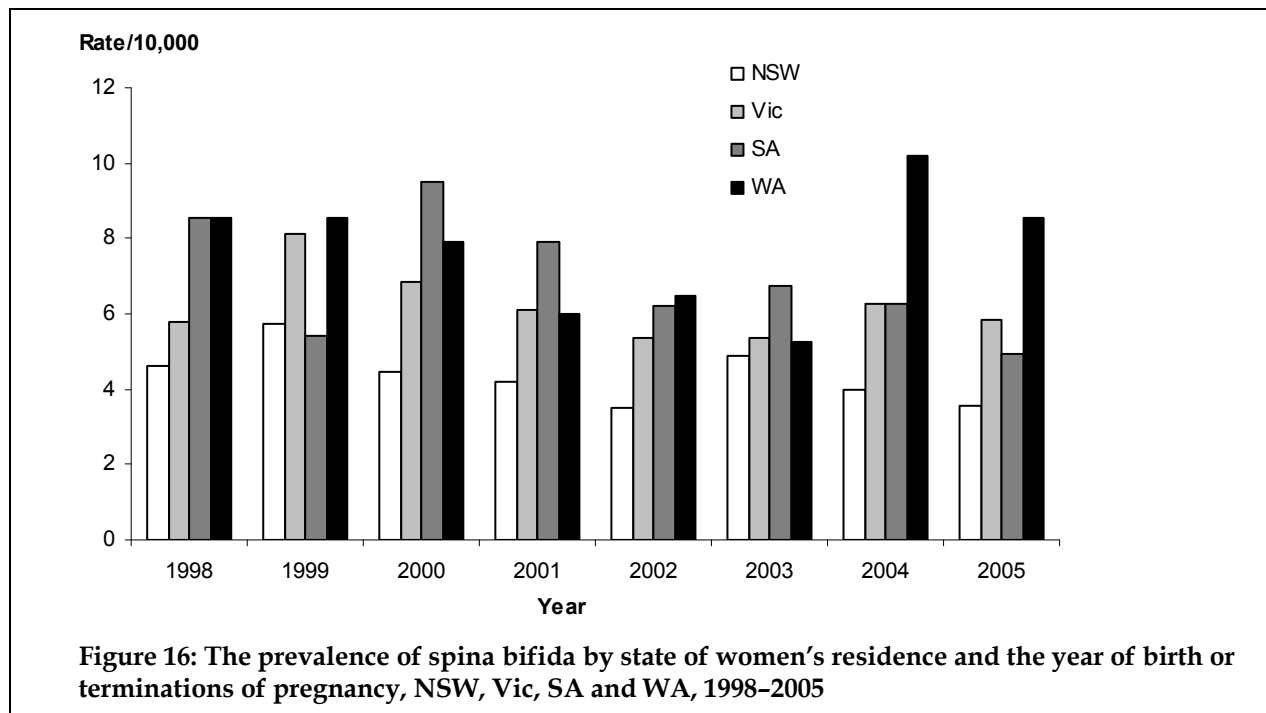
Year	Live births		*Fetal deaths		**TOP <20 weeks		All spina bifida	
	Number	Rate ^(a)	Number	Rate ^(a)	Number	Rate ^(a)	spina bifida	Rate ^(a)
1998	28	2.7	12	1.1	34	3.2	74	7.1
1999	25	2.4	13	1.2	45	4.3	83	7.9
2000	28	2.7	11	1.1	41	3.9	80	7.7
2001	22	2.1	19	1.8	26	2.5	67	6.5
2002	18	1.7	13	1.3	30	2.9	61	5.9
2003	14	1.3	18	1.7	27	2.6	59	5.7
2004	22	2.1	27	2.6	28	2.7	77	7.3
2005	26	2.4	23	2.1	22	2.0	71	6.5
1998–2005	183	2.2	136	1.6	253	3.0	572	6.8

(a) Rates are per 10,000 live births and stillbirths.

* Fetal deaths include stillbirths and terminations of pregnancy with at least 20 weeks gestation.

** TOP – Terminations of pregnancy before 20 weeks gestation.

After excluding data from New South Wales, the live birth and fetal death rates did not show a marked difference (Table 6.3, Table 6.4). Data from the three states (Victoria, South Australia and Western Australia) that have near complete data showed a slightly higher rate in early terminations. The overall prevalence of spina bifida in the three states was about 18% higher than the data from four states. Unlike anencephaly, more than 30% of pregnancies resulted in live births and most of those babies were still alive at the end of neonatal period. Between 1998 and 2005, the proportions of pregnancy terminations before 20 weeks gestation in these three states varied by 30–50%.



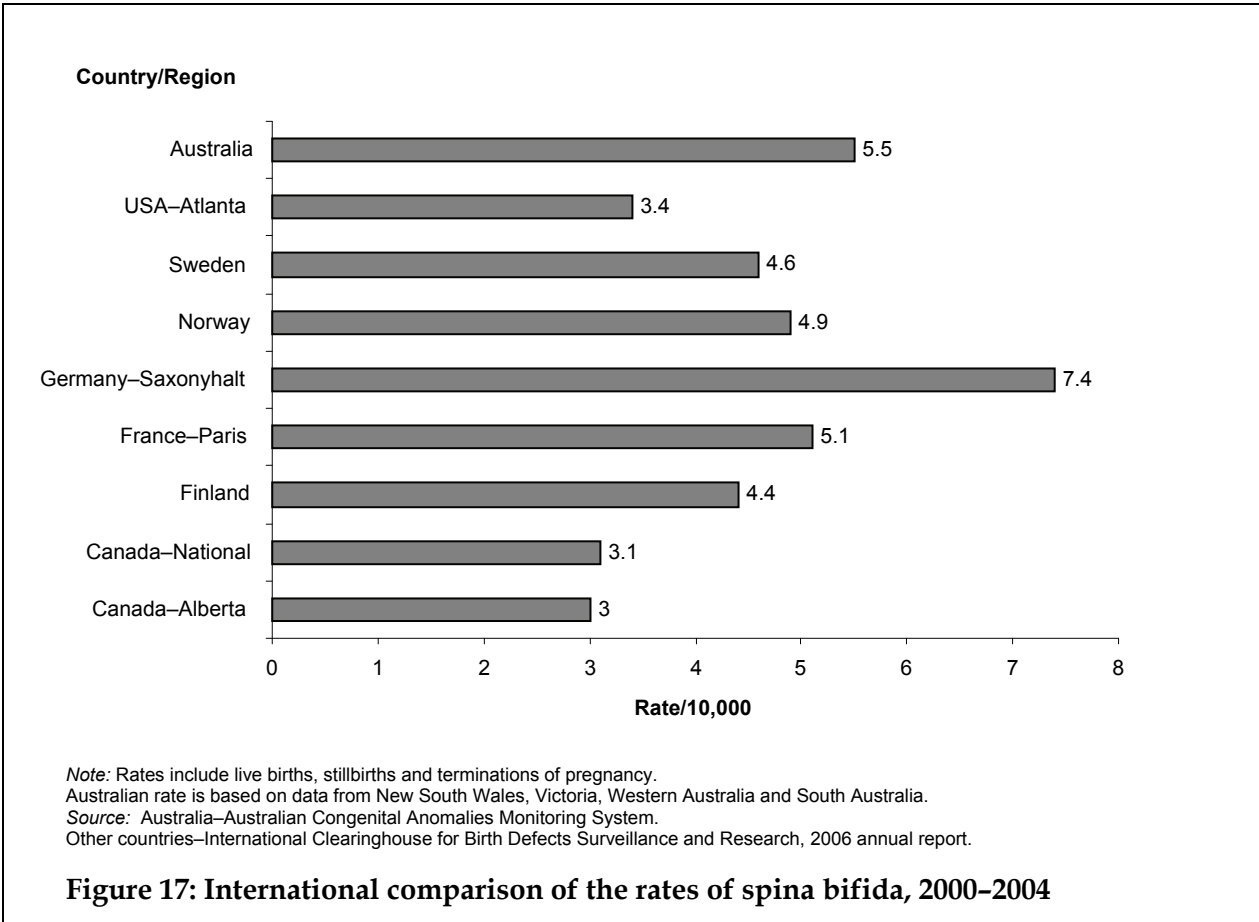
The prevalence of spina bifida was higher than the prevalence of anencephaly in each state. Western Australia and South Australia showed the highest prevalence. The highest rates were seen in Western Australia in 2004 and 2005. New South Wales showed a lower rate than Victoria, but these rates could be underestimations (Figure 16). The average spina bifida rate in New South Wales was 4.4 per 10,000 pregnancies while the other three states had averages between 6.2 and 7.7 per 10,000 pregnancies.

