1. Maternal and perinatal mortality

1.1 Definitions

The Council uses the following definitions.

Fetal deaths (known as stillbirth)

Defined by the *Registration of Births, Deaths and Marriages Act 2003* as:

a child who has shown no sign of respiration or heartbeat, or other sign of life, after completely leaving the child's mother; and who has been gestated for 20 weeks or more, or weighs 400 grams or more.

Livebirths

Defined by the *Public Health Act 2005* as:
a baby whose heart has beaten after delivery of the baby is completed.

Birthweight and gestation are not included in this definition. Therefore, in this report, deaths of liveborn babies where both the birthweight is less than 400 grams and/or the gestation is less than 20 weeks, and deaths of liveborn babies when the birthweight and gestational age are unknown, are included as neonatal deaths.

Neonatal deaths

Neonatal deaths are those occurring in live births within the first 28 days of life.

Mothers

The number of mothers is defined as:
the number of women having a pregnancy which resulted in a livebirth or fetal death.

Maternal death

A maternal death is defined by the World Health Organization (WHO) as:
the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management.

This definition excludes deaths from accidental or incidental causes.

Maternal mortality ratio

The maternal mortality ratio (MMR) is defined as: $\frac{\textit{Number of maternal deaths}}{\textit{Number of mothers}} \times 100{,}000$

The definitions used by the Council in this report include, in addition to the WHO definition, incidental deaths and deaths occurring more than 42 days after termination of the pregnancy[7].

Late maternal death

Death of a woman within one year of giving birth or otherwise ending a pregnancy.

These deaths are not included in the calculation of the MMR.

Classification of maternal deaths

***Direct deaths** are those which result from obstetric complications of the pregnant state (pregnancy, labour and puerperium), including deaths from interventions, omissions, inappropriate treatment, or from a chain of events resulting from any of the above. They are complications of the pregnancy itself.*

***Indirect deaths** are those which result from pre-existing disease or disease that developed during pregnancy and was not due to direct obstetric causes, but which may have been aggravated by physiological effects of pregnancy.*

***Incidental deaths** are those due to conditions occurring during pregnancy, where the pregnancy is unlikely to have contributed significantly to the death, although it is sometimes possible to postulate a distant association.*

7 Maternal Mortality Working Party, NHMRC. Report on Maternal Deaths in Australia 1991-93. Canberra: NHMRC.

1.2 Maternal deaths

1.2.1 Maternal mortality ratio (MMR)

For comparison purposes, data presented in this section uses the ICD–10/WHO definition of maternal death.

Table 1: Maternal mortality ratios, Queensland and Australia 2000 to 2011
(ICD–10/WHO definition of maternal death—Australian MMR for 2006 to 2010)

Trienium	Direct	Indirect	Number of women who gave birth	MMR Queensland	MMR Australia
2000–02	8	10	145,756	12.3	11.1
2003–05	9	12	153,900	13.6	8.4
2006–08	6	7	175,275	7.4	6.8
2009–11	4	12	183,174	8.7	

The most recent maternal death data for Australia (2006 to 2010) shows a national MMR of 6.8 per 100,000 births[8]. The Queensland MMR for this same period is 8.1 per 100,000 births. The difference between these two rates is not statistically significant (The Queensland versus Australia risk ratio for maternal mortality RR = 1.18, 95% confidence limits = 0.76, 1.85).

1.2.2 Classification of cause of maternal deaths 2009 to 2011

In the remainder of this chapter (1.2 Maternal deaths) the broader Council definition of maternal death is used, including incidental and late maternal deaths.

Table 2: Classification of maternal deaths in Queensland, 2009 to 2011
(includes incidental and late maternal deaths)

Maternal death timing	Total	Classification
Deaths during pregnancy	3	3 (indirect)
Deaths within 42 days of their pregnancy	15	4 (direct) 9 (indirect) 2 (incidental)
Deaths between 43 days and 365 days after their pregnancy	48	
Total	66	

1.2.3 Cause of maternal death

Table 3: Cause of maternal deaths in Queensland, during pregnancy or within 42 days after their pregnancy, 2009 to 2011

Classification	Cause of death	Number
Direct deaths	Thromboembolism	1
	Amniotic fluid embolism	1
	Haemolysis, elevated liver enzymes, low platelet count (HELLP) syndrome	1
	Sepsis secondary to acute cholecystitis	1
Indirect deaths	Suicide	4
	Intracerebral haemorrhage	2
	Intractable intracerebral hypertension	1
	Ruptured splenic artery aneurysm	1
	Ruptured thoracic aortic dissection	1
	Arrhythmic cardiovascular death	1
	Influenza B	1
	Homicide	1
Incidental deaths	Motor vehicle trauma	2

8 Maternal Deaths Australia 2006–10. Australian Institute of Health and Welfare (AIHW) National Perinatal Statistics Unit.

Table 4: Cause of maternal deaths in Queensland, between 43 and 365 days after their pregnancy, 2009 to 2011

Cause of death	Number
Suicide	15
Malignancy	9
Trauma - Motor vehicle trauma	8
Trauma – Hit by train	1
Homicide	3
Drug overdose / toxicity	3
Suspected accidental poisoning	1
Diabetic keto-acidosis	1
Drowning	1
Anaphylaxis complicating care for rheumatic valvular disease	1
Aspiration pneumonitis secondary to poorly controlled epilepsy	1
Hypoxic Ischemic Encephalopathy secondary to poorly controlled epilepsy	1
Asthma	1
Cerebral infarct secondary to infective endocarditis	1
Coronary thrombosis	1

1.2.4 Avoidability

Table 5: Avoidable factors in maternal deaths in Queensland during pregnancy or within 365 days after their pregnancy 2009 to 2011

Potentially avoidable—sub-optimal healthcare	3
Possibly avoidable	2
No structured follow up identified post-termination of pregnancy (post-top)	1
Inadequate maternal engagement with appropriate healthcare	2
No avoidable factors identified	55
Unable to determine	3

1.2.5 Data collection and quality

Data regarding the maternal deaths available to the Maternal Mortality Sub-Committee, of the Council, was extremely variable, as noted in its previous report. In all cases of death of a woman within one year of ending a pregnancy, the Council chair approached the health practitioner with primary responsibility of the care of that woman, seeking case notes. While many responded well to such requests, some responded with minimal information and some refused to co-operate at all. Excellent assistance was provided by the Office of the State Coroner and the Queensland Forensic and Scientific Services.

1.2.6 Reporting of maternal deaths

The Maternal Mortality Sub-Committee was unable to access all data potentially relevant to some of the maternal deaths despite requests for co-operative assistance from relevant health professionals. The Council looks forward to proposed changes to the *Public Health Act 2005* in 2013 will mandate reporting by health professionals[9].

1.2.7 Deaths of Aboriginal and Torres Strait Islander women

- 15 out of 66 women who died during pregnancy or within one year after their pregnancy were Aboriginal and/or Torres Strait Islander women (Relative risk (RR) 4.84, 95% confidence limits 2.72, 8.61).
- 2 of the 14 women who died during pregnancy or within 42 days after their pregnancy were Aboriginal and/or Torres Strait Islander women (Aboriginal and/or Torres Strait Islander MMR = 19.1, non-Indigenous MMR = 8.1—this difference is not statistically significant.
- 13 of the 50 women who died between 43 and 365 days after their pregnancy were Aboriginal and/or Torres Strait Islander women.

