Perinatal and Maternal Mortality Review Committee

He matenga ohorere, he wairua uiui, wairua mutungakore

Health Quality & Safety Commission New Zealand

Kupu Taurangi Hauora o Aotearoa

Methodology and definitions for Perinatal and Maternal Mortality Review Committee (PMMRC) reporting

JUNE 2018

"He mate nga ohorere, he wairua uiui, wairua mutunga-kore. The grief of a sudden, untimely death will never be forgotten."

Methodology and definitions for Perinatal and Maternal Mortality Review Committee (PMMRC) reporting

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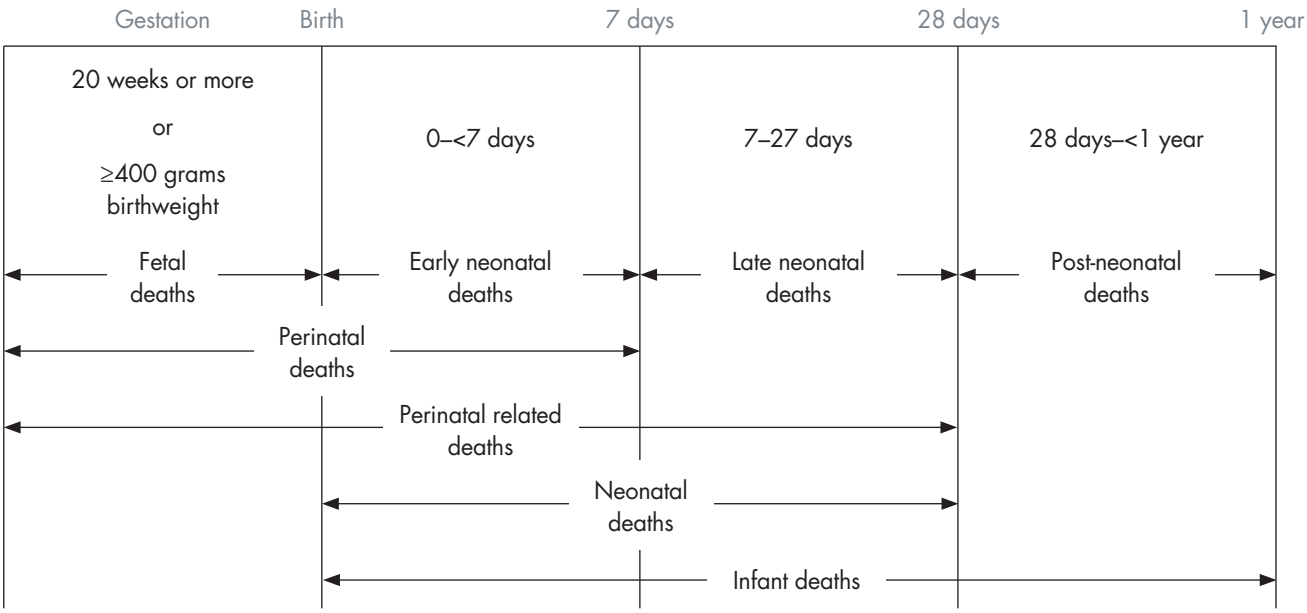


(Adapted from New Zealand Health Information Service 2007 and Ministry of Health 2010)

Fetal death

Fetal death is the death of a fetus at 20 weeks gestation or beyond (≥20 weeks) or weighing at least 400g if gestation is unknown. Fetal death includes stillbirth and termination of pregnancy. Note that the term 'stillbirth' does not include terminations in PMMRC reports. Where a termination of pregnancy died after birth, the pregnancy is included as a termination of pregnancy and therefore as a fetal death rather than as a neonatal death.

Stillbirth

Stillbirth is the birth of a fetus showing no signs of life at 20 weeks gestation or beyond (≥20 weeks) or weighing at least 400g if gestation is unknown.

Termination of pregnancy

Termination of pregnancy is the interruption of an ongoing pregnancy (whether the baby was stillborn or live born). The PMMRC reports only include terminations of pregnancy from 20 weeks gestation.

Fetal death rate

Fetal death rate is calculated as fetal deaths per 1000 babies born at 20 weeks gestation or beyond or weighing at least 400g if gestation is unknown.

Neonatal death

Neonatal death is the death of any baby showing signs of life at 20 weeks gestation or beyond (for the purposes of the PMMRC dataset), or weighing at least 400g if gestation is unknown, that occurs up until midnight of the 27th day of life. Early neonatal death is a death that occurs up until midnight of the sixth day of life. Late neonatal death is a death that occurs between the seventh day and midnight of the 27th day of life.

Neonatal death rate

Neonatal death rate is calculated as neonatal deaths per 1000 live born babies at 20 weeks gestation or beyond or weighing at least 400g if gestation is unknown.

Perinatal mortality rate

Perinatal mortality rate is calculated in New Zealand as fetal deaths and early neonatal deaths per 1000 total babies born alive or born dead at 20 weeks gestation or beyond, or weighing at least 400g if gestation is unknown.

In some places, PMMRC reports refer to a UK definition of perinatal mortality, which was developed for the surveillance of perinatal deaths in the UK and is based on the UK legal definition of stillbirths, which excludes deaths before 24 weeks gestation and terminations of pregnancy (CMACE 2011).