Prevalence of spina bifida in other countries

The rates in Figure 17 include live births, stillbirths and terminations of pregnancy at all gestations for all countries and states/regions. The Australian rate was calculated using data from New South Wales, Victoria, South Australia and Western Australia and given as an estimated rate for Australia. This prevalence could be an under-estimate because of some missing data, mainly from New South Wales.

The prevalence of spina bifida in Australia was slightly higher than for national rates of other developed countries. Saxonyhalt of Germany showed the highest rate. The Alberta birth defects register showed the lowest rate.

When the Australian rate is calculated using the data from Victoria, South Australia and Western Australia, the average rate would be 6.9 per 10,000 pregnancies, which is considerably higher than the rates in many other developed countries.



Characteristics

The rates presented in Table 6.5 are based on data from New South Wales, Victoria, South Australia and Western Australia where data include terminations of pregnancy. Some characteristics were not available for some terminations, but rates were computed for available data. Characteristics are presented for 875 women.

Women's age was available for 96.7% of affected women. About 79% of affected women were less than 35 years of age. A considerably higher number of teenage women had a pregnancy affected with spina bifida and they had the highest rate among age groups. Women younger than 30 years of age had significantly higher rates of spina bifida affected pregnancies compared with women aged 30 years or more (PR= 1.3, 95% CI 1.2-1.5).

About 28% of the women did not have Indigenous status reported. Available data showed that the Indigenous women were more likely to have spina bifida affected pregnancies than non-Indigenous women (PR=2.6, 95% CI 2.3-2.8).

Sex was not available for most early terminations of pregnancy. Therefore, sex was not stated for about 30% of the data. The rate of females affected with spina bifida was slightly higher than the rate of males affected (3.6 per 10,000 versus 4.1 per 10,000). This difference was not statistically significant.

Plurality was available for all pregnancies affected with spina bifida. Multiple pregnancies had nearly two times higher rate of spina bifida than the singleton pregnancies. Women who were pregnant with multiple fetuses were more likely to have spina bifida affected fetuses than women with singleton pregnancies (PR=1.9, 95% CI 1.7-2.1).

About 42% of the pregnancies were detected early and terminated before 20 weeks of gestation. A quarter of pregnancies continued until full term. However 70% of the pregnancies did not continue beyond 31 weeks of gestation.

Table 6.5: Characteristics of pregnancies affected with spina bifida, NSW, Vic, SA, and WA, 1998–2005

Characteristics	Number	Per cent	Rate
Women's age group (years)^(a)			
<20	45	5.1	7.0
20–24	149	17.0	6.8
25–29	271	31.0	6.1
30–34	223	25.5	4.4
35–39	132	15.1	5.5
≥40	26	3.0	5.7
Not stated	29	3.3	..
Indigenous status^(a)			
Indigenous	38	4.3	10.3
Non-Indigenous	594	67.9	4.0
Not stated	243	27.8	..
Plurality^(a)			
Singleton	848	96.9	5.7
Multiple	27	3.1	10.8
Sex^(b)			
Male	286	32.7	3.6
Female	307	35.1	4.1
Indeterminate	7	0.8	..
Not stated	275	31.4	..
Gestational age^(b)			
<20	370	42.4	..
20–31	239	27.4	97.9
32–36	44	5.0	4.7
≥37	219	25.1	1.5

(a) Rates are per 10,000 women who gave birth.

(b) Rates are per 10,000 live births and stillbirths.

Encephalocele

Encephalocele could be only a protrusion of meninges through an opening in the skull or it could be protrusion of brain tissue with the meninges. It is often accompanied by craniofacial abnormalities or other brain malformations. This condition is less common than the spina bifida and anencephaly. The severity and prognosis depend on the type of brain tissue involved, the location of the sacs and the accompanying brain malformations. Occipital encephaloceles are more common in Western countries and anterior encephaloceles are common in Asian countries. Encephalocele is not counted when present with spina bifida or anencephaly in this report.

Prevalence

There was no change in the prevalence of births with encephalocele from 1998 to 2005. Neither the live birth rate nor the fetal death rate changed markedly during this period. About 61% of births were live births. More than 80% of them were alive on day 28. Neonatal death rates varied little throughout this period.

Table 7.1: All encephalocele among births^(a), Australia, 1998–2005

Year	Live births	Rate ^(b)	*Fetal deaths	Rate ^(b)	All encephalocele	Rate ^(b)
1998	10	0.4	6	0.2	16	0.6
1999	12	0.5	5	0.2	17	0.7
2000	8	0.3	7	0.3	15	0.6
2001	11	0.4	6	0.2	17	0.7
2002	7	0.3	5	0.2	12	0.5
2003	7	0.3	6	0.2	13	0.5
2004	10	0.4	8	0.3	18	0.7
2005	11	0.4	5	0.2	16	0.6
1998–2005	76	0.4	48	0.2	124	0.6

(a) Includes all live births, stillbirths and pregnancy terminations with at least 20 weeks gestation or at least 400 g birthweight.

(b) Rates are per 10,000 live births and stillbirths.

* Fetal deaths include stillbirths and terminations of pregnancy with at least 20 weeks gestation.

Table 7.2: Outcomes of the live births of encephalocele, Australia, 1998–2005

Year	Live births		Alive on day 28		Neonatal deaths		Rate ^(a)	
	Number	Rate ^(a)	Number	Per cent	Number	Per cent	Rate ^(a)	Rate ^(a)
1998	10	0.4	7	70.0	3	30.0	0.3	0.1
1999	12	0.5	9	75.0	3	25.0	0.4	0.1
2000	8	0.3	8	100.0	0	0.0	0.3	0.0
2001	11	0.4	9	81.8	n.p.	18.2	0.4	0.1
2002	7	0.3	7	100.0	0	0.0	0.3	0.0
2003	7	0.3	6	85.7	n.p.	14.3	0.2	0.0
2004	10	0.4	7	70.0	3	30.0	0.3	0.1
2005	11	0.4	8	72.7	3	27.3	0.3	0.1
1998–2005	76	0.4	61	80.3	15	19.7	0.3	0.1

(a) Rates are per 10,000 live births and fetal deaths.

The data from the four states providing information on termination of pregnancy showed that 44.6% of affected pregnancies were terminated before 20 weeks of gestation. There was no significant difference in rates of live births and fetal deaths. About 30% of the pregnancies were live births. There was no decline in rates from 1998 to 2005. There was only a slight increase in rates, when New South Wales data were excluded.

Table 7.3: All encephalocele including terminations of pregnancy, NSW, Vic, SA, and WA, 1998–2005

Year	Live births		Fetal deaths		TOP <20 weeks		All spina bifida	Rate ^(a)
	Number	Rate ^(a)	Number	Rate ^(a)	Number	Rate ^(a)		
1998	5	0.3	6	0.3	8	0.4	19	1.0
1999	9	0.5	5	0.3	11	0.6	25	1.3
2000	5	0.3	5	0.3	19	1.0	29	1.5
2001	7	0.4	6	0.3	8	0.4	21	1.1
2002	4	0.2	5	0.3	9	0.5	18	0.9
2003	7	0.4	6	0.3	7	0.4	20	1.0
2004	7	0.4	7	0.4	8	0.4	22	1.1
2005	8	0.4	5	0.2	8	0.4	21	1.0
1998–2005	52	0.3	45	0.3	78	0.5	175	1.1

(a) Rates are per 10,000 live births and stillbirth.

* Fetal deaths include stillbirths and terminations of pregnancy with at least 20 weeks gestation.