9 Recommendation five, QMPQC report 2011: Legislative change to the *Public Health Act 2005* with reference to a requirement for all deaths of women during pregnancy or within one year of the end of a pregnancy being reported via the PDCT is necessary to improve the quality of information available for review of the causation of deaths and the possible presence of avoidable factors.

1.2.8 Suicide

Suicide is the leading cause of death in women within 42 days after their pregnancy and between 43 days and 365 days after their pregnancy. There appears to be a significant worldwide risk of maternal suicide following termination of pregnancy and, in fact, a higher risk than that following term delivery.

The potential for depression and other mental health issues at this time needs to be better appreciated. Active follow-up of these women needs to happen. Practitioners referring women for termination of pregnancy or undertaking termination of pregnancy should ensure adequate follow up for such women, especially if the procedure is undertaken for mental health concerns.

Good practice points

- Women with a history of serious mental illness (e.g. schizophrenia, bipolar affective disorder, schizoaffective disorder) should routinely be offered mental health follow-up for at least the first 12 months post-partum.
- Practitioners referring women for termination of pregnancy or undertaking termination of pregnancy should ensure adequate follow-up, especially if the procedure is undertaken for mental health concerns.
- Mental health screening is performed almost universally in the public healthcare sector, but less so in the private healthcare sector. Use of the EPDS in the private sector may help to identify women who warrant further follow-up.

Beyond Blue's Clinical Practice Guidelines[10], recommend that:

- the EPDS should be used by health professionals as a component of the assessment of all women for symptoms of depression in the antenatal period
- the EPDS should be used by health professionals as a component of the assessment of all women in the postnatal period for symptoms of depression or co-occurring depression and anxiety
- a score of 13 or more can be used for detecting symptoms of major depression in the postnatal period.

1.2.9 Maternal cardiac disease

There has been a substantial fall in the number of maternal deaths due to cardiovascular disease when compared to recent previous reports. It remains to be seen whether this is a consistent trend, but given the recommendations of the last report[11], and the recognised importance of maternal heart disease as a cause of death, the findings of this report are very welcome.

1.2.10 Hypertension in pregnancy

Recognition of the significance of and management of hypertension complicating pregnancy was a feature of several deaths.

Good practice points

- A rise in blood pressure during antenatal care needs careful evaluation and review. This is particularly important in women with gestational diabetes, who are an increased risk of developing pre-eclampsia.
- Hypertension in labour needs to be actively managed, even if the aetiology of the hypertension is not clearly apparent.

10 Austin M-P, Highet N and the Guidelines Expert Advisory Committee. (2011). *Clinical practice guidelines for depression and related disorders—anxiety, bipolar disorder and puerperal psychosis—in the perinatal period. A guideline for primary care health professionals*. Melbourne: beyondblue: the national depression initiative.

11 Recommendation two, QMPQC report 2011: When pregnant women present with common symptoms, such as chest pain, palpitations, syncope and shortness of breath, there should be a low threshold for considering significant cardiovascular disease and referral for specialist opinion and investigation within a clinically appropriate time frame.

1.2.11 Other clinical issues raised by case review

A report of this type does not allow for detailed discussion of individual case management. However, the Maternal Mortality Sub-Committee noted several areas of concern.

Good practice points

- Vaginal bleeding in pregnancy warrants a careful history and examination, including visualising the cervix, rather than replacing these procedures with an ultrasound scan alone.
- Post-partum thromboprophylaxis in high risk women should be continued for six weeks. The finding of ovarian vein thrombosis is an indication for full anticoagulation in the post-partum period.
- Multiple presentations post-partum need to be thoroughly assessed and reviewed at a senior level even if the pregnancy and birth were uncomplicated.

1.2.12 Malignant melanoma

The Maternal Mortality Sub-Committee noted a total of eight women died within one year after their pregnancy between 2004 and 2011 (three between 2009 and 2011 covered by this report). Further study of the rate and risk of malignant melanoma deaths in relation to pregnancy is being considered.

1.2.13 Autopsies following maternal death

Table 6: Incidence of autopsy being performed in maternal deaths, Queensland 2009 to 2011

	Deaths	Autopsies
Total deaths between 2009 and 2011	66	51 (77.3%)
Deaths meeting ICD–10 definition of maternal death	16	13 (81.3%)
Deaths not due to advanced malignancy	57	51 (89.5%)

The Maternal Mortality Sub-Committee noted some instances where autopsy was not performed, but where diagnosis confirmation would have been wise and where information about potential inheritable conditions may have been found.

Good practice point

- Autopsy should be undertaken whenever possible, even if a coronial autopsy is not ordered, because inheritable conditions may be discovered.

1.3 Perinatal deaths

1.3.1 Perinatal mortality review modus operandi

All perinatal deaths in Queensland are subject to a systematic review. Perinatal mortality data has been obtained from the PDCT and the Registry of Births Deaths and Marriages, and case summaries from hospital and regional perinatal mortality committees in Queensland. A number of local perinatal mortality committees collaborated with the Council in the perinatal mortality review process, submitting confidential case summaries and classifications.

1.3.2 Clinical classification

The Council has adopted the PSANZ classification system, including the PSANZ-PDC and PSANZ-NDC[12], and all perinatal deaths in Queensland are classified accordingly. The system has been shown to perform well against other contemporary systems[13]. The purpose of classifying deaths according to the PSANZ system is to identify preventable factors associated with perinatal death, through the systematic application of clinically relevant categories to large populations.

12 Chan A, King J, Flenady V, Haslam R, Tudehope D. (2004). *Classification of perinatal deaths: development of the Australian and New Zealand Classifications*. J Paediatr. Child Health. Jul; 40(7):340–7.

13 Flenady V, Frøen JF, Pinar H, Torabi R, Saastad E, Guyon G, Russell L, Charles A, Harrison C, Chauke L, Pattinson R, Koshy R, Bahrin S, Gardener G, Day K, Petersson K, Gordon A, Gilshenan K. (2009). *An evaluation of classification systems for stillbirth. BMC Pregnancy Childbirth.*9:24.

1.3.3 Data collection and data quality

The data used to assist in classification of perinatal deaths by the Council's Perinatal Mortality Sub-Committee was sourced from:

- MR63D perinatal data collection forms, which are completed by all maternity hospitals in Queensland and forwarded to the PDCT. The MR63D form (a potentially rich data source containing over 50 data fields) is used to supply information to the National Perinatal Epidemiology and Statistics Unit (NPESU) and can also be used for benchmarking and other research projects.
- the Medical Certificate of Cause of Perinatal Death (Forms 9 and 9A).
- The National Perinatal Death Clinical Audit Tool (NPDCAT) summaries received and discharge summaries (where available) from hospitals
- pathology reports, including autopsy and placental pathology, cytogenetics.

During the course of review of perinatal deaths, the sub-committee's ability to classify cause of death accurately was often limited due to inadequate investigation and conflicting or lacking information in the materials provided. Low autopsy rates continue to pose a major limitation.

Placental pathology, which is an essential component of investigation protocol for stillbirths and neonatal deaths, was often not performed in cases of death where this examination may have provided the only lead to reasons for the death. Despite a presumed cause of death, placental pathology should be undertaken for all stillbirths and also for births of infants at increased risk of neonatal death. Placental histopathology remains a cornerstone investigation of perinatal death and other poor pregnancy outcomes.

The overall autopsy rate has remained relatively constant at 30%. This rate is disappointingly low. Autopsy remains the gold standard investigation and appropriate counselling should be provided to all parents following a stillbirth or neonatal death about the option of a high quality autopsy[14]. Parents should be made aware that important information about the cause of death may be missed if an autopsy is not performed. Unfortunately, insufficient number of pathologists with expertise in perinatal autopsy in Queensland is an impediment to quality and reporting. Delays in receiving autopsy reports of six months or more are not uncommon in Queensland.