Perinatal related mortality rate

Perinatal related mortality rate refers to fetal deaths and early and late neonatal deaths per 1000 total babies born at 20 weeks gestation or beyond or weighing at least 400g if gestation is unknown.

International (WHO) perinatal mortality rates

The World Health Organization (WHO) recommends international perinatal mortality rates to facilitate international comparison (WHO 2006). These are rates of fetal death, neonatal death, perinatal mortality and perinatal related mortality of babies weighing ≥1000g, or ≥28 weeks if birthweight is unknown, per 1000 total births of babies ≥1000g, or ≥28 weeks if birthweight is unknown. Babies without birthweight or gestation are to be included if they have been registered.

Lethal and terminated fetal abnormalities

Lethal and terminated fetal abnormalities are all perinatal related deaths classified by the Perinatal Society of Australia and New Zealand perinatal death classification (PSANZ-PDC) system as PSANZ-PDC 1 (congenital abnormality) and neonatal deaths classified by the PSANZ neonatal death classification (PSANZ-NDC) system as PSANZ-NDC 1 (congenital abnormality).

Intrapartum stillbirth rate

Intrapartum stillbirth rate calculates deaths of babies of at least 24 weeks gestation without congenital abnormality who entered labour alive but then died during labour as a rate per 1000 births 24 weeks and beyond without lethal congenital abnormality.

Maternal death

Maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy (miscarriage, termination or birth), irrespective of the duration and site of the pregnancy, from any

cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes (WHO nd).

The cause of maternal death is sub-classified into the following categories based on *The WHO Application of ICD-10 to Deaths during Pregnancy, Childbirth and Puerperium: ICD MM* (WHO 2012).

- **Direct maternal deaths:** those resulting from obstetric complications of the pregnant state (pregnancy, labour or puerperium), from interventions, omissions, incorrect treatment or from a chain of events resulting from the above. In the 12th report (2018), the PMMRC adopted the WHO revision to include deaths by suicide with direct maternal deaths. This was then applied retrospectively to data from previous years.
- **Indirect maternal deaths:** those resulting from previous existing disease or disease that developed during pregnancy and was not due to direct obstetric causes but that was aggravated by the physiologic effects of pregnancy.
- **Unknown/Undetermined (or Unclassifiable) maternal deaths:** deaths during pregnancy, childbirth and the puerperium where the underlying cause is unknown or was not determined.
- **Coincidental maternal deaths:** deaths from unrelated causes that happen to occur in pregnancy or the puerperium.

Maternal mortality ratio

Maternal mortality ratio is the number of maternal related deaths per 100,000 maternities.

The term 'ratio' is used to describe 'incidence' of maternal mortality because cases included in the numerator may arise from pregnancies that end before 20 weeks. As the total number of pregnancies ending before 20 weeks is unknown, the denominator cannot include all women at risk and thus the estimate cannot truly be called a 'rate'.

Maternities

Maternities are defined in this report as all births at 20 weeks or beyond or weighing 400g or more if gestation was unknown. Pregnancies ending before 20 weeks are not included in this working definition because the absolute number of pregnancies ending before this time is unknown.

The variable definition of 'maternities' creates unnecessary confusion when making international comparisons. The WHO recommends 100,000 live births as the most available denominator in countries with limited vital statistics collection. In countries where fetal deaths are also collected, the WHO recommends the denominator be 100,000 live births plus fetal deaths of 20 weeks or greater gestation.

- The UK uses the number of pregnancies that result in a live birth at any gestation or a stillbirth at or after 24 completed weeks gestation (as only stillbirths at 24 or more weeks gestation are required to be notified by law) (Lewis 2007).
- Australia reports the number of women who gave birth to either a live or stillborn baby of 20 or more completed weeks gestation or weighing at least 400g at birth (as required to be reported to the National Perinatal Data Collection) (Sullivan et al 2008).

Other definitions

Contributory factors and potentially avoidable death

Contributory factors are defined as modifiable components of the health system and issues of quality of care that cover a broad spectrum of organisational and/or management factors, personnel factors, and barriers to access and/or engagement with care factors.

Examples of contributory factors are:

- organisational and/or management factors (eg, delays in procedures or accessing results; lack of policies, protocols or guidelines; lack of maintenance of equipment)
- personnel factors (eg, failure to maintain competence)
- barriers to access and/or engagement with care (eg, unregistered pregnancies, language barriers, distance from adequate facilities) that are considered to have contributed to the death.

Potentially avoidable death is when the absence of a contributory factor may have prevented the death. More details on the process of development of the tool to assess contributory factors and potentially avoidable death have been published (Farquhar et al 2011).

Processes for assigning contributory factors and potentially avoidable death:

- Perinatal related mortality: An assessment of contributory factors and potentially avoidable perinatal related death is completed by a multidisciplinary team led by the PMMRC local coordinators following local review and submitted along with the PSANZ-PDC. From 2011, local coordinators were asked to indicate the main contributory factor(s) in identifying the death as potentially avoidable.
- Maternal mortality: An assessment of contributory factors and potentially avoidable maternal death is completed by the multidisciplinary Maternal Mortality Review Working Group at national review.

Customised birthweight centiles

Customised birthweight centiles (from 0-100th) use an ultrasound-based fetal weight standard and adjust for maternal height, weight, parity, and ethnicity, and baby sex to calculate the birthweight as a proportion of optimal weight for gestation. Customised birthweight centiles are calculated using a bulk calculator available from the Gestation Network (www.gestation.net).