** TOP – Terminations of pregnancy before 20 weeks gestation.

Table 7.4: All encephalocele including terminations of pregnancy, Vic, SA, and WA, 1998–2005

Year	Live births		*Fetal deaths		**TOP <20 weeks		All	
	Number	Rate ^(a)	Number	Rate ^(a)	Number	Rate ^(a)	spina bifida	Rate ^(a)
1998	5	0.5	4	0.4	3	0.3	12	1.1
1999	6	0.6	4	0.4	8	0.8	18	1.7
2000	4	0.4	3	0.3	12	1.2	19	1.8
2001	5	0.5	6	0.6	5	0.5	16	1.6
2002	2	0.2	2	0.2	5	0.5	9	0.9
2003	3	0.3	5	0.5	6	0.6	14	1.3
2004	4	0.4	5	0.5	7	0.7	16	1.5
2005	6	0.5	4	0.4	5	0.5	15	1.4
1998–2005	35	0.4	33	0.4	51	0.6	119	1.4

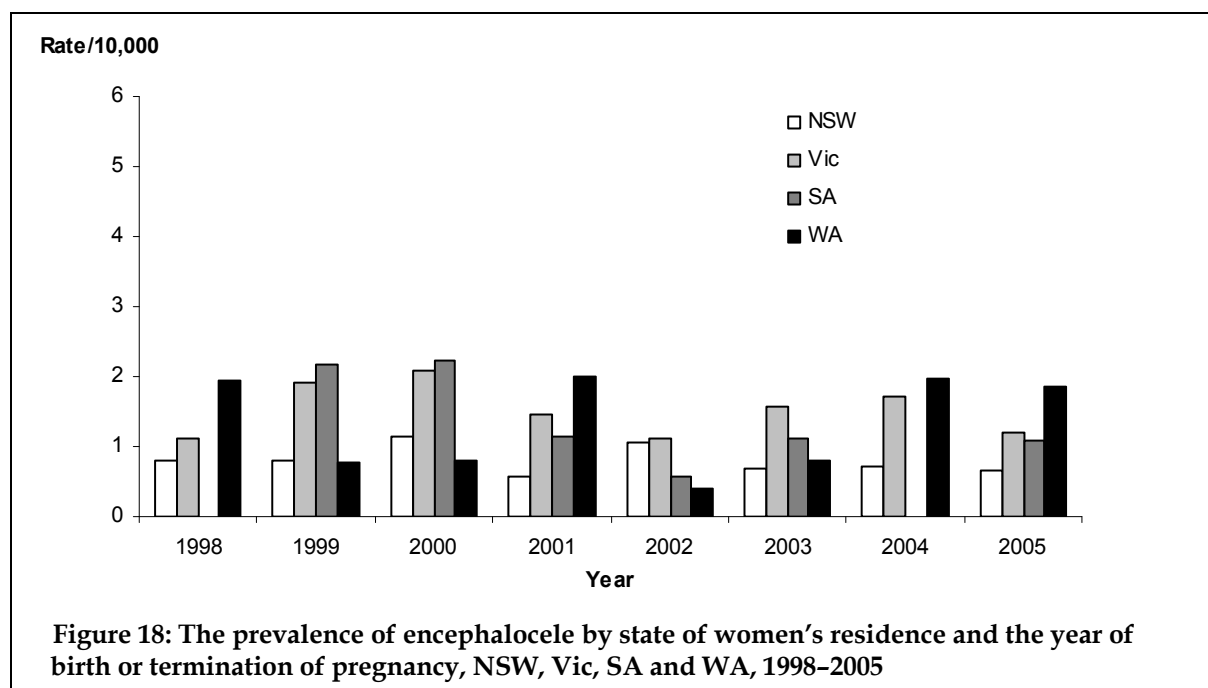
(a) Rates are per 10,000 live births and stillbirth.

* Fetal deaths include stillbirths and terminations of pregnancy with at least 20 weeks gestation.

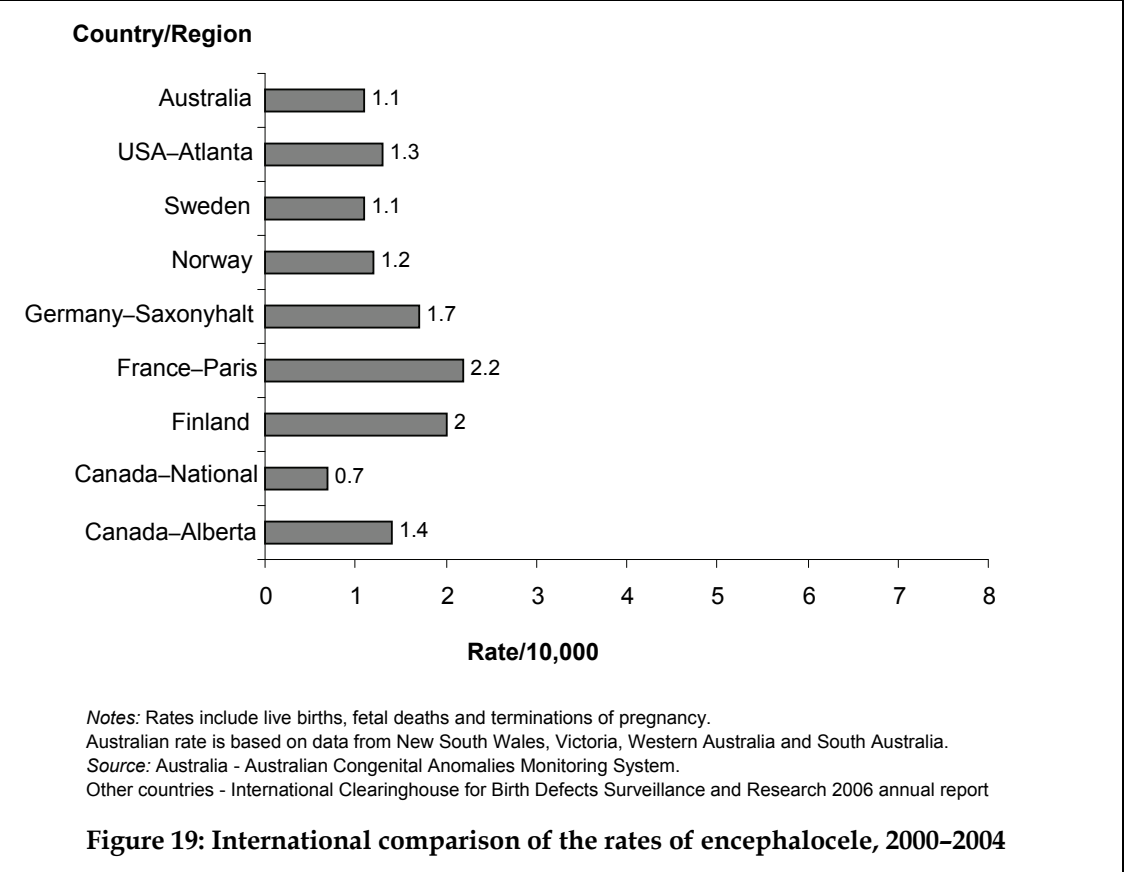
** TOP – Terminations of pregnancy before 20 weeks gestation.

Pregnancies affected with encephalocele were rarer than the anencephaly and spina bifida in each state. All states had small numbers of affected pregnancies. Victoria had the largest numbers. South Australia did not have any affected pregnancies in 1998 and 2004 (Figure 18).

The highest rates were seen in South Australia in 1999 and 2000. All states had variations in rates each year, but the highest rate was 2.2 per 10,000 pregnancies. The average encephalocele rate in New South Wales was 0.8 per 10,000 pregnancies while other three states had averages between 1.3 and 1.5 per 10,000 pregnancies.



Prevalence of encephalocele in other countries/regions



The Australian rates given in international comparison are based on data from New South Wales, Victoria, South Australia and Western Australia. This is a rare condition and the prevalence is low in all the other countries. However, some regions have slightly higher prevalence than others. The prevalence of encephalocele in Australia is similar to the other developed countries.

Characteristics

The rates presented in Table 7.5 are based on 175 affected pregnancies from four states that include details of terminations of pregnancy. Some characteristics were not available for some terminations, but rates were computed for available data.

Women of all age groups had similar rates of affected pregnancies, and teenage women had the lowest rate. About one-third of the women did not have Indigenous status reported. Available data show that Indigenous women are more likely to have encephalocele-affected pregnancies than non-Indigenous women. Sex was available for 66.3% of pregnancies. Male and female rates were similar for encephalocele. About 45% pregnancies were detected early and terminated before 20 weeks of gestation, but 22% of pregnancies continued until full term. Women who were pregnant with multiple fetuses were more likely to have encephalocele-affected fetuses than women with singleton pregnancies.