Good practice point

- Following a perinatal death, all parents should be offered the option of an autopsy examination. The Queensland Maternal and Perinatal Quality Council strongly encourages requesting placental histopathology in every case of stillbirth, neonatal death and high risk newborn according to the *PSANZ Perinatal Mortality Guidelines*[15]. Placentas should be sent to pathology fresh and un-fixed.

The need for high quality perinatal autopsies, performed by pathologists with specialised paediatric and perinatal training, and experience is emphasised. This is of particular importance at a time of potential changes in the structure and delivery of health services. The necessity for training, retaining, and supporting pathologists with expertise in perinatal autopsy procedures is highlighted. Recognition of the need for continued investment of time and resources is required for maintenance of accessible, sustainable, tertiary level post-mortem services. Perinatal post-mortem services are largely restricted to the public healthcare sector. Access to perinatal post-mortem services and out-of-pocket costs are significant barriers to bereaved parents in the private healthcare sector seeking perinatal post-mortem services.

Death certificate data are notoriously inaccurate worldwide[16] and, in Australia, it is largely attributed to the policy of completing the death certificate at the time of a perinatal death prior to full investigation and review of the death. The Perinatal Mortality Sub-Committee found the information on death certificates was often inaccurate. Common errors included administrative aspects due to lack of knowledge of the requirements and assigned cause of death. The Perinatal Mortality Sub-Committee is undertaking a detailed review of death certificates to identify areas for clinician education to improve accuracy of this information. Following review and classification of perinatal deaths, clinicians are encouraged to submit a revised death certificate where information is found to be inaccurate for re-issuing to the parents. Parents should be contacted prior to receiving a revised death certificate to inform them of this outcome.

14 Flenady V, King J, Charles A, et al. (2009). *Clinical practice guideline for perinatal mortality*. Version 2.2 April. www.psanz.org.au Accessed August 2011

15 PSANZ Clinical Practice Guideline for Perinatal Mortality, Chapter 4 – Perinatal post-mortem examination. www.stillbirthalliance.org.au/guideline1.htm

16 Kirby RS. (1993). "The coding of underlying cause of death from fetal death certificates: issues and policy considerations." Am J Public Health. 83: 1088-91

Good practice point

- Determining the accuracy of completion of the death certificates, and submitting amendments when required, should be a routine part of local perinatal mortality committee review of all perinatal deaths. Parents should be informed of this outcome prior to receiving a revised death certificate.

1.3.4 The Improving Perinatal Review and Outcomes Via Education program

The Improving Perinatal Review and Outcomes Via Education (IMPROVE) program has been well received across Queensland. Throughout the conduct of these workshops it has become clear that the program addresses a real gap in knowledge and expertise for many frontline clinicians when caring for parents following a perinatal death. Continuation of this program is crucially important to ensure optimal bereavement care and to illustrate and explain the advantages of a thorough investigation of every perinatal death, particularly autopsy, and to better equip clinicians with appropriate information and skills for counselling parents regarding their decision on autopsy.

Through one-off funding made available by the Maternity Unit, Primary, Community and Extended Care Branch, Department of Health, the program, based on the *PSANZ Perinatal Mortality Guidelines*, was made available to clinicians providing maternity care in the larger Queensland maternity hospitals.

Between January 2010 and December 2012, 18 IMPROVE workshops were conducted in Queensland:
- Mater Mothers' Hospital (3)
- Gold Coast Hospital (2)
- Ipswich Hospital (2)
- Royal Brisbane and Women's Hospital (2)
- Cairns Base Hospital
- Logan Hospital
- Mackay Base Hospital
- Roma Hospital
- Rockhampton Base Hospital
- The Townsville Hospital
- Toowoomba Hospital.

A total of 441 participants attended these workshops:
- medical staff (23%)
- midwives (63%)
- nurses (4.2%)
- other (9.8%).

In Queensland, the program is currently offered on a fee for service basis which may result in suboptimal coverage. Continuation of this program is important to ensure high quality investigation and audit of all perinatal deaths and optimal care for women, their partners and families who experience this loss.

Further information on the program can be found at **www.stillbirthalliance.org.au**

Recommendation

- It's strongly recommended that all frontline clinicians (medical officers, nurses and bereavement support personnel) involved in Queensland hospital maternity and newborn services attend the program to enhance optimal clinical practice around the time of a perinatal death according to the *PSANZ Perinatal Mortality Guidelines*.

1.3.5 National Perinatal Death Clinical Audit Tool

The Council is participating in pilot testing a new national form for reporting perinatal deaths developed by the PSANZ. The overarching purpose of the form is to improve the quality of information on perinatal deaths to enhance hospital committee review and national reporting through relevant health department committees, such as the Council. The form has been developed in collaboration with National Perinatal Statistics Unit (NPESU) and the Perinatal Maternal Mortality Review Committee (PMMRC) in New Zealand. To enable comparisons, the form is almost identical to that used by the PMMRC.

Hospital committees are asked to submit the completed form, which can be accessed on the Council website (**www.health.qld.gov.au**) following review of each perinatal death. Through a National Health and Medical Research Council (NHMRC) funded study, the form will be piloted as an online tool in 27 hospitals in Queensland and across Australia (see Appendix 2).

1.3.6 Definitions of perinatal deaths

Comparison with Australia-wide data needs to be undertaken carefully, as the AIHW and the Australian Bureau of Statistics (ABS) uses different perinatal death definitions in the National Perinatal Data Collection (NPDC) to those found in the Queensland legislation.

The AIHW *Australia's Mothers and Babies series* states:

> *In Australia, all fetal and neonatal deaths of at least 400 grams birthweight or, if birthweight is unavailable, a gestational age of at least 20 weeks should be registered.*

The NPDC restricts the inclusion of live births to those of at least 400 grams birthweight.

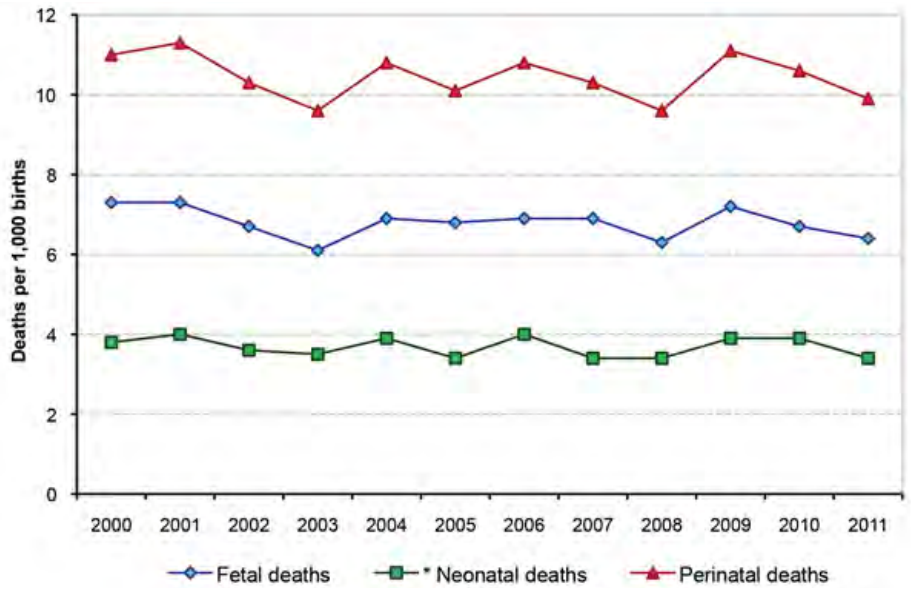
Queensland legislation applies different definitions (see Section 1.1) such that live born babies where the birthweight is less than 400 grams and/or the gestation is less than 20 weeks, and deaths of liveborn babies when the birthweight and gestational age are unknown, are included.