Customised birthweight centile calculation:

- **In the PMMRC numerator datasets** (perinatal mortality and neonatal encephalopathy), customised centile is calculated using data from the PMMRC (ie, gestation at death (stillbirths) or birth in weeks and days, birthweight, baby sex, maternal ethnicity, height, weight, and parity).
- **In the New Zealand National Maternity Collection (MAT) denominator dataset**, customised centile is calculated using data from the MAT dataset (gestation in weeks (rather than weeks and days), birthweight, baby sex, maternal height, weight, parity, and ethnicity); centiles are only calculated for babies whose mothers were under the care of midwifery, private obstetrician and general practitioner (GP) lead maternity carers (LMCs) (because of missing data among women cared for by district health board (DHB) primary maternity care) and from 2008 (as maternal height and weight data were missing for over 90 percent of mothers prior to 2008).

- **In the linked PMMRC MAT dataset**, customised centile is calculated using data from the PMMRC dataset (gestation at death (stillbirths) or birth in weeks (not weeks and days so consistent with the denominator), birthweight, baby sex, parity) and data from the MAT dataset (maternal height, weight, and ethnicity).
- If maternal height and weight are missing, these are interpolated using averages by maternal ethnicity.
- For fetal deaths, the gestation at the time of estimated death (not birth) is used to calculate the birthweight centile. If gestation at death is unknown or gestation at death is <20 weeks or is seven days or more prior to birth, then customised centile is not calculated.

Ethnicity

Mother and baby ethnicities for perinatal related deaths were collected from two sources: from information supplied to the Births, Deaths and Marriages (BDM) Registrar (with priority given to information in the birth registration over information in the death registration) and from rapid reporting forms completed by LMCs (eg, in cases where the death had not been registered by the time of analysis), with information from BDM taking priority over data from rapid reporting forms. In both instances, ethnicity should be identified by the mother/parents. The ethnicity in the deaths dataset (held by BDM) is not validated. Death registration forms are usually completed by either the parents or a funeral director.

Mother and baby ethnicities in the birth registration denominator dataset are those provided by the parent(s) to BDM at birth registration and are thus consistent with numerator data.

Mother and baby ethnicities in the MAT denominator dataset are "derived from ethnic codes reported to NMDS [National Minimum Dataset] birth and postnatal events, LMC Labour & Birth claims and NHI [National Health Index] at time of delivery. The 3 highest priority ethnic codes that reach a threshold proportion are stored in the Aggregated Pregnancy table" (National Health Board Business Unit 2011, p 134).

Prioritised ethnicity has been reported. This method is frequently used in health statistics in New Zealand. Multiple ethnicities can be identified for both mother and baby. The PMMRC follows the guidelines in *Health Information Standards Organisation (HISO) 10001:2017 Ethnicity Data Protocols* (Ministry of Health 2017) for prioritising ethnicity. These protocols prioritise ethnicity into the following hierarchy: Māori; Pacific peoples; Indian; Other Asian; Middle Eastern, Latin American, or African (MELAA); Other European; Other (including Not Stated); and New Zealand European. Indian has been identified as a separate ethnicity from Other Asian because New Zealand data suggest that pregnancies of Indian women are at higher risk than those of Other Asian women. In the PMMRC reports, most analyses use these ethnic groups, but sometimes ethnic groups are aggregated.

Where multiple ethnic groups are recorded for an individual, the process prioritises minority ethnic groups that might otherwise be swamped by New Zealand European. In doing so, it does not allow individuals to identify a group with which they most feel affinity. It is a simple system that results in relatively few groups for analysis and, when used across different datasets, ensures a standardised process is used.

Lead maternity carer (LMC)

LMC is defined as the practitioner or caregiver who provides a woman and her baby with continuity of care throughout pregnancy, labour and birth, and the postnatal period as described in the Section 88 Primary Maternity Services Notice 2007, Subpart DA.

Maternity care in New Zealand

In New Zealand, maternity care is funded by the Ministry of Health. Maternity care is provided by 20 DHBs nationally and by LMCs, who receive funding from the Ministry of Health. LMCs may be self-employed midwives, GPs, private obstetricians, or hospital-based midwives and obstetricians. Their services are free for eligible women, except in the case of private obstetricians, who have the right to charge co-payments for their services.

LMCs are required to sign access agreements with any maternity facility where they intend to provide care. Women have the right to choose whom they engage as their LMC. However, professional colleges and the Ministry of Health provide guidelines about appropriate care for mothers with risk factors. The *Guidelines for Consultation with Obstetric and Related Medical Services (Referral Guidelines)* provide information about referring pregnant women, transferring clinical responsibility and transferring care in emergencies (Ministry of Health 2012).

Neonatal encephalopathy (NE)

NE is a clinically defined syndrome of disturbed neurological function within the first week of life in an infant born from 35 weeks gestation (≥35/40), manifested by difficulty in initiating and maintaining respiration, depression of tone and reflexes, subnormal level of consciousness and often seizures (Nelson and Leviton 1991). The PMMRC dataset of NE cases includes Sarnat stages 2 or 3 equivalent to moderate and severe only.

The introduction of induced cooling has made the definition of NE more difficult as cooling is frequently initiated before many of the defining signs of NE have appeared, and has been used for increasingly milder cases. It is usual to include babies who warrant cooling in the dataset even though they may, due to the ameliorative effects of the cooling, never reach the level of morbidity consistent with moderate NE.