Table 7.5: Characteristics of pregnancies affected with encephalocele, NSW, VIC, SA, and WA, 1998–2005

Characteristics	Number	Per cent	Rate
Women's age group^(a)			
<20	5	2.9	0.8
20–24	31	17.7	1.4
25–29	43	24.6	1.0
30–34	56	32.0	1.1
35–39	27	15.4	1.1
≥40	6	3.4	1.3
Not stated	7	4.0	..
Indigenous status^(a)			
Indigenous	6	3.4	1.6
Non-Indigenous	105	60.0	0.7
Not stated	64	36.6	..
Plurality^(a)			
Singleton	163	93.1	1.1
Multiple	11	6.3	4.4
Not stated	1	0.6	..
Sex^(b)			
Male	58	50.0	0.7
Female	55	47.4	0.7
Indeterminate	3	2.6	..
Gestational age^(b)			
<20	78	44.6	..
20–31	47	26.9	19.2
32–36	9	5.1	1.0
≥37	39	22.3	0.3
Not stated	2	1.1	..

(a) The rates are per 10,000 women who gave birth.

(b) The rates are per 10,000 live births and stillbirths.

Conclusions and recommendations

This report outlines the prevalence of all NTD including early terminations and the trends over the years from 1992 to 2005 in four jurisdictions including New South Wales, Victoria, South Australia and Western Australia and also presents estimated prevalence of NTD based on three states (data excluding New South Wales). The prevalence and trends of births with NTD are presented for all jurisdictions in Australia except Northern Territory from 1998 to 2005. As most NTD are obvious at birth and information is collected from multiple sources, the prevalence reported on births is expected to be accurate. This information will be useful in comparing the rates of NTD in the future, especially after mandatory fortification of flour with folic acid is introduced in September 2009. This information also will allow policy development and planning of services for the future. The information on live births, neonatal deaths and births that survived until the end of the neonatal period will be useful in planning services for future management and rehabilitation of the survivors.

However, at least 50% of the pregnancies with NTD were terminated before 20 weeks gestation. Therefore collection of data on early terminations is critical in reporting the accurate prevalence of NTD. The report shows that the rates vary across all jurisdictions, so generalisation of findings are difficult.

The total NTD rates for New South Wales, Victoria, South Australia and Western Australia include all terminations of pregnancy, but data from New South Wales was incomplete. Therefore estimated rates calculated using these four states could be under-estimates. Nevertheless, data for individual states can be used to compare rates for each jurisdiction in the future. As there were a large number of women who had pregnancies affected with NTD from these four states (including pregnancy terminations), findings on the characteristics of women and births was of value.

The data from four states showed a decreasing trend in NTD since the early 1990s. This decline in NTD was approximately 33% between 1992 and 2005.

Victoria, South Australia and Western Australia had near complete data and estimated prevalence based on data from these three states is expected to provide more reliable baseline estimates for total NTD prevalence prior to the introduction of mandatory fortification of bread flour with folic acid in Australia. The decline in NTD prevalence was 26% in these three states from 1992 to 2005.

Folic acid fortification may cause beneficial effects on other congenital anomalies. This can be observed using data from the congenital anomalies monitoring systems' database.

The differences in data collected among the states demonstrate the need for a good quality national data set. A program of national data development is underway with the aim of developing a national minimum data set on congenital anomalies with the expectation of providing high quality national data on congenital anomalies. This initiative will assist the ACAMS in providing consistent national data on NTD that could be used in the future evaluation of the outcomes of mandatory folic acid fortification of bread on NTD.

Ongoing data development and improvement of the quality of termination of pregnancy data in all jurisdictions are essential to support national reporting of congenital anomalies and to ensure the collection of high quality data.

Since ACAMS is collecting only a limited number of data items, linking to other data sets that collect relevant data items will reduce the duplication of efforts.

Data development

This report on neural tube defects in Australia is a part of the project funded by the Australian Health Ministers' Advisory Council (AHMAC) through the Statistical Information Management Committee (SIMC) to work towards developing a National Minimum Data Set (NMDS) for congenital anomalies. NMDS is a minimum set of data elements agreed for mandatory collection and reporting at a national level. Definitions of all data elements that will be included in ACAMS National Minimum Data Set will be incorporated in the AIHW's online metadata registry, METeOR.

The development of data standards improves quality, makes data collection activities more efficient and reduces duplication of effort. It ensures that information to be collected is relevant and appropriate to its purpose and more comparable and consistent for reporting purposes.

The development of an NMDS for congenital anomalies includes developing and agreeing on:

- a definition for congenital anomalies
- the scope of the NMDS, including the conditions to be included, the period of notification and the data elements to be included
- the data element definitions
- a classification for congenital anomalies
- a time frame for implementation
- integration with the Perinatal NMDS
- producing congenital anomalies annual reports

Part of the work of this project has been completed.

A definition for congenital anomalies

A definition for congenital anomalies has been drafted and circulated among the NCASC and STICCA members. Suggestions by the members were incorporated and it is pending recirculation for confirmation of the final definition.

Developing ICD-10-AM classification for congenital anomalies

Development of the classification system is a critical part of the developmental work of the ACAMS. Currently, none of the available coding systems have adequate specificity required to effectively classify congenital anomalies; different jurisdictions use diverse classifications that distort the consistency of the national data collection. NPSU aims to address this shortcoming and collect good quality data as far as possible. Precise coding ensures the accurate statistics which assist in preparing policy guidelines and planning for management of the illnesses and disabilities arising from congenital anomalies.

Some jurisdictions use ICD-9-BPA to code congenital anomalies and others use ICD-10-AM. The jurisdictions using ICD-9-BPA have not moved to ICD-10-AM because it lacks specificity for some congenital anomalies. The National Centre for Classification in Health (NCCH) in

collaboration with the NPSU has already completed development of maps from ICD-9-BPA to ICD-10-AM, so that the data can be presented in a single classification in national reports. Mappings assist in extracting and analysing many years of data when there are differences in the coding.

Development of ICD-10-AM classification

Following is a description of the work that has been undertaken to develop the classification:

A national committee was formed to develop the chromosomal abnormalities section of the ICD-10-AM. The members include Prof. Mac Gardner (Human Genetics Society of Australia), Prof David Tudehope (neonatologist, Mater Mother's Hospital), Assoc Prof Liz Sullivan (NPSU), Assoc Prof Jane Halliday (Victorian Birth Defects Registry), Dr Felicity Collins (Clinical Geneticist), Dr Janet Vaughn (Feto Maternal Specialist), Dr Lynette Lee (Rehabilitation Physician), Dr David Lester-Smith (Paediatrician), Ms Vera Dimitropoulos (NCCH), Ms Bronwyn Graham (NCCH), Ms Christine Erratt (NSW Birth Defects Register), Ms Sue Travis (NSW Birth Defects Register), Ms Merilyn Riley (Victorian Birth Defects Register), Ms Heather Scott (South Australian Birth Defects Register), Dr Samantha Abeywardana (ACAMS).

A national workshop was held at the NCCH in December 2007 to develop the ICD-10-AM classification for chromosomal abnormalities. The above committee representing many experts in relevant areas attended the workshop. Professor Mac Gardner prepared draft chromosomal abnormalities classification which was discussed at the workshop. A new classification with a more descriptive coding system that can be applied with ease to chromosomal abnormalities by all states and territories was proposed. It will replace the existing complex coding system.

Some issues concerning the new chromosomal abnormalities classification were discussed at a teleconference in February 2008. Another meeting is to be held in August 2008 to finalise these changes.

Since there were major changes to the existing system, approval from the World Health Organisation (WHO) to have necessary changes is a requirement. Therefore the new classification will not be adopted until the approval procedure is completed.

Another workshop was held in May 2008 to discuss the cardio vascular system, respiratory system and digestive system. Assoc Prof Liz Sullivan (NPSU), Dr Kei Lui (neonatologist, Randwick Women's Hospital), Ms Vera Dimitropoulos (NCCH), Ms Bronwyn Graham (NCCH), Ms Christine Erratt (NSW Birth Defects Register), Ms Sue Travis (NSW Birth Defects Register), Ms Sonya Palma (Victorian Birth Defects Register), Ms Heather Scott (South Australian Birth Defects Register), Ms Edwina Rudy (Western Australian Birth Defects Register), Ms Joanne Bunney and Ms Corrie Martin (Queensland Health Information Centre), Dr Samantha Abeywardana (ACAMS) participated for this work shop. A comprehensive classification system for these systems was suggested during the workshop.

There will be more workshops to complete this task before the end of 2008.