1.3.7 Perinatal mortality rates and trends

Table 7: Stillbirth, neonatal and perinatal death rates, Queensland 2009 to 2011
(see Section 1.1 for definitions of neonatal deaths and stillbirths)

Year	Total births	Live births	Stillbirths		Neonatal deaths		Perinatal deaths	
			n	Rate (per 1,000 births)	n	Rate (per 1,000 live births)	n	Rate (per 1,000 births)
2009	62,052	61,605	447	7.2	239	3.9	686	11.1
2010	62,032	61,619	413	6.7	242	3.9	655	10.6
2011	62,179	61,778	400	6.4	213	3.4	613	9.9
Total	**186,263**	**185,002**	**1260**	**6.8**	**694**	**3.8**	**1954**	**10.5**

Figure 1: Perinatal mortality rates, Queensland 2000 to 2011 (*neonatal mortality rates are per 1000 live births)
see Section 1.1 for definitions of neonatal deaths and stillbirths)



The most recent year of publication of Australia-wide data AIHW *Australia's Mothers and Babies 2010*[17] shows the Australian PNMR for 2010 was 9.3 deaths per 1000 births, with the stillbirth rate 7.4 deaths per 1000 births and the NMR 2.9 per 1000 live births.

17 Li Z, Zeki R, Hilder L & Sullivan EA. (2012). *Australia's mothers and babies 2010*. Perinatal statistics series no. 27. Cat. no. PER 57. Canberra: AIHW National Perinatal Epidemiology and Statistics Unit.

Applying the standard definition used by ABS and AIHW of all fetal and neonatal deaths of at least 400 grams birthweight or, if birthweight is unavailable, a gestational age of at least 20 weeks, and using the statistical comparator for Queensland of the remainder of Australia minus one state for which neonatal mortality data was missing:

- the PNMR for Queensland was 10.4 deaths per 1000 births versus 9.4 deaths per 1000 births (RR = 1.11, 95% confidence limits 1.01, 1.22)
- the stillbirth rate for Queensland was 6.7 deaths per 1000 births versus 6.9 deaths per 1000 births (RR = 0.96, 95% confidence limits 0.86, 1.07)
- the NMR for Queensland was 3.8 deaths per 1000 births versus 2.5 deaths per 1000 births (RR = 1.54, 95% confidence limits 1.31, 1.81).

The PNMR for public hospital and private hospital modes of healthcare delivery are seen in Table 8. The differential in rates has multiple explanations, including differences in acuity of care needed, gestation and birth weight limits, and maternal profiles (see Tables 26 to 28).

Table 8: Perinatal mortality rates by facility type, Queensland 2009 to 2011

	Perinatal deaths		Stillbirths		Neonatal deaths	
	n	PNMR	n	SBR	n	NMR
Public hospital care	1,591	12.2	1,025	7.9	566	4.4
Private hospital care	361	6.5	233	4.2	128	2.3
Care mode not stated	2	7.2	2	7.2	0	-
Total	**1,954**	**10.5**	**1,260**	**6.8**	**694**	**3.8**

PNMR = perinatal mortality rate per 1000 births / SBR = stillbirth rate per 1000 births / NMR = neonatal mortality rate per 1000 live births

1.3.8 PSANZ-PDC and PSANZ-NDC classification of perinatal deaths

Between 2000 and 2011, the main causes or important contributing conditions of perinatal deaths, according to the PSANZ-PDC and PSANZ-NDC classification, are shown in Tables 9 and 10, and Figures 2 to 4. Detailed sub-classifications are found in Tables 31 and 32.

The overall PNMR between 2009 and 2011 was 10.5 per 1000 births—1954 of the 186,262 babies born in this period (see Table 8). Almost two-thirds (1260) of these perinatal deaths were stillbirths (64.5%), and the remaining 694 babies (35.5%) died in the newborn period.

Tables 9 and 10 show the classification of perinatal deaths by PSANZ-PDC and PSANZ-NDC classifications (see Section 1.3.2). Tables 30 and 31 show the classifications in greater detail.

The principal PSANZ-PDC categories for perinatal deaths were congenital abnormality (26.7%), spontaneous preterm (24.6%) and unexplained antepartum death (19.7%) (see Figure 2 and Tables 9 and 10).

The most frequent categories of the PSANZ-PDC for stillbirths, accounting for almost 70% of these deaths, were unexplained antepartum death (30.6%), congenital abnormality (25.0%), and spontaneous preterm (13.9%). No obstetric antecedent was identified in 2.6% of stillbirths (see Figure 3).

Neonatal deaths were classified by both PSANZ-PDC and PSANZ -NDC. The main categories of the PSANZ-PDC were spontaneous preterm (43.9%) and congenital abnormality (29.7%) with no obstetric antecedent found in 7.1% (see Figure 4). The major categories according to the PSANZ-NDC were extreme prematurity (36.2%) and congenital abnormality (29.1%) (see Figure 5).

The major subcategories of the congenital abnormality category according to the PSANZ-PDC were, for stillbirths and neonatal deaths respectively:

- chromosomal 8% and 4%
- central nervous system 7% and 3.9%
- cardiovascular 3.2% and 7.2%.

In the majority (62.5%) of perinatal deaths assigned to the category of spontaneous preterm, chorioamnionitis was either clinically suspected or confirmed on histopathology of the placenta. In 17.5%of these perinatal deaths, either no placental histopathology was undertaken or it was unknown whether this was performed.

Of unexplained stillbirths (unexplained antepartum death), 42 (10.%) of the 385 were associated with significant placental insufficiency (see Table 30, Category 10.1) and according to other approaches to classification internationally (Froen[18], Korteweg[19]) would be classified as a placental pathology cause of death rather than unexplained. Further, in 56 (14.5%) of these apparently unexplained deaths, placental histopathology was either not performed or unknown whether it was performed.

As placental pathology is a crucially important investigation for stillbirths, it could be argued that causes in these cases should be classified as 'unclassifiable' rather than 'unexplained'.

Removing the 'unclassifiable' and the placental insufficiency groups reduces the unexplained stillbirth proportion to 22.7% (rather than 30.6%). Including an autopsy examination as part of the criteria for assignment of the unexplained antepartum stillbirth category may reduce this further.

Revisions to the PSANZ–PDC definition of the unexplained antepartum death category to clearly identify the 'true' proportion of 'unexplained' is currently being considered by the PSANZ Perinatal Mortality Group.

Further, the proportion of the 'unexplained' stillbirth group where a placental pathology report was not available at the time of classification indicates room for improvement in standards of investigation and audit of stillbirths.