Although hypoxia-ischemia is the predominant pathology, reported cases of term infants with NE are included in this dataset whatever the cause. Therefore, the full cohort includes a small number of cases where NE is associated with hypoglycaemia, congenital abnormality of the central nervous system, or infection.

From 2016 the Neonatal Encephalopathy Working Group (NEWG) widened the inclusion criteria for the NE cohort and included cases from 35 weeks gestation at birth in line with international literature and practice of cooling from this gestation (American College of Obstetricians and Gynecologists 2014), although the cases from 35–37 weeks gestation are not included in all analyses for consistency with previous years' cohorts.

New Zealand Index of Deprivation 2006 and 2013 (NZDep2006/2013)

The NZDep2006/2013 is an area-based measure of socioeconomic deprivation based on variables from the Census of Population and Dwellings in 2006 and 2013 in New Zealand (Atkinson et al 2014; Salmond et al 2007).

The score is assigned according to maternal place of residence and is presented as a decile or quintile. Increasing deciles of deprivation, from least deprived at decile 1 to most deprived at decile 10, are associated with higher mortality and rates of many diseases (Atkinson et al 2014; Salmond et al 2007). Census area unit-level data have been used since the 11th PMMRC report (in previous reports meshblock unit level data were used to assign a deprivation score). Generally, data are presented as quintiles rather than deciles so that individual categories are large enough for analysis.

NZDep2013 deciles are assigned to births and deaths from 2013, while NZDep2006 is used for previous years. It is not possible to assign NZDep2013 to deaths prior to 2013 as in 2013 some areas split and the new areas for individuals in historical datasets are not available.

Perinatal Society of Australia and New Zealand (PSANZ) death classifications

Perinatal death classification (PSANZ-PDC) – the purpose of the PSANZ-PDC is to identify the single most important factor that led to the chain of events that resulted in the death.

Neonatal death classification (PSANZ-NDC) – the purpose of the PSANZ-NDC is in addition to the PSANZ-PDC to identify the single most important factor in the neonatal period that caused the death.

Place of birth

Place of birth is defined for the data collection as:

- home: a home environment does not have to be the mother's own home
- birthing unit: stand-alone birthing centre
- hospital level 1: a hospital with no neonatal or caesarean section facilities
- hospital level 2: a hospital that is unable to provide long-term ventilation for babies
- hospital level 3: a hospital with full neonatal intensive care including facilities for long-term ventilation
- other: for example, car, ambulance
- not registered: the woman is not registered at any facility.

Registration with a lead maternity carer (LMC)

Registration with an LMC is the process by which a woman selects her LMC. This generally occurs at the time of the first antenatal visit with the LMC. Upon registration the LMC assumes clinical responsibility for maternity care. Clinical responsibility for care may transfer from the LMC to another service or provider; for example, if a woman's condition warrants transfer of clinical responsibility to a specialist.

1.2 Numerator data

Case ascertainment and data collection

Perinatal mortality

The perinatal deaths presented in the PMMRC reports occurred between 1 January and 31 December of the year. (This is inconsistent with denominator data, which include all births that occurred between 1 January and 31 December of the year, as some deaths of births in one year will occur in the next year and vice versa). For fetal deaths, the date of birth is used in place of the date of death. For neonatal deaths, the actual date of death is used.

An expanded description of data collection methods is available in the first PMMRC report (PMMRC 2007).

Individual PMMRC local coordinators within each DHB identify perinatal deaths and oversee the collection of the required data. These data are submitted to the Mortality Review Data Group at the University of Otago. The coordinators are also responsible for initiating local clinical reviews of each

case, including assigning PSANZ-PDCs for cause of death, determining contributory factors and potentially avoidable deaths, and ensuring appropriate, timely follow-up with parents.

The dataset of perinatal deaths is a compilation of data submitted by LMCs, local coordinators, the Ministry of Health and BDM. A website commissioned by the PMMRC and run by the University of Otago enables web-based data entry.