Clinical definitions

The Australian Paediatric Surveillance Unit (APSU) has undertaken a project, in consultation with the NPSU, to develop nationally standardised clinical definitions for selected congenital anomalies that are adequate for the Australian context and will provide more accurate information about the prevalence of these conditions. APSU has completed definitions for the conditions included in the Australian congenital anomalies report, and is awaiting approval from the NCASC.

A minimum dataset for congenital anomalies

The work on development of the minimum dataset is ongoing. Congenital anomalies monitoring system's staff had METeOR training to improve knowledge of data development principles and procedures. Some data elements have already been completed. The rest of the data elements will be completed within the next few months.

Several committees will be involved in developing the dataset. The NPSU, NCASC, STICCA and when relevant, the National Perinatal Data Development Committee (NPDDC) will be consulted in the future. Following endorsement by the NCASC and the STICCA, submissions will be made to the Health Data Standards Committee (HDSC) and the SIMC.

Proposed timeframe

The proposed timeframe for the development of the NMDS for congenital anomalies is completion by March 2009, with implementation from 1 July 2009. The timeframe for the development of the ICD-10-AM classification for congenital anomalies is completion by early 2009.

Appendix A: Denominator data

Note: The source for all denominators is the National Perinatal Data Collection (Northern Territory excluded)

Table A: All births in Australia, 1998–2005

	1998	1999	2000	2001	2002	2003	2004	2005
All births	251,798	253,834	253,572	250,556	251,376	253,263	253,731	268,720
Live births	249,952	252,075	251,793	248,828	249,699	251,478	251,834	266,783
Women who gave birth	247,945	249,830	249,443	246,342	247,084	248,965	249,434	264,142

Table B: Number of all births by characteristics 1998–2005

Sex	Male	1,046,070
	Female	990,089
Gestational age (weeks)	<32	33,168
	32–36	125,568
	≥37	1,872,479
Birthweight (grams)	<1500	30,246
	1500–2499	107,159
	≥2500	1,899,383

Table C: Number of births by plurality, Australia, 1998–2005

Plurality	All births	Live births
Singleton	1,970,271	1,957,283
Plural	32,913	32,296

Table D: Women who gave birth by age group, Australia, 1998–2005

Live births + stillbirths	<20	20–24	25–29	30–34	35–39	≥40	not stated	Total
1998	12,413	40,716	81,014	74,413	33,581	5,714	92	247,943
1999	12,035	39,276	79,134	76,680	36,106	6,551	48	249,830
2000	12,118	38,496	78,276	77,738	36,211	6,547	57	249,443
2001	11,879	37,909	73,824	79,387	36,190	7,069	84	246,342
2002	11,686	37,206	70,878	82,334	37,429	7,473	78	247,084
2003	10,882	36,565	69,087	84,996	39,342	8,061	32	248,965
2004	11,070	36,121	67,745	85,534	40,680	8,242	42	249,434
2005	11,316	38,332	70,632	89,652	45,315	8,874	21	264,142
1998–2005	93,399	304,621	590,590	650,734	304,854	58,531	454	2,003,183
Live births 1998–2005	92,305	302,309	586,969	646,950	302,770	57,863	411	1,989,577

Table E: Age group of women who gave birth by gestational age at delivery, Australia, 1998–2005

Women's age (years)	<32	32–36	≥37
<20	2,267	6,238	84,454
20–24	4,972	17,457	281,106
25–29	7,742	31,155	550,109
30–34	8,208	34,061	606,854
≥35	5,949	22,482	334,072

Table F: Remoteness of the area of residence, women who gave birth, 1998–2005

Major cities	1,324,812
Regional areas	564,914
Remote areas	49,055

Table G: Outcomes of all births by Indigenous status of women who gave birth, Australia, 1998–2005

	Indigenous	Non-Indigenous	Not stated
Live births	69,840	1,902,349	533
All births	70,684	1,914,946	581

Table H: Age group of women who gave birth by, Indigenous status, Australia, 1998–2005

Women's age (years)	Indigenous	Non-Indigenous	Not known
<20	15,719	78,748	31
20–24	21,934	280,805	61
25–29	17,487	568,657	123
30–34	10,567	633,130	195
35–39	4,222	296,567	126
≥40	737	56,742	24
Not stated	18	297	21

Table I: Indigenous status of women who gave birth by gestational age at delivery, Australia, 1998–2005

Gestational age (weeks)	Indigenous	Non-Indigenous	Not known
<32	2,422	30,562	46
32–36	7,396	117,971	41
≥37	61,602	1,798,632	489
Not stated	83	208	12

Table J: Indigenous status of women who gave birth by plurality, Australia, 1998–2005

Plurality	Indigenous	Non-Indigenous	Not known
Singleton	69,877	1,883,249	574
Multiple	807	1,916,603	7

Table K: Number of all births by individual states, NSW, Vic, Qld, SA and WA 1998–2005

Year	NSW	Vic	Qld	SA	WA
1998	86,305	62,091	48,163	18,733	25,677
1999	87,289	62,689	48,746	18,519	25,771
2000	87,922	62,564	49,316	17,872	25,229
2001	85,858	62,149	49,690	17,704	24,939
2002	86,005	63,133	49,196	17,745	24,784
2003	86,414	63,552	50,366	17,844	24,681
2004	85,626	63,700	50,910	17,521	25,528
2005	90,608	66,654	55,280	18,195	26,983
1998–2005	696,027	506,532	401,667	144,133	203,592

Table L: Number of all births, NSW, Vic, SA and WA, 1992–2005

Year	All births
1992	200,749
1993	197,748
1994	197,888
1995	196,152
1996	194,045
1997	194,283
1998	192,806
1999	194,268
2000	193,587
2001	190,650
2002	191,667
2003	192,491
2004	192,375
2005	202,440

Table M: Number of all live births, NSW, Vic, SA and WA, 1998–2005

Year	Live births
1998	191,402
1999	192,952
2000	192,260
2001	189,367
2002	190,403
2003	191,116
2004	190,895
2005	200,963

Table N: Women who gave births by age group, NSW, Vic, SA and WA, 1998–2005

Women's age (years)	1998	1999	2000	2001	2002	2003	2004	2005
<20	8,659	8,183	8,274	8,109	7,990	7,273	7,529	7,683
20–24	29,663	28,269	27,844	27,367	26,913	26,238	25,820	27,100
25–29	61,902	60,097	59,394	55,813	53,544	52,227	50,894	52,680
30–34	58,367	60,351	60,973	61,926	64,260	66,004	66,438	69,140
35–39	26,640	28,874	28,669	28,472	29,756	31,077	31,973	35,392
≥40	4,540	5,363	5,244	5,655	5,906	6,398	6,490	6,975
Not known	81	29	31	66	58	17	27	21

Table O: Number of all births, NSW, Vic, SA and WA by sex, 1998–2005

Male	795,480
Female	754,203
Indeterminate	166
Not stated	435

Table P: Number of all births, NSW, Vic, SA and WA by Plurality, 1998–2005

Year	Singleton	Multiple
1998	186,982	2,872
1999	188,148	3,018
2000	187,334	3,095
2001	184,233	3,175
2002	185,234	3,193
2003	186,039	3,195
2004	186,024	3,147
2005	195,606	3,385
1998–2005	1,499,600	25,080

Table Q: Remoteness of the area of residence of women, NSW, Vic, SA and WA, 1998–2005

Major cities	1,113,578
Regional areas	378,260
Remote areas	32,175

Table R: Indigenous status by women's characteristics, NSW, Vic, SA and WA, 1998–2005

	Indigenous	Non-Indigenous
All births	36,745	1,487,563
Maternal age		
<20	8,110	56,232
20–24	11,472	208,497
25–29	9,037	438,816
30–34	5,503	501,099
35–39	2,219	237,040
≥40	390	45,585
Not known	14	294
Gestational age		
20–31	1,161	20,319
32–36	3,670	79,416
≥37	31,908	1,387,677

Appendix B:

National Congenital Anomalies Steering Committee

Name	Position/Organisation
Professor Elizabeth Elliott	Chair/ Disciplines of Paediatrics and Child Health, University of Sydney and Director, Australian Paediatric Surveillance Unit
Professor David Tudehope	Deputy Chair/Director, Neonatal Intensive Care Unit, Mater Mother's Hospital, Brisbane
Professor Carol Bower	Head, Division of Population Sciences, The University of Western Australia and Western Australian Birth Defects Register
Associate Professor Elizabeth Sullivan	AIHW, NPSU
Associate Professor Jane Halliday	Epidemiologist/Victorian Birth Defects Register, Head, Public Health Genetics, Murdoch Children's Research Institute
Associate Professor Annabelle Chan	Senior Medical Consultant, Pregnancy Outcome Unit, South Australian Department of Health
Dr Hugh Martin	Paediatric Surgeon, Royal Australasian College of Paediatric Surgeons
Dr Lee Taylor	Manager, Centre for Epidemiology and Research, NSW Department of Health
Ms Sue Cornes	Senior Director, Health Information Centre, Queensland Health

State and Territory Implementation Committee for Congenital Anomalies

Ms Meryllyn Riley	Victorian Birth Defects Register
Ms Sue Travis	Birth Defects Register, New South Wales
Ms Edwina Rudy	Western Australian Birth Defects Register
Ms Phillipa van Essen	South Australian Birth Defects Register
Ms Maureen Bourne	Population Health Research Centre, Australian Capital Territory
Mr Peter Mansfield	Clinical Data Services, Department of Health and Human Services, Tasmania
Ms Joanne Bunney	Health Information Centre, Queensland Department of Health

References

- Abraham B & Webb K 2001. Interim evaluation of the voluntary folate fortification policy. Canberra: Australian Food and Nutrition Monitoring Unit.
- Australian Bureau of Statistics (ABS) 2001. Australian Standard Geographical Classification. ABS Cat. no. 1216.0. Canberra: ABS.
- Al-Gazali LI, Sztriha L, Dawodu A et al. 1999. Pattern of central nervous system anomalies in a population with a high rate of consanguineous marriages. *Clinical Genetics* 55: 95–102.
- Armitage P, Berry G 1994. *Statistical Methods in Medical Research*, third edition, Oxford: Blackwell Scientific Publications, 118–132.
- Berry RJ, Li Z, Erickson JD, Li S, Moore CA, Wang H et al. 1999. Prevention of neural-tube defects with folic acid in China: China-U.S. Collaborative Project for Neural Tube Defect Prevention. *New England Journal of Medicine* 341:1485–1490.
- Botto LD, Moore CA, Khoury MJ & Erickson JD 1999. Neural tube defects. *New England Journal of Medicine* 341:1509–1519.
- Botto LD, Lisi A, Robert-Gnansia E, Erickson JD, Vollset SE, Mastroiacovo P et al. 2005. International retrospective cohort study of neural tube defects in relation to folic acid recommendations: are the recommendations working? *BMJ* 330(7491): 571.
- Boushey CJ, Beresford SA, Omenn GS & Motulsky AG 1995. A quantitative assessment of plasma homocysteine as a risk factor for vascular disease. Probable benefits of increasing folic acid intakes. *Journal of American Medical Association* 274 (13): 1049-1057.
- Bower C, Blum L, O'Daly K, Higgins C, Loutsky F & Kosky C 1997. Promotion of folate for the prevention of neural tube defects: trends in the knowledge and use of periconceptional folic acid supplements in Western Australia, 1992–1995. *Australian and New Zealand Journal of Public Health* 21:716–721, and Erratum 1998. *Australian and New Zealand Journal of Public Health* 22:72.
- Bower C, Ryan A & Rudy E 2001. Ascertainment of pregnancies terminated because of birth defects: Effect on completeness of adding a new source of data. *Teratology* 63:23–25.
- Bower C, Rudy E, Ryan A & Miller M 2002. Trends in neural tube defects in Western Australia. *Australian and New Zealand Journal of Public Health* 26:150–151.
- Bower C & Stanley F J 2004^A, Case for mandatory fortification of food with folate in Australia, for the prevention of neural tube defects. *Birth Defects Research (Part A): Clinical and Molecular Teratology* 70:842–843.
- Bower C, Miller M, Payne J & Serna P 2004^B. Folate promotion in Western Australia and the prevention of neural tube defects. *Australian and New Zealand Journal of Public Health* 28(5): 458–464.
- Bower C, Eades S, Payne J, D'Antoine H & Stanley F 2004^C. Trends in neural tube defects in Western Australia in Indigenous and non-Indigenous populations. *Paediatric and Perinatal Epidemiology* 18:277–280.

- Bower C, Miller M, Payne J & Serna P 2005. Promotion of folate for the prevention of neural tube defects: who benefits? *Paediatric and Perinatal Epidemiology* 19:435-444.
- Bower C 2006. Primary prevention of neural tube defects with folate in Western Australia: the value of the Western Australian Birth Defects Registry. *Congenital Anomalies* 46(2):118-121.
- Busby A, Abramsky L, Dolk H & Armstrong B 2005. Preventing neural tube defects in Europe: population based study *BMJ* 330(7491):574-575.
- Campbell LR, Sohal GS 1990. The pattern of neural tube defects created by secondary reopening of the neural tube. *Journal of Child Neurology* (5):336-340.
- Centers for Disease Control and Prevention 2004. Spina bifida and anencephaly before and after folic acid mandate – United States, 1995-1996 and 1999-2000. *Morbidity and Mortality Weekly Report (MMWR)* 53:362-365.
- Chan A, Pickering J, Haan EA, Netting M, Burford A, Johnson A et al. 2001. Folate before pregnancy: the impact on women and health professionals of a population-based health promotion campaign in South Australia. *Medical Journal of Australia* 174:631-636.
- Charles D, Ness AR, Campbell D, Davey Smith G, Hall MH 2004. Taking folate in pregnancy and risk of maternal breast cancer. *BMJ* 329:1375-6.
- Coerdts W, Miller K, Holzgreve W, Rauskolb R, Schwinger E, Rehder H 1997. Neural tube defects in chromosomally normal and abnormal human embryos. *Ultrasound Obstet Gynecol* 10: 410-415.
- Conlin M L, MacLennan A H & Broadbent J L 2006. Inadequate compliance with periconceptional folic acid supplementation in South Australia. *Australian and New Zealand Journal of Obstetrics and Gynaecology* 46: 528-533.
- Czeizel A, Métneki J 1984. Recurrence risk after neural tube defects in a genetic counselling clinic. *Journal of Medical Genetics* 21:413-416.
- Czeizel AE & Dudas I 1992. Prevention of the first occurrence of neural-tube defects by periconceptional vitamin supplementation. *New England Journal of Medicine* 327:1832-1835.
- Date I, Yagyu Y, Asari S, Ohmoto T 1993. Long-term outcome in surgically treated spina bifida cystica. *Surg Neurology* 40:471-475.
- Detrait ER, George TM, Etchevers HC, Gilbert JR, Vekemans M & Speer MC 2005. Human neural tube defects: Developmental biology, epidemiology, and genetics. *Neurotoxicology and Teratology* 27(3): 515-524.
- De Wals P, Tairou, F & Van Allen, MI et al. 2007. Reduction in neural-tube defects after folic acid fortification in Canada. *New England Journal of Medicine* 357:135-142.
- DOH (Department of Health, NSW 2000), New South Wales mothers and babies 1998. *NSW Public Health Bulletin Supplement*. Sydney: DOH.
- DOH 2001 (Department of Health, Public Health Division, NSW). New South Wales mothers and babies 2000. *NSW Public Health Bulletin Supplement* 12(S-3). Sydney: DOH.
- Duncan S, Mercho S, Lopes-Cendes I, Seni M, Benjamin A, Dubeau F et al. 2001. Repeated neural tube defects and valproate monotherapy suggest a pharmacogenetic abnormality. *Epilepsia* 42:750-753.