Table 9: Perinatal deaths by type and PSANZ-PDC, Queensland 2009 to 2011

	Type of perinatal death								
	Stillbirth			Neonatal death			Perinatal death		
PSANZ-PDC classification	**n**	**%**	**Rate[1]**	**n**	**%**	**Rate[2]**	**n**	**%**	**Rate[1]**
1. Congenital abnormality	315	25.0	1.7	206	29.7	1.1	521	26.7	2.8
2. Perinatal infection	36	2.9	0.2	10	1.4	0.1	46	2.4	0.2
3. Hypertension	35	2.8	0.2	12	1.7	0.1	47	2.4	0.3
4. Antepartum haemorrhage	76	6.0	0.4	36	5.2	0.2	112	5.7	0.6
5. Maternal conditions	21	1.7	0.1	4	0.6	0.0	25	1.3	0.1
6. Specific perinatal conditions	105	8.3	0.6	25	3.6	0.1	130	6.7	0.7
7. Hypoxic peripartum deaths	19	1.5	0.1	34	4.9	0.2	53	2.7	0.3
8. Fetal growth restriction	60	4.8	0.3	13	1.9	0.1	73	3.7	0.4
9. Spontaneous preterm	175	13.9	0.9	305	43.9	1.6	480	24.6	2.6
10. Unexplained antepartum death	385	30.6	2.1			0.0	385	19.7	2.1
11. No obstetric antecedent	33	2.6	0.2	49	7.1	0.3	82	4.2	0.4
Total	**1,260**	**100**	**6.8**	**694**	**100**	**3.8**	**1954**	**100**	**10.5**

% = percentage | 1 = per 1000 births | 2 = per 1000 live births

Table 10: Neonatal deaths PSANZ-NDC, Queensland 2009 to 2011

	Neonatal deaths		
PSANZ–NDC classification	n	%	Rate[1]
1. Congenital abnormality	202	29.1	1.1
2. Extreme prematurity	251	36.2	1.4
3. Cardio-respiratory disorders	68	9.8	0.4
4. Infection	24	3.5	0.1
5. Neurological	76	11.0	0.4
6. Gastrointestinal	25	3.6	0.1
7. Other	48	6.9	0.3
Total	**694**	**100**	**3.8**

% = percentage | 1 = per 1000 live births

18 Froen, J. F., Pinar H., Flenady V.J. et al. (2009). *Causes of death and associated conditions (Codac): a utilitarian approach to the classification of perinatal deaths.* BMC Pregnancy Childbirth 9: 22.

19 Korteweg, F. J., Gordijn S. J., et al. (2006). *The Tulip classification of perinatal mortality: introduction and multidisciplinary inter-rater agreement.* BJOG 113(4): 393-401.

Figure 2: Perinatal death by PSANZ-PDC classification, Queensland 2009 to 2011

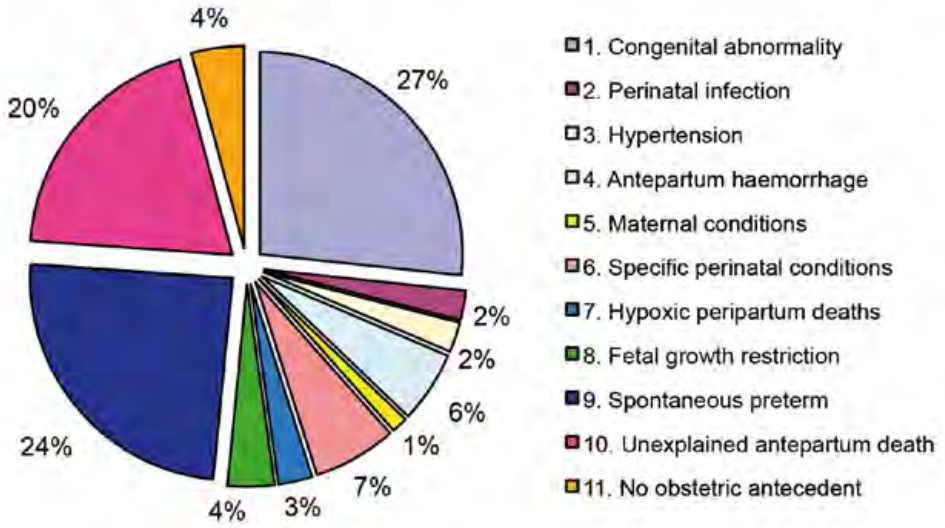


Figure 3: Stillbirths by PSANZ-PDC classification, Queensland 2009 to 2011

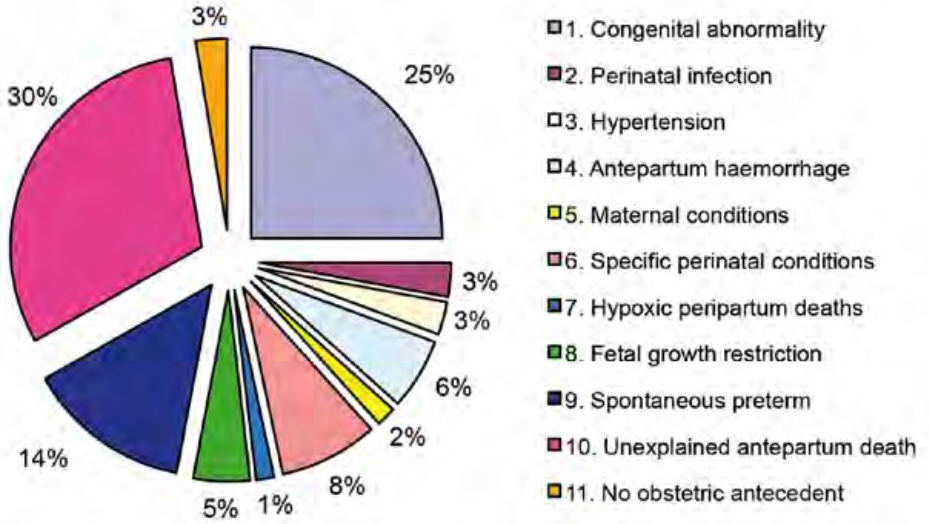


Figure 4: Neonatal deaths by PSANZ-PDC classification, Queensland 2009 to 2011

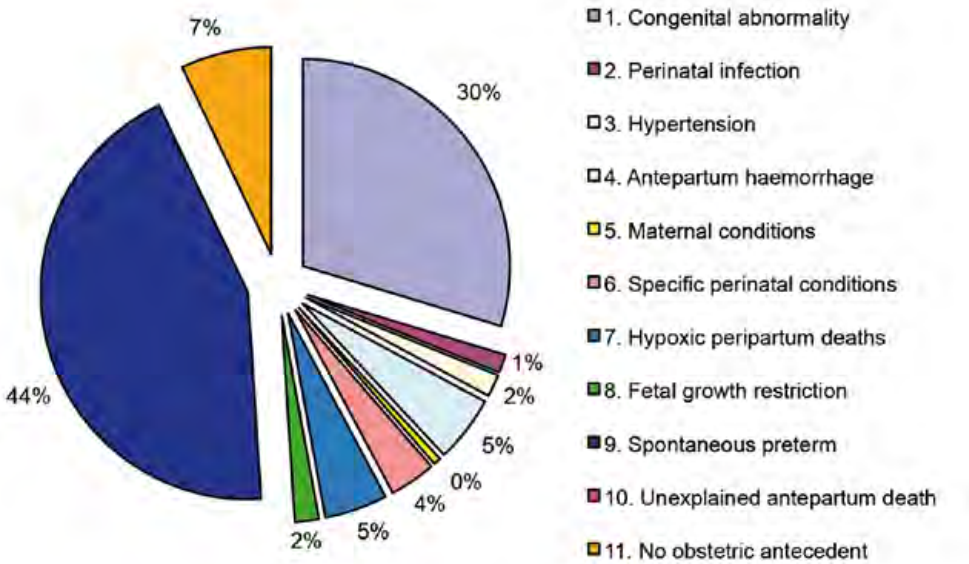
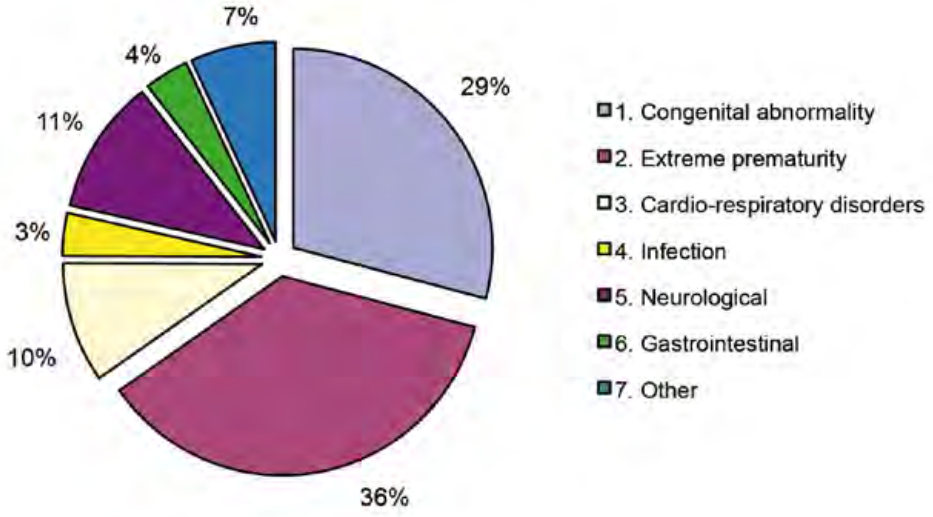