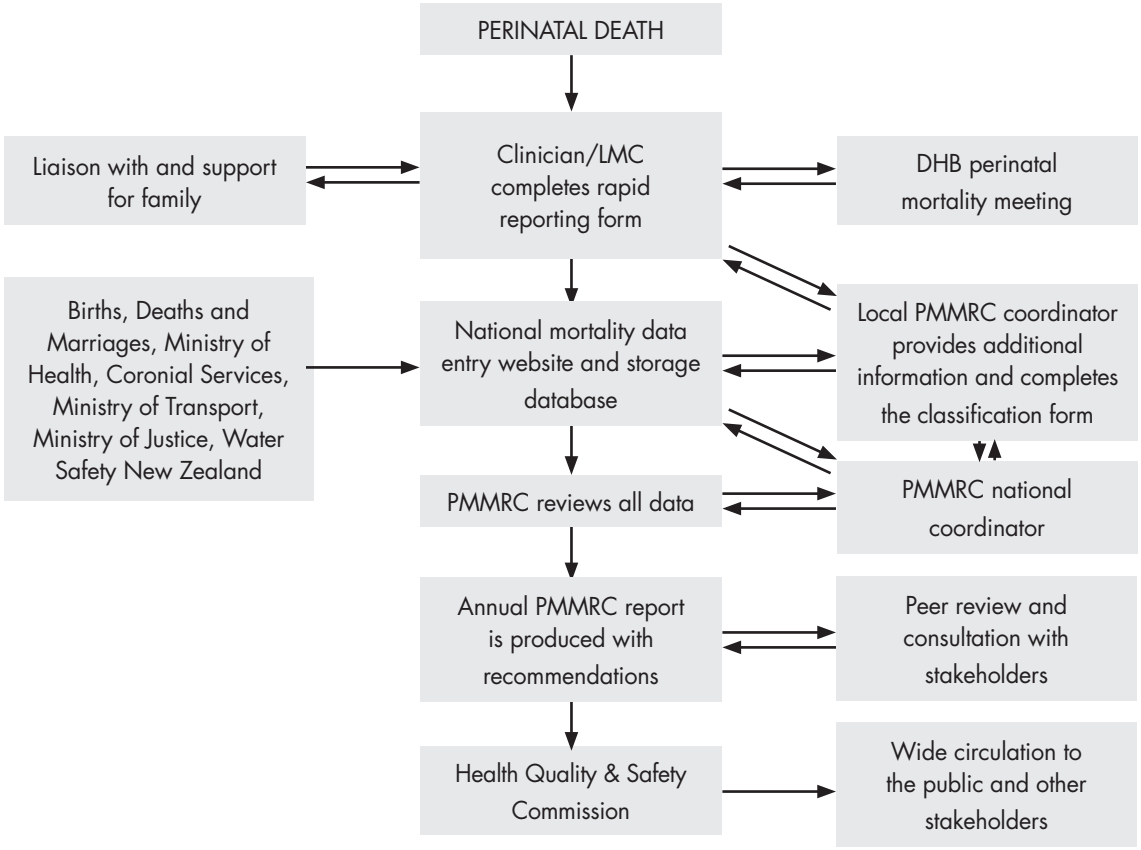
LMCs and/or local coordinators are required to complete rapid reporting forms within 48 hours of a perinatal death. One form contains information on the mother (eg, her past medical and obstetric history and details of the birth), and the other form contains information on the baby. The questions are reviewed and adjusted annually to ensure the data collection remains relevant and robust.

After local review, a multidisciplinary team led by the local coordinator completes the PMMRC classification form. The classification system that has been adopted is the PSANZ system of classification of cause of perinatal death (PSANZ 2009). This system includes both perinatal and neonatal classifications. The local coordinator also submits the post-mortem and histology reports with the classification form.

Figure 1.1 outlines the PMMRC process. A user guide describing the definitions and data elements used by the PMMRC is available online at: www.hqsc.govt.nz/assets/PMMRC/Publications/Perinatal_Mortality_RRF_Guidelines_2018.pdf.

In 2017 for the 11th PMMRC report, the numerator dataset of perinatal mortalities was merged with the MAT denominator dataset so that compatible data could be used for analyses where there was a potential issue of numerator–denominator bias. The development of this amended numerator dataset is described below under "Compiling the MAT denominator and numerator data".

Figure 1.1: Flow of information in the PMMRC's perinatal data collection process



Maternal mortality

Since 2006, the PMMRC has asked that all clinicians aware of a maternal death notify either their PMMRC DHB local coordinator or the PMMRC national coordinator.

Deaths are brought to the Maternal Mortality Review Working Group's (MMRWG's) attention in the main by PMMRC DHB local coordinators and other clinicians within DHBs. Other sources include pathologists, Coronial Services and media reports. Often multiple notifications are received.

The Coroners Act 2006 requires that maternal deaths are notified to Coronial Services. A specific tick box on the Medical Certificate of Cause of Death identifies women who were pregnant at time of death or within 42 days of death to assist in ascertainment of all maternal deaths.

The MMRWG has developed a data collection tool for maternal deaths. Following notification of a maternal death, the PMMRC national coordinator issues maternal death reporting forms to the appropriate local coordinator, who is then responsible for gathering the relevant clinical information from practitioners involved with the woman's care.

All completed reporting forms, along with relevant clinical information and reports from DHBs, Coronial Services and any other relevant investigative processes, are reviewed by designated members of the MMRWG, who present a summary of each case to the working group. The MMRWG then discusses each case in detail, including assessing the presence of contributory factors and potential avoidability.

Neonatal encephalopathy (NE)

Cases of NE were initially identified with the assistance of the New Zealand Paediatric Surveillance Unit and the collection of data facilitated by paediatricians, LMCs and the national coordination service of the PMMRC, as described in detail in the fifth PMMRC report (PMMRC 2011). Since 2012, cases are notified by key clinicians in neonatal and special care units and the PMMRC local coordinators.

In 2018 for the 12th PMMRC report, the numerator dataset of babies with NE was merged with the MAT denominator dataset so that compatible data could be used for analyses where there was a potential issue of numerator–denominator bias. The development of this amended numerator dataset is described below under "Compiling the MAT denominator and numerator data".

Data validation

Data are regularly validated, using a standard set of queries, to eliminate duplicate records, complete missing mother or baby information, clarify DHB of residence (where this is inconsistent with the given residential address) and rectify other inconsistencies. The PMMRC national coordinator reviews all perinatal death classifications and discusses complicated cases with a PMMRC member with expertise in PSANZ classifications.

At the end of each year, PMMRC DHB local coordinators and key clinicians in special care and neonatal units are contacted to ensure the NE data collection is complete.