- Duthie SJ 1999. Folic acid deficiency and cancer: mechanisms of DNA instability. *British Medical Bulletin* 55:578-592.
- Ellenbogen RG 2006. Neural tube defects in the neonatal period. *eMedicine*, 20 June. Viewed 6 August 2008, <www.emedicine.com/ped/topic2805.htm#section~AuthorsandEditors>.
- Flood VM, Web KL, Mitchell P, Bantick JM, Macintyre R et al. 2001. Folate fortification: potential impact on folate intake in an older population. *European Journal of Clinical Nutrition* 55, 793-800.
- Food Liaison Pty Ltd 2007. Australia New Zealand Food Law on Disc® Version 51, October. Canberra: Food Liaison. Viewed 6 August 2008, <<http://www.foodliaison.com.au/newsletter/notes51.pdf>>.
- Food Standards Australia New Zealand 2006. Final assessment report – Proposal 295 – Consideration of mandatory fortification with folic acid. Viewed 6 August 2008, <www.foodstandards.gov.au/_srcfiles/FAR_P295_Folic_Acid_Fortification_%20Attachs_1_6.doc>.
- Fuchs CS, Willett WC, Colditz GA, Hunter DJ, Stampfer MJ, Speizer FE, Giovannucci EL 2002. The Influence of Folate and Multivitamin Use on the Familial Risk of Colon Cancer in Women. *Cancer Epidemiology Biomarkers & Prevention* 11: 227-234.
- Gindler J, Li Z, Berry RJ, Zheng J, Correa A, Sun X et al. 2001. Folic acid supplements during pregnancy and risk of miscarriage. *Lancet* 358:796–800.
- Halliday JL, Riley M 2000. Fortification of foods with folic acid. *New England Journal of Medicine* 343: 970-971.
- Hickling s, Hung J, Knuiman M, Jamrozik K, McQuillan B et al. 2005. Impact of voluntary folate fortification on plasma homocysteine and serum folate in Australia from 1995 to 2001: a population based cohort study. *J Epidemiology & Community Health* 59: 371-376.
- Honein MA, Paulozzi LJ, Mathews TJ, Erickson JD, Wong LC 2001. Impact of folic acid fortification of the US food supply on the occurrence of neural tube defects. *JAMA* 285(23):2981–2986.
- The International Clearinghouse for Birth Defects Surveillance and Research, Annual report 2006 with data for 2004.
- Jacques PF, Selhub J, Bostom AG, Wilson PWF & Rosenberg IH 1999. The effect of folic acid fortification on plasma folate and total homocysteine concentrations. *New England Journal of Medicine* 340 (19):1449-1454.
- Kashani A 2001. Meningeal-cutaneous relationships in anencephaly: Evidence for a primary mesenchymal abnormality. *Human Pathology* 32(5):553–558.
- Kim YI 2003. Role of Folate in Colon Cancer Development and Progression, *Journal of nutrition*. 133:3731S-3739S.
- Kim YI 2004. Will mandatory folic acid fortification prevent or promote cancer? *American Journal of Clinical Nutrition* 80(5): 1123-1128.
- Laurence KM, James N, Miller MH, Tennant GB & Campbell H 1981. Double-blind randomized controlled trial of folate treatment before conception to prevent recurrence of neural-tube defects. *British Medical Journal* 282:1509–1511.

- Lemire RJ 1988. Neural tube defects. *JAMA* 259:558-562.
- Li Z, Gindler J, Wang H, Berry R, Li S, Correa A, Zheng J, Erickson J, Wang Y 2001. Folic acid supplements during early pregnancy and likelihood of multiple births: a population-based cohort study. *The Lancet* 361(9355):380-384.
- Lindhout D, Omtzigt JGC & Cornel MC 1992. Spectrum of neural-tube defects in 34 infants prenatally exposed to antiepileptic drugs. *Neurology* 42:111-118.
- Maberly GF & Stanley FJ 2005. Mandatory fortification of flour with folic acid: an overdue public health opportunity. *Medical Journal of Australia* 183:342-343.
- Malinow MR, Duell PB, Hess DL, Anderson PH, Kruger WD, Phillipson BE, et al. 1998. Reduction of plasma homocysteine levels by breakfast cereal fortified with folic acid in patients with coronary heart disease. *New England Journal of Medicine* 338(15):1009-1015.
- Malouf M; Grimley E-J; Areosa SA 2003. Folic acid with or without vitamin B12 for cognition and dementia. *Cochrane-Database-Syst-Rev.* 2003; (4): CD004514.
- March of Dimes 2005. Survey highlights the need to increase folic acid fortification of the grain supply. *Women's Health News* 3 October. Viewed 6 August 2008, <www.news-medical.net/?id=13484>.
- McFadden DE, Friedman JM 1997. Chromosome abnormalities in human beings. *Mutat Res* 396: 129-140.
- Moretti ME, Bar-Oz B, Fried S & Koren G 2005. Maternal hyperthermia and the risk for neural tube defects in offspring: Systematic review and meta-analysis. *Epidemiology* 16(2):216-219.
- MRC (Medical Research Council Vitamin Study Research Group) 1991. Prevention of neural tube defects: results of the Medical Research Council Vitamin Study. *Lancet* 338:131-137.
- Muggli EE & Halliday JL 2007. Folic acid and risk of twinning: a systematic review of the recent literature, July 1994 to July 2006. *Medical Journal of Australia* 186: 243-248.
- Muller PR, Wilkinson C, Cocciolone R, Haan E & Chan A 2007. Trends in state/population-based screening for neural tube defects, South Australia 1986-2004. Viewed 6 August 2008, <www.wch.sa.gov.au/services/az/divisions/labs/geneticmed/documents/NTDPosterWeb.pdf>.
- National Institute of Clinical Studies. Folic acid 2005. Encouraging periconceptional use of folic acid supplements. Evidence-Practice Gaps Report, Volume 2. Viewed Nov 2007, <<http://www.nicsl.com.au/data/portal/00000005/content/18991001155272057026.pdf>>.
- Oakley GP Jr, Weber MB, Bell KN, Colditz P 2004. Scientific evidence supporting folic acid fortification of flour in Australia and New Zealand. *Birth Defects Research Part A: Clinical and Molecular Teratology* 70:838-841.
- Oddy WH, Miller M, Payne JM, Serna P & Bower C 2007. Awareness and consumption of folate-fortified foods by women of childbearing age in Western Australia. *Public Health Nutrition* 10(10):989-995.
- Olney RS & Mulinare J 2002. Trends in neural tube defects prevalence, folic acid fortification and vitamin supplement use. *Seminars in Perinatology* 26(4): 277-285.

Owen TJ & Halliday JL 2000. Neural tube defects in Victoria, Australia: potential contributing factors and public health implications. *Australian and New Zealand Journal of Public Health* 24(6): 584-589.

Padmanabhan R 2006, Etiology, pathogenesis and prevention of neural tube defects. *Congenital Anomalies* 46:55-67.

Riley M, Phyland S, Halliday J 2004. Validation study of the Victorian Birth Defects Register. *Journal of Paediatrics and Child Health* 40: 544-548.

Sadovnick AD & Baird PA 1982. A cost-benefit analysis of prenatal diagnosis of neural tube defects selectively offered to relatives of index cases. *American Journal of Medical Genetics* 12:63-73.

Shurtleff DB 2004. Epidemiology of neural tube defects and folic acid. *Cerebrospinal Fluid Research* 1:5. Viewed 6 August 2008, <<http://www.cerebrospinalfluidresearch.com/content/1/1/5>>.

Signore C, Mills JL, Cox C, Trumble AC 2005. Effects of Folic Acid Fortification on Twin Gestation Rates *Obstetrics & Gynecology* ,105:757-762.

Smithells RW, Sheppard S, Schorah CJ, Seller MJ, Nevin NC et al. 1981. Apparent prevention of neural tube defects by periconceptional vitamin supplementation. *Archives of Disease in Childhood* 56(12): 911-918.

Stolzenberg-Solomon RZ, Chang SC, Leitzmann MF, Johnson KA, Johnson C, Buys SS, et al. 2006. Folate intake, alcohol use, and postmenopausal breast cancer risk in the Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial. *Am J Clin Nutr* 83:895-904.

Tjonneland A, Christensen J, Olsen A, Stripp C, Nissen SB, Overvad K, et al 2006. Folate intake, alcohol and risk of breast cancer among postmenopausal women in Denmark. *Eur J Clin Nutr*; 60:280-6.

Waller DK, Tita ATN, Annegers JF 2003. Rates of twinning before and after fortification of foods in the US with folic acid, Texas, 1996 to 1998 *Paediatric and Perinatal Epidemiology* 17(4): 378-383.

Watson LF, Brown SJ, Davey MA 2006. Use of periconceptional folic acid supplements in Victoria and New South Wales, Australia. *Australian and New Zealand Journal of Public Health* 30(1):42-9.

Watson M, Waters E & Halliday J 2004. Folate and the prevention of neural tube defects: update of the evidence in relation to public health policy. Report for Victorian Department of Human Services, July. Melbourne: Department of Human Services.