Figure 5: Neonatal deaths by PSANZ-NDC classification, Queensland 2009 to 2011



1.3.9 Multiple pregnancy

Multiple pregnancy was associated with a PNMR of 43.6 per 1000 births, compared with 9.4 per 1000 births for singleton pregnancies (see Tables 11 and 12). The 2009 to 2011 multiple pregnancy versus singleton pregnancy risk ratio for perinatal death: RR = 4.65, 95% confidence limits = 4.10, 5.28.

The principal conditions contributing to the excessive rate of perinatal death in multiple pregnancy are specific perinatal conditions (twin-twin transfusion), spontaneous preterm, congenital abnormality and unexplained antepartum death (PSANZ-PDC)—the principal known causes of the excessive rate of neonatal death in multiple pregnancy are extreme prematurity, congenital abnormality, cardio-respiratory and neurological (PSANZ-NDC).

Table 11: Perinatal deaths by PSANZ-PDC and plurality, Queensland 2009 to 2011

	Plurality						
	Singleton			Multiple			Relative risk (95% confidence limits) multiple versus singleton
PSANZ-PDC	n	%	Rate	n	%	Rate	
1. Congenital abnormality	494	29.3	2.7	27	10.1	4.4	1.61 (1.09, 2.37)†
2. Perinatal infection	41	2.4	0.2	5	1.9	0.8	Not calculated–small cell size
3. Hypertension	46	2.7	0.3	np	np	np	Not calculated–small cell size
4. Antepartum haemorrhage	104	6.2	0.6	8	3.0	1.3	2.26 (1.10, 4.64)†
5. Maternal conditions	24	1.4	0.1	np	np	np	Not calculated–small cell size
6. Specific perinatal conditions	77	4.6	0.4	53	19.9	8.6	20.23 (14.27, 28.68)†
7. Hypoxic peripartum deaths	51	3.0	0.3	np	np	np	Not calculated–small cell size
8. Fetal growth restriction	68	4.0	0.4	5	1.9	0.8	2.16 (0.87, 5.36)
9. Spontaneous preterm	359	21.3	2.0	121	45.3	19.7	9.91 (8.08, 12.16)†
10. Unexplained antepartum death	358	21.2	2.0	27	10.1	4.4	2.22 (1.50, 3.28)†
11. No obstetric antecedent	65	3.9	0.4	17	6.4	2.8	7.69 (4.51, 13.10)†
Total	**1,687**	**100**	**9.4**	**267**	**100**	**43.6**	**4.65 (4.10, 5.28)†**

Rate = per 1000 births | † = statistically significant | Total babies born 2009 to 2011 = 186,263, Total singletons born 2009 to 2011 = 180,135 | Total multiples born between 2009 to 2011 = 6,128, Small cell size numbers are not published = np

Table 12: Neonatal deaths by PSANZ-NDC and plurality, Queensland 2009 to 2011

	Plurality						
	Singleton			Multiple			Relative risk (95% confidence limits) multiple versus singleton
PSANZ-NDC	n	%	Rate	n	%	Rate	
1. Congenital abnormality	181	32.9	1.0	21	14.6	3.5	3.46 (2.20, 5.43)†
2. Extreme prematurity	175	31.8	1.0	76	52.8	12.7	12.95 (9.90, 16.82)†
3. Cardio-respiratory disorders	56	10.2	0.3	12	8.3	2.0	6.39 (3.43, 11.91)†
4. Infection	18	3.3	0.1	6	4.2	1.0	9.94 (3.95, 25.02)†
5. Neurological	64	11.6	0.4	12	8.3	2.0	5.59 (3.02, 10.35)†
6. Gastrointestinal	20	3.6	0.1	5	3.5	0.8	7.45 (2.80, 19.85)†
7. Other	36	6.5	0.2	12	8.3	2.0	9.94 (5.17, 19.09)†
Total	**550**	**100**	**3.1**	**144**	**100**	**24.0**	**7.80 (6.51, 9.36)†**

Rate = per 1000 births / † = statistically significant / Total live babies born 2009 to 2011 = 185,002
Total live singletons born 2009 to 2011 = 178,997 / Total live multiples born 2009 to 2011 = 6005

1.3.10 Indigenous perinatal mortality

Indigenous babies were almost twice as likely to die in the perinatal period (18.3 per 1000 births) as their non-Indigenous counter parts (10.0 per 1000 births). The 2009 to 2011 Indigenous versus non-Indigenous risk ratio for perinatal death was statistically significant: RR = 1.79, 95% confidence limits = 1.55, 2.08 (see Table 13). The rate of both stillbirth and neonatal deaths was significantly higher for Indigenous babies compared with non-Indigenous babies (9.9 per 1000 births versus 6.6 per 1000 births, and 8.3 per 1000 live births versus 3.5 per 1000 live births respectively).

Table 13: Perinatal deaths by Indigenous status, Queensland 2009 to 2011

	Total births	Live births	Stillbirths		Neonatal deaths		Perinatal deaths	
			n	Rate[1]	n	Rate[2]	n	Rate[1]
Indigenous	10,617	10,512	105	9.9	87	8.3	192	18.1
Non-Indigenous	175,601	174,445	1,156	6.6	607	3.5	1,763	10.0
Indigenous status not stated	45	45	0	-	0	-	0	-
Relative risk for Indigenous (95% confidence limits)[3]				1.50 (1.23, 1.83)		2.38 (1.90, 2.98)		1.79 (1.55, 2.08)

1 = per 1000 births / 2 = per 1000 live births / 3 excludes 45 live births where the Indigenous status was not stated

PSANZ-PDC classification of perinatal deaths indicates that spontaneous preterm birth, unexplained antepartum deaths and deaths associated with congenital abnormalities are all more likely to occur as causes of perinatal death in Indigenous babies (see Table 14). PSANZ-NDC classification of neonatal deaths indicates that Indigenous babies are more likely to die in the newborn period from extreme prematurity, congenital abnormality, cardio-respiratory disorders and 'other' (principally unknown/ undetermined) when compared with non-Indigenous babies.