Twice a year the Mortality Collection at the BDM registry is cross-referenced to ensure maternal mortality data collection is complete.

1.3 Denominator data

Prior to the 11th report (published 2017), PMMRC reporting of perinatal and maternal mortality and morbidity used the New Zealand birth registrations dataset (BDM) as the denominator dataset. In 2017 (11th report), the birth registration dataset was replaced by the New Zealand National Maternity Collection (MAT, administered by the Ministry of Health) for almost all analyses. In 2017 (11th report), perinatal deaths were merged with the MAT dataset to establish a compatible numerator for analyses, and in 2018 this process was extended to a merge of NE cases with the MAT dataset. This process will not be possible for maternal mortalities and morbidities as not all potential cases are included in the denominator dataset, which only includes births from 20 weeks of gestation.

New Zealand birth registration dataset

The New Zealand birth registration dataset is collated by BDM from birth notifications supplied by public and private hospitals, and by LMCs in the case of home births. Births are only added to the birth registration dataset when the birth is registered by the parents, which can occur up to some years following birth. The registration dataset is based on date of registration, so it includes births from previous years and fewer than all births from the current year. While this dataset is representative of the total number of births in a year, it does not truly represent the denominator.

An advantage of the birth registration dataset is the collection of ethnicity data from parents for themselves and their babies. A disadvantage of the birth registration dataset for reporting maternity analyses in New Zealand is that it includes limited maternity data. The dataset does not retain an individual's unique NHI number (for either the mother or the baby), and so the data it contains cannot easily be linked to hospital discharge data or LMC data for further analyses.

New Zealand National Maternity Collection (MAT)

The MAT combines data collected by LMCs, which are required to enable claims for payment, with hospital discharge data.

Compiling the MAT denominator and numerator data

1. **Denominator MAT data (all babies born ≥20 weeks):** The MAT is a dataset based on mothers. For reporting, the PMMRC requires a dataset based on babies. To create a MAT denominator dataset with the correct number of babies, the 'Delivery outcome' field for each MAT mother was used as an indicator of the number of babies who should be in the denominator dataset. For example, if the delivery outcome variable was 'Twin', then two babies were expected. 'Other multiple' was assumed as three babies. This method was modified (and overridden) in cases where a MAT mother was linked by NHI to a PMMRC dataset mother, and the PMMRC data were then used to determine the number of expected babies. An 'entry' or 'baby' was added for each expected baby. If there was no MAT baby linked where a baby was expected, then a baby was created with no MAT baby data (but with mother data from the delivery or mother dataset). If there were more babies in the MAT baby dataset than expected, only the expected number of babies was kept in the dataset (except if these were perinatal death babies who were always kept in the dataset). If there were no 'Delivery outcome' data for a mother, then one baby was expected and this baby was created, again without MAT baby data but including mother data.
2. **Numerator (perinatal related deaths):** The PMMRC asked the Ministry of Health to help merge the PMMRC perinatal related deaths (and babies with NE) with their MAT mother and baby records so that the consistency of data in the PMMRC data collection and in the MAT dataset could be examined.

The MAT consists of two datasets, one of mothers and another of babies. Stillborn babies are often not included in the MAT dataset and so need to be matched to a mother record.

a. Mothers of babies who died or had NE in the perinatal period (PMMRC dataset) were matched to mothers in the MAT dataset (delivery dataset) by matching the mother NHI and the date of birth, allowing a 28-day window either side of the recorded date of birth.

b. Perinatal mortality and NE babies (PMMRC dataset) were matched to MAT babies (birth dataset) by matching the baby NHI.

c. Perinatal mortality and NE babies (PMMRC dataset) were then matched to the mother MAT dataset (delivery dataset) using the matched PMMRC mother; that is, babies with no MAT birth (baby) dataset record were matched to their mother using the mother NHI.

This process of matching results in a PMMRC to MAT match of approximately 96 percent for the babies who died and almost 100 percent for NE babies.

3. **Denominator MAT data further cleaning:** Some field values in the MAT data were considered extreme and so they were 'cleaned' before being used to calculate other fields:

a. Gestation (at birth): overridden with perinatal or NE data, if available

b. Birthweight: if >7000g, set to missing; overridden with perinatal or NE data, if available

c. BMI at first LMC registration: if <10 or ≥100, set to missing

d. Mother height: if <130cm or >190cm, set to missing

e. Mother weight: if <35kg or >200kg, set to missing

f. Parity: overridden with perinatal or NE data, if available

g. Plurality (singleton, twin, multiple, unknown): overridden with perinatal or NE data, if available

h. Baby sex: overridden with perinatal or NE data, if available

i. Mother age at baby date of birth: calculated from mother date of birth and baby date of birth (or date of delivery, if birth data not available); if mother age was <12 years or >60 years, set to missing.

4. **Denominator MAT data further exclusions:** the MAT dataset was further checked to make sure all cases were compatible with the numerator, using the 'cleaned' gestation and birthweight.

a. The following cases were excluded:

i) Gestation <20 weeks and birthweight <400g

ii) Gestation <20 weeks and birthweight missing

iii) Gestation missing and birthweight <400g

iv) Gestation >43 weeks and birthweight <400g

b. The following cases were included:

i) Gestation <20 weeks and birthweight ≥400g, the case was included but gestation was set to missing

ii) Gestation missing and birthweight ≥400g

iii) Both gestation and birthweight were missing

iv) Gestation >43 weeks and birthweight ≥400g, the case is included but gestation was set to missing

v) Gestation >43 weeks and birthweight missing, the case is included but gestation was set to missing.