Zlotogora J 1997 Genetic disorders among Palestinian Arabs: 1. Effects of consanguinity. *Am J Med Genet* 68: 472-475.

List of tables

Table 1.1: Number and rates of NTD among births as reported to the ACAMS, Australia, 1998–2005.....	14
Table 1.2: Outcomes of live births with NTD, Australia, 1998–2005.....	14
Table 1.3: Sex of the births with NTD and the outcome, Australia, 1998–2005.....	15
Table 1.4: Gestational age of the births with NTD and the outcome, Australia, 1998–2005.....	17
Table 1.5: Birthweight of the babies born with NTD and the outcome, Australia, 1998–2005.....	18
Table 1.6: Outcome of births with NTD by plurality, Australia, 1998–2005.....	19
Table 1.7: Number of women who gave birth at 20 weeks gestation or later by age group and year of birth, Australia, 1998–2001.....	20
Table 1.8: Outcome of live births with NTD by women’s age group, Australia, 1998–2005.....	21
Table 1.9: Women who had NTD-affected births by age group and gestation at delivery.....	21
Table 1.10: Characteristics of women who gave birth by Indigenous status, 1998–2005, Australia.....	22
Table 1.11: Remoteness of the residence of women who had NTD-affected births, 1998–2005, Australia.....	23
Table 2.1: Total number of NTD by year of pregnancy, NSW, Vic, SA and WA, 1992–2005.....	25
Table 2.2: All pregnancies affected with NTD by outcome, NSW, Vic, SA, and WA, 1998–2005.....	26
Table 2.3: Outcomes of the live births with NTD by year of birth, NSW, Vic, SA, and WA, 1998–2005.....	26
Table 2.4: Plurality and year of pregnancy NSW, Vic, SA, and WA, 1998–2005.....	27
Table 2.5: All NTD, women’s age group by year of pregnancy, NSW, Vic, SA and WA, 1998–2005.....	28
Table 2.6: Remoteness of residence of women who had NTD-affected pregnancies NSW, Vic, SA, and WA, 1998–2005.....	29
Table 2.7: Characteristics of women who had pregnancies affected with NTD by Indigenous status, NSW, Vic, SA, and WA, 1998–2005.....	30
Table 3.1: Number and estimated rate of all NTD, New South Wales, 1992–2005.....	34
Table 3.2: Number and estimated rate of all NTD, Victoria, 1992–2005.....	34
Table 3.3: Number and estimated rate of all NTD, South Australia, 1992–2005.....	34
Table 3.4: Number and estimated rate of all NTD, Western Australia, 1992–2005.....	34
Table 4.1: All NTD reported from Vic, SA and WA by year of birth or terminations of pregnancy, 1992–2005.....	36
Table 4.2: All neural tube defects by outcome, Vic, SA, and WA, 1998–2005.....	37
Table 4.3: All live births with neural tube defects by outcome, Vic, SA, and WA, 1998–2005.....	37
Table 4.4: All NTD, women’s age group by year of pregnancy, Vic, SA, and WA, 1998–2005.....	38
Table 5.1: All anencephaly among births, Australia, 1998–2005.....	39
Table 5.2: All anencephaly, including terminations of pregnancy, NSW, Vic, SA, and WA, 1998–2005.....	40

Table 5.3: All anencephaly, including terminations of pregnancy, Vic, SA, and WA, 1998–2005.....	41
Table 5.4: Characteristics of pregnancies affected with anencephaly, NSW, Vic, SA, and WA, 1998–2005.....	44
Table 6.1: All spina bifida among births, Australia, 1998–2005.....	45
Table 6.2: Outcomes of the live births with spina bifida, Australia, 1998–2005.....	46
Table 6.3: All spina bifida including terminations of pregnancy, NSW, Vic, SA, and WA, 1998–2005.....	46
Table 6.4: All spina bifida including terminations of pregnancy, Vic, SA, and WA, 1998–2005.....	47
Table 6.5: Characteristics of pregnancies affected with spina bifida, NSW, Vic, SA, and WA, 1998–2005.....	50
Table 7.1: All encephalocele among births, Australia, 1998–2005.....	51
Table 7.2: Outcomes of the live births of encephalocele, Australia, 1998–2005.....	52
Table 7.3: All encephalocele including terminations of pregnancy, NSW, Vic, SA, and WA, 1998–2005.....	52
Table 7.4: All encephalocele including terminations of pregnancy, Vic, SA, and WA, 1998–2005.....	53
Table 7.5: Characteristics of pregnancies affected with encephalocele, NSW, VIC, SA, and WA, 1998–2005.....	55
Table A: All births in Australia, 1998–2005.....	60
Table B: Number of all births by characteristics 1998–2005.....	60
Table C: Number of births by plurality, Australia, 1998–2005.....	60
Table D: Women who gave birth by age group, Australia, 1998–2005.....	60
Table E: Age group of women who gave birth by gestational age at delivery, Australia, 1998–2005.....	61
Table F: Remoteness of the area of residence, women who gave birth, 1998–2005.....	61
Table G: Outcomes of all births by Indigenous status of women who gave birth, Australia, 1998–2005.....	61
Table H: Age group of women who gave birth by, Indigenous status, Australia, 1998–2005.....	61
Table I: Indigenous status of women who gave birth by gestational age at delivery, Australia, 1998–2005.....	61
Table J: Indigenous status of women who gave birth by plurality, Australia, 1998–2005.....	62
Table K: Number of all births by individual states, NSW, Vic, Qld, SA and WA 1998–2005.....	62
Table L: Number of all births, NSW, Vic, SA and WA, 1992–2005.....	62
Table M: Number of all live births, NSW, Vic, SA and WA, 1998–2005.....	63
Table N: Women who gave births by age group, NSW, Vic, SA and WA, 1998–2005.....	63
Table O: Number of all births, NSW, Vic, SA and WA by sex, 1998–2005.....	63
Table P: Number of all births, NSW, Vic, SA and WA by Plurality, 1998–2005.....	63
Table Q: Remoteness of the area of residence of women, NSW, Vic, SA and WA, 1998–2005.....	64
Table R: Indigenous status by women’s characteristics, NSW, Vic, SA and WA, 1998–2005.....	64

List of figures

- Figure 1: Rate and confidence intervals of neural tube defects among births, Australia, 1998–2005...13
- Figure 2: Babies born with NTD by sex, rates per 10,000 births, Australia, 1998-2005.....15
- Figure 3: Outcome of births with NTD by gestation at birth, Australia, 1998-2005.....16
- Figure 4: Rate of NTD by Indigenous status, 1998–2005, Australia23
- Figure 5: Estimated prevalence and confidence intervals of all NTD including all births and terminations of pregnancy, NSW, Vic, SA and WA, 1992–2005.....25
- Figure 6: Proportion of terminations of pregnancy before 20 weeks gestation (TOP), fetal deaths and live births, NTD in NSW, Vic, SA and WA, 1998 to 2005.....27
- Figure 7: Rates of pregnancies with NTD, by maternal age group and year, NSW, Vic, SA, and WA, 1998–200529
- Figure 8: Indigenous status of women affected with NTD by year of birth or terminations of pregnancy, NSW, Vic, SA and WA, 1998–200531
- Figure 9: Prevalence of NTD among births, by year of birth and state, NSW, Vic, Qld, SA and WA, 1998–200532
- Figure 10: Prevalence of all NTD, in NSW, Vic, SA and WA, 1992–200533
- Figure 11: Estimated overall prevalence of NTD based on data of three and four states, 1992–200535
- Figure 12: Estimated NTD rates in Australia based on data from Vic, SA and WA, 1992– 2005.....36
- Figure 13: Rates of NTD by maternal age group when rates were based on three and four states38
- Figure 14: Estimated prevalence of anencephaly by state of women’s residence and year of birth or termination of pregnancy, NSW, Vic, SA and WA, 1998–200541
- Figure 15: International comparison of the rates of anencephaly, 2000–2004.....42
- Figure 16: The prevalence of spina bifida by state of women’s residence and the year of birth or terminations of pregnancy, NSW, Vic, SA and WA, 1998–2005.....47
- Figure 17: International comparison of the rates of spina bifida, 2000–2004.....48
- Figure 18: The prevalence of encephalocele by state of women’s residence and the year of birth or termination of pregnancy, NSW, Vic, SA and WA, 1998–200553
- Figure 19: International comparison of the rates of encephalocele, 2000–200454