Table 14: Perinatal deaths by PSANZ-PDC and Indigenous status, Queensland 2009 to 2011

	Indigenous status						Relative risk (95%confidence limits) Indigenous versus non-Indigenous
	Indigenous			Non-Indigenous			
PSANZ-PDC	n	%	Rate	n	%	Rate	
1. Congenital abnormality	40	20.8	3.8	481	27.3	2.7	1.39 (1.01, 1.92)†
2. Perinatal infection	6	3.1	0.6	40	2.3	0.2	2.51 (1.07, 5.93)†
3. Hypertension	np	np	np	43	2.4	0.2	Not calculated–small cell size
4. Antepartum haemorrhage	11	5.7	1.0	101	5.7	0.6	1.83 (0.98, 3.40)
5. Maternal conditions	np	np	np	21	1.2	0.1	Not calculated–small cell size
6. Specific perinatal conditions	np	np	np	127	7.2	0.7	Not calculated–small cell size
7. Hypoxic peripartum deaths	5	2.6	0.5	48	2.7	0.3	1.75 (0.70, 4.38)
8. Fetal growth restriction	7	3.6	0.7	66	3.7	0.4	1.78 (0.82. 3.87)
9. Spontaneous preterm	70	36.5	6.7	410	23.3	2.3	2.86 (2.22, 3.68)†
10. Unexplained antepartum death	34	17.7	3.2	351	19.9	2.0	1.62 (1.14, 2.31)†
11. No obstetric antecedent	8	4.2	0.8	74	4.2	0.4	1.81 (0.87, 3.76)
Total	**192**	**100**	**18.3**	**1,762**	**100**	**10.0**	**1.83 (1.58, 2.12)†**

Rate = per 1000 births / † = statistically significant / Total babies born 2009 to 2011 = 186,263
Total Indigenous babies born 2009 to 2011 = 10,617 / Total non-Indigenous babies born 2009 to 2011 = 175, 6014
Indigenous status not stated = 45 / Small cell size numbers are not published = np

Table 15: Neonatal deaths by PSANZ-NDC and Indigenous status, Queensland 2009 to 2011

	Indigenous status						Relative risk (95% confidence limits) Indigenous versus non-Indigenous
	Indigenous			Non-Indigenous			
PSANZ-NDC	n	%	Rate	n	%	Rate	
1. Congenital abnormality	22	25.3	2.1	180	29.7	1.0	2.07 (1.33, 3.21)†
2. Extreme prematurity	43	49.4	4.2	208	34.3	1.2	3.49 (2.52, 4.85)†
3. Cardio-respiratory disorders	8	9.2	0.8	60	9.9	0.3	2.25 (1.08, 4.71)†
4. Infection	np	np	np	21	3.5	0.1	Not calculated–small cell size
5. Neurological	np	np	np	72	11.9	0.4	Not calculated–small cell size
6. Gastrointestinal	np	np	np	24	4.0	0.1	Not calculated–small cell size
7. Other	6	6.9	0.6	42	6.9	0.2	2.41 (1.03, 5.68)†
Total	**87**	**100**	**8.5**	**607**	**100**	**3.5**	**2.42 (1.94, 3.03)†**

Rate = per 1000 births / † = statistically significant / Total babies liveborn 2009 to 2011 = 185,002.
Total Indigenous babies liveborn 2009 to 2011 = 10,512 / Total non-Indigenous babies liveborn 2009 to 2011 = 174,445
Indigenous status not stated = 45 / Small cell size numbers are not published = np

1.3.11 Gestation and birthweight specific perinatal mortality rates

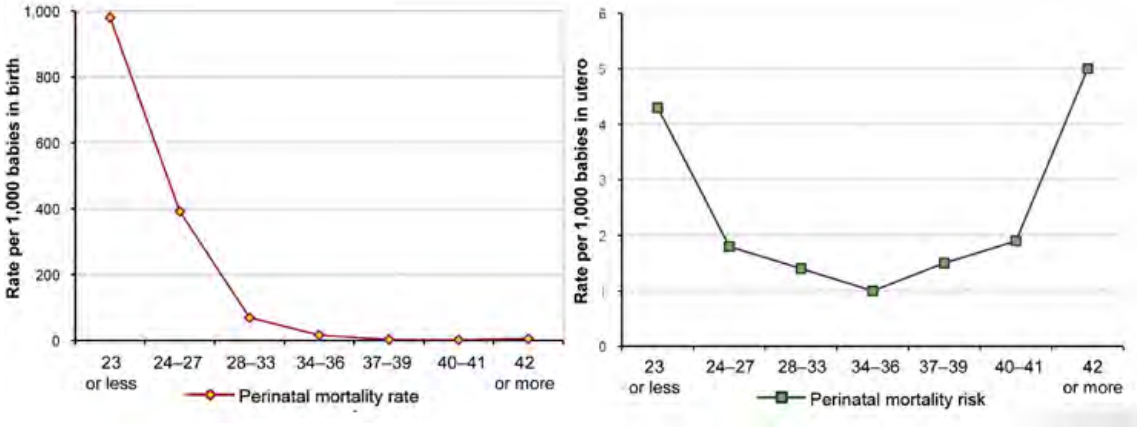
Table 16 and Figure 6 show the PNMR for gestational groups, and indicates the continuing risk of perinatal death (the 'perinatal mortality risk') to babies still in-utero at that gestation. The risk is lowest between 34 and 36 weeks gestation.

Table 16: Perinatal deaths by gestation (completed weeks), Queensland 2009 to 2011

Gestation (weeks)	Number of perinatal deaths at this gestation	Number of babies born at this gestation	% of perinatal deaths	% of babies born	Perinatal mortality rate	Perinatal mortality risk*
23 or less	797	813	40.8	0.4	980.3	4.3
24–27	326	833	16.7	0.4	391.4	1.8
28–33	260	3,753	13.3	2.0	69.3	1.4
34–36	175	10,878	9.0	5.8	16.1	1.0
37–39	252	96,593	12.9	51.8	2.6	1.5
40–41	138	72,248	7.1	38.8	1.9	1.9
42 or more	6	1,127	0.3	0.6	5.3	5.0
Not stated	1	18				
Total	**1955**	**186,263**	**100.0**	**100.0**	**10.5**	**10.5**

(risk = per 1000 fetuses remaining in-utero)*

Figure 6: Perinatal mortality rates and risk* by gestation, Queensland 2009 to 2011



** risk = per 1000 fetuses remaining in utero*

The PNMR for different birthweight groups is shown in Table 17. The perinatal mortality drops significantly over 1000 grams birthweight.

Table 17: Perinatal deaths by birthweight, Queensland 2009 to 2011

Birthweight (g)	Number of perinatal deaths in this birthweight group	Number of babies born in this birthweight group	% of perinatal deaths	% of babies born	PNMR
‹ 500	685	695	35.0	0.4	3.7
500–999	482	1,198	24.7	0.6	2.6
1000–1499	140	2,526	7.2	1.4	0.8
1500–1999	99	7,554	5.1	4.1	0.5
2000–2499	126	27,107	6.4	14.6	0.7
2500–2999	147	64,678	7.5	34.7	0.8
3000–3499	133	58,138	6.8	31.2	0.7
3500–3999	99	19,820	5.1	10.6	0.5
4000–4499	23	3,169	1.2	1.7	0.1
4500–4999	3	1,014	0.2	0.5	0.0
5000+	2	334	0.1	0.2	0.0
Not stated	16	30	0.8	0.0	0.1
Total	**1955**	**186,263**	**100**	**100**	**10.5**

Table 18 shows the PSANZ-PDC categories for perinatal deaths by gestational age groups. At term (37 weeks or more), 75.3% of perinatal deaths were not due to congenital abnormality and can therefore be considered as potentially preventable. Of these normally formed term infants, 46.3% were unexplained stillbirths. The next largest group accounting for 16.1% of these deaths was hypoxic peripartum death which includes deaths occurring either intrapartum or in the neonatal period without major pre-existing conditions. In 12.0% of these term perinatal deaths no obstetric antecedent was identified.