In the process, 63 cases were excluded and 702 cases had gestation set to missing. No cases with linked mortalities and morbidities (PMMRC dataset) were eliminated.

Specific limitations to the use of the MAT dataset

1. Deaths are included in the numerator dataset based on their year of death (as previously), but births are included in the MAT denominator dataset according to their year of birth. Some babies are born in one year and die in the next, creating a numerator–denominator mismatch. For the purposes of these analyses, deaths will remain in the year of their death (to be comparable to previous years).
2. More than 90 percent of the smoking and BMI data are missing from the MAT dataset in 2007. Therefore, analyses using these variables only include data from 2008.
3. Not all registration data are provided to the MAT (specifically, BMI and smoking are missing for many mothers provided primary maternity care by DHBs). For this reason, analyses involving these variables are limited to women under the care of community-based midwives, private obstetricians, and GPs. In 2008, this was 79.9 percent of births in New Zealand, and in 2016, 92.1 percent.
4. As the PMMRC deaths have been merged where possible with records in the MAT dataset, data are now available from both the PMMRC dataset and the MAT dataset for the mothers of babies who had perinatal related deaths or were diagnosed with NE, and their babies). It is therefore possible to examine the consistency of some of the collected data fields. Some variables have systematically different measurements in the PMMRC dataset compared to the MAT dataset; for example, BMI and smoking are systematically higher and more common in the PMMRC dataset than in the MAT dataset for the mothers of babies who died in the perinatal period. (In addition, smoking data are collected at time of death in the PMMRC dataset but at time of registration with an LMC and at two weeks postpartum in the MAT dataset.)
   a. MAT data have therefore been used for the numerator as well as the denominator for BMI and smoking to avoid numerator–denominator bias (and as a consequence, the analysis is limited to mothers and babies where there was a successful match).
   b. For variables (eg, gestation, birthweight, plurality, parity) where the MAT and PMMRC data are variably inconsistent but not systematically different, the PMMRC data are used for the numerator deaths data because we believe these have been checked for accuracy more thoroughly than the MAT dataset and because it means all babies can be included in the analyses.
5. The variable for LMC is inaccurate for any LMC prior to 2008. From 2008 this variable provides a reasonable estimate of LMC for the groups midwife (self-employed or community), private obstetrician, and GP. The LMC variable for DHB remains inaccurate, with some women under the care of DHB primary maternity services still noted as having 'No LMC'. This arises because some DHBs do not provide primary maternity data to the MAT dataset.
6. There is a systematic error in the data sent to the MAT dataset by DHBs when parity is 'zero' (nulliparity) such that these mothers are recorded in the MAT dataset as 'missing' parity. For this reason analyses of parity are limited to women under the care of midwifery, private obstetric and GP LMCs. As the variable for LMC is inaccurate prior to 2008, parity is only reported from 2008.
7. There are differences in the ethnicity defined for mothers and babies in the PMMRC datasets compared to the MAT dataset. Ethnicity for numerators (perinatal and maternal mortality and neonatal encephalopathy) has been defined in most instances using the ethnicity data in the PMMRC datasets (primarily obtained from BDM registration) because BDM data are most similar to Census data (ie the ethnicity in the BDM dataset is obtained directly from parents). Exceptions, such as in multivariable analyses, are indicated as footnotes to tables and figures. Denominator ethnicity is that defined in the MAT dataset.

a. Ethnicity in the MAT is 'derived from ethnic codes reported to NMDS birth and postnatal events, LMC Labour & Birth claims and NHI at time of delivery. The 3 highest priority ethnic codes that reach a threshold proportion are stored in the Aggregated Pregnancy table' (National Health Board Business Unit 2011). Unfortunately the definition is not further clarified.

b. Further analysis of the impact of differences in the collection and output of ethnicity data can be found in chapter 5 of the 11th PMMRC report (PMMRC 2017, p 138). Briefly, it appears that the MAT dataset overestimates Māori ethnicity in comparison to BDM data, at least for live births. When BDM data are used for deaths (numerator) and BDM data are used for births (denominator), a higher perinatal related mortality is observed for Māori than when MAT data are used for either denominator alone or for both numerator and denominator. The 11th PMMRC report changed to using the MAT dataset as the preferred denominator because the BDM denominator dataset includes very few variables for analyses in maternity; in addition, it does not retain NHIs and so data are not easy to merge. Using the MAT denominator for PMMRC analyses enabled linking of the PMMRC dataset of deaths with their birth data in the MAT dataset and therefore provided a dataset that could be used for more extensive analysis. In the 12th PMMRC report, NE data were also linked to the MAT dataset of births. On a number of occasions the PMMRC has recommended that the Ministry of Health retain the ethnicity data shared with it by BDM within the MAT dataset so that an ethnicity variable that more closely resembles Census data (at least in definition) could be available for more accurate analysis of ethnicity associations within maternity (PMMRC 2015, 2017). This should be available in the near future.

8. In the MAT dataset, only census area unit based deprivation score is available as a measure of residence based deprivation. Previously, mesh block based deprivation score was used in PMMRC analyses. Census area units are larger than mesh blocks. Census area unit based deprivation score will be used for both numerator and denominator so that rates can still be presented.

1.4 Data analysis

Percentages

Percentages have been displayed with one decimal place or without decimal places when the denominator is small. In some cases, due to rounding, the percentages do not add to exactly 100 percent.

Tables

In any table where there are denominator data, the table includes a column for the absolute number of births and the proportion of all births in the time period, distributed by the levels of the variable of interest. There are columns for the absolute number of deaths that were terminations of pregnancy, stillbirths, neonatal deaths and total perinatal deaths, the proportions within each of these by the variable of interest, and the rate of death as a proportion of all births in that category of the variable of interest.

Confidence intervals

Ninety-five percent confidence intervals (CIs) for perinatal mortality rates have been computed using the methods for vital statistics described by the Centers for Disease Control and Prevention (Heron 2011). The CI represents the degree of uncertainty around the point estimate of the rate for the particular period.

This uncertainty depends on the absolute number of deaths and the number of births from which the deaths arose. If the number of births is large, then the CI (ie, the level of uncertainty) is generally small; if the number of births is small, the CI is large. The CI represents the limits within which the 'true' rate is most likely to lie. This calculation is necessary when numbers are small because the point estimate of the rate calculated from the data given may by chance have taken a wide range of values. The CI describes this range.

It is possible to compare rates by looking at the CI. If the CI for one rate does not overlap the estimate of another rate, it is likely that the rates are different. This is equivalent to the rates being statistically significantly different at the $p<0.05$ level. If the CI does overlap the estimate, the rates may or may not be different.

Statistical testing

Where the text notes that there is a statistically significant difference or association, this indicates that a statistical test has been applied and that the p-value is less than (<) 0.05. Conversely, if a difference is said to be not statistically significant, then the p-value is equal to or greater than (≥) 0.05. If the words 'statistically significant' are not used to describe a difference or association, it can be assumed that a statistical test has not been applied.

Where tests for trend have been used, a score test for linear trend of the log odds has been performed in STATA13 using the 'tabodds' function or in EpiInfo using the chi-square test for trend or the chi-square test for trends in proportions using R. A p-value of <0.05 has been used to indicate statistical significance.

Where multivariable analyses are reported, these were undertaken by logistic regression in STATA13.

Missing data

Cases that have missing data have still been included in the data tables and are generally discussed in the text. Percentages in the tables generally include missing data, although the text sometimes describes findings among women with complete data only. However, where missing data exceed 30 percent of all possible data points, the data have generally not been presented.

At the lower extremes of gestation and birthweight, denominator numbers are small and almost all babies will not survive. If the denominator dataset does not include all births for whatever reason, then it will appear that more babies died than were born. For this reason, perinatal related mortality rates at the lower extremes have not been reported.

Multiple-year data

Figures (and tables) in the reports sometimes include combined data for the most recent five years (or for all years) that the PMMRC has collected data. This increases the numbers and so improves the confidence around the estimates given, while restricting to the most recent five years of data to minimise the impact of changes over time on rates.

Management of late notifications

Cases notified after the dataset is closed are included in overall mortality rates in the initial tables of each section but not in subsequent tables.

1.5 List of Abbreviations

ACC	Accident Compensation Corporation
aEEG	Amplitude-integrated electroencephalogram
AFE	Amniotic fluid embolism
AGA	Appropriate for gestational age
AGREE	Appraisal of Guidelines for Research and Evaluation
AOR	Adjusted odds ratio
APH	Antepartum haemorrhage
BBA	Born before arrival
BDM	Births, Deaths and Marriages
BMI	Body mass index (kg/m2)
CI	Confidence interval
CTG	Cardiotocograph
CYMRC	Child and Youth Mortality Review Committee
DHB	District health board
EEG	Electroencephalogram
FPA	Family Planning Association
GAP	Growth Assessment Protocol
GP	General practitioner
hCG	Human chorionic gonadotropin
HDC	Health and Disability Commissioner
HISO	Health Information Standards Organisation
ICD-10	ICD-MM tenth revision
ICD-MM	International Classification of Diseases – Maternal Mortality
IPPV	Intermittent positive pressure ventilation
LGA	Large for gestational age
LMC	Lead maternity carer
MAT	New Zealand National Maternity Collection
MBRRACE-UK	Mothers and Babies: Reducing risk through audits and confidential enquiries across the UK
MDAC	Maternal Deaths Assessment Committee

MELAA	Middle Eastern, Latin American, or African
MMR	Maternal mortality ratio
MMRWG	Maternal Mortality Review Working Group
MMWG	Maternal Morbidity Working Group
MRI	Magnetic resonance imaging
NDC	Neonatal death classification
NE	Neonatal encephalopathy
NEWG	Neonatal Encephalopathy Working Group
NHI	National Health Index
NICE	National Institute for Health and Care Excellence
NMDS	National Minimum Dataset
NMMG	National Maternity Monitoring Group
NZDep	New Zealand Index of Deprivation
OR	Odds ratio
PDC	Perinatal death classification
PMMRC	Perinatal and Maternal Mortality Review Committee
PSANZ	Perinatal Society of Australia and New Zealand
PSANZ-NDC	PSANZ neonatal death classification
PSANZ-PDC	PSANZ perinatal death classification
RANZCOG	Royal Australian and New Zealand College of Obstetricians and Gynaecologists
Sands	Stillbirth and Newborn Death Support
SB	Stillborn
SGA	Small for gestational age
SIDS	Sudden infant death