Babies born at gestational ages of less than 28 weeks account for more than half of all perinatal deaths (57.4%). The rate of death drops over gestation in all PSANZ-PDC categories except unexplained antepartum death and deaths without a known obstetric antecedent, and is constant across all gestations in the PSANZ-NDC category of congenital abnormality (see Table 19).

Table 18: Perinatal deaths by PSANZ-PDC and gestational age, Queensland 2009 to 2011

	Gestational age at birth (weeks)								
	‹28			28–36			37+		
PSANZ–PDC classification	**n**	**%**	**Rate**	**n**	**%**	**Rate**	**n**	**%**	**Rate**
1. Congenital abnormality	296	26.4	1.6	127	29.2	0.7	98	24.7	0.5
2. Perinatal infection	22	2.0	0.1	9	2.1	0.0	15	3.8	0.1
3. Hypertension	26	2.3	0.1	15	3.4	0.1	6	1.5	0.0
4. Antepartum haemorrhage	62	5.5	0.3	40	9.2	0.2	10	2.5	0.1
5. Maternal conditions	9	0.8	0.0	9	2.1	0.0	7	1.8	0.0
6. Specific perinatal conditions	60	5.3	0.3	44	10.1	0.2	26	6.6	0.1
7. Hypoxic peripartum deaths	1	0.1	0.0	4	0.9	0.0	48	12.1	0.3
8. Fetal growth restriction	33	2.9	0.2	27	6.2	0.1	13	3.3	0.1
9. Spontaneous preterm	453	40.4	2.4	26	6.0	0.1	0	-	-
10. Unexplained antepartum death	123	11.0	0.7	124	28.5	0.7	138	34.8	0.7
11. No obstetric antecedent	37	3.3	0.2	10	2.3	0.1	35	8.8	0.2
Total	**1122**	**100**	**6.0**	**435**	**100**	**2.3**	**396**	**100**	**2.1**

1 case excluded in the gestational age analysis due to missing gestation data
Rate = per 1000 births / % = percentage of that gestational group

Table 19: Neonatal deaths by PSANZ-NDC and gestational age, Queensland 2009 to 2011

	Gestational age at birth (weeks)								
	<28			28–36			37+		
PSANZ–NDC classification	n	%	Rate	n	%	Rate	n	%	Rate
1. Congenital abnormality	51	12.2	0.3	73	59.3	0.4	78	51.0	0.4
2. Extreme prematurity	247	59.1	1.3	4	3.3	0.0	0	-	-
3. Cardio-respiratory disorders	39	9.3	0.2	17	13.8	0.1	12	7.8	0.1
4. Infection	12	2.9	0.1	6	4.9	0.0	6	3.9	0.0
5. Neurological	30	7.2	0.2	11	8.9	0.1	35	22.9	0.2
6. Gastrointestinal	19	4.5	0.1	6	4.9	0.0	0	-	-
7. Other	20	4.8	0.1	6	4.9	0.0	22	14.4	0.1
Total	**418**	**100**	**2.3**	**123**	**100**	**0.7**	**153**	**100**	**0.8**

1 case excluded in the gestational age analysis due to missing gestation data
Rate = per 1000 live births | % = percentage of that gestational group

Two-thirds of perinatal deaths occur in the group of babies weighing less than 1500 grams (67.4%) (see Table 20). All PSANZ-PDC categories of cause of death show a decrease as birthweight increases. A similar pattern is seen for PSANZ-NDC categories of cause of neonatal death, with 67.6% of these babies weighing less than 1500g (see Table 21).

Similar to the analysis by gestational age, 76.4% (n=311) of perinatal deaths in non-low birthweight infants (› 2500 grams) occurred in infants without major congenital abnormalities. Similarly, 14.8% (n=46) of these death were assigned to the category of Hypoxic peripartum death.

Table 20: Perinatal deaths by PSANZ-PDC and birthweight, Queensland 2009 to 2011

	Birthweight											
	‹1500g			1500–2499g			2500–3999g			4000+g		
PSANZ–PDC classification	n	%	Rate	n	%	Rate	n	%	Rate	n	%	Rate
1. Congenital abnormality	335	25.6	1.8	88	39.1	0.5	93	24.5	0.5	3	10.7	0.0
2. Perinatal infection	26	2.0	0.1	3	1.3	0.0	16	4.2	0.1	1	3.6	0.0
3. Hypertension	38	2.9	0.2	4	1.8	0.0	5	1.3	0.0	0	-	-
4. Antepartum haemorrhage	74	5.7	0.4	18	8.0	0.1	19	5.0	0.1	0	-	-
5. Maternal conditions	12	0.9	0.1	2	0.9	0.0	6	1.6	0.0	4	14.3	0.0
6. Specific perinatal conditions	84	6.4	0.5	12	5.3	0.1	25	6.6	0.1	4	14.3	0.0
7. Hypoxic peripartum deaths	3	0.2	0.0	3	1.3	0.0	43	11.3	0.2	3	10.7	0.0
8. Fetal growth restriction	53	4.1	0.3	13	5.8	0.1	7	1.8	0.0	0	-	-
9. Spontaneous preterm	469	35.9	2.5	6	2.7	0.0	2	0.5	0.0	0	-	-
10. Unexplained antepartum death	171	13.1	0.9	68	30.2	0.4	131	34.6	0.7	13	46.4	0.1
11. No obstetric antecedent	42	3.2	0.2	8	3.6	0.0	32	8.4	0.2	0	-	-
Total	**1307**	**100**	**7.0**	**225**	**100**	**1.2**	**379**	**100**	**2.0**	**28**	**100**	**0.2**

15 cases excluded in the birthweight analysis due to missing birthweight data
Rate = per 1000 births | % = percentage of that birthweight group

Table 21: Neonatal deaths by PSANZ-NDC and birthweight, Queensland 2009 to 2011

	Birthweight										
	‹1500g			1500–2499g			2500–3999g			4000+g	
PSANZ–NDC classification	n	%	Rate	n	%	Rate	n	%	Rate	n	Rate
1. Congenital abnormality	72	15.4	0.4	56	80.0	0.3	73	48.3	0.4	1	0.01
2. Extreme prematurity	250	53.4	1.4	1	1.4	0.0	0	-	-		-
3. Cardio-respiratory disorders	49	10.5	0.3	2	2.9	0.0	15	9.9	0.1	1	0.01
4. Infection	13	2.8	0.1	4	5.7	0.0	7	4.6	0.0		-
5. Neurological	36	7.7	0.2	3	4.3	0.0	35	23.2	0.2	1	0.01
6. Gastrointestinal	25	5.3	0.1	0	-	-	0	-	-		-
7. Other	23	4.9	0.1	4	5.7	0.0	21	13.9	0.1		-
Total	**468**	**100**	**2.5**	**70**	**100**	**0.4**	**151**	**100**	**0.8**	**3**	**0.02**

2 cases excluded in the birthweight analysis due to missing birthweight data | Rate = per 1000 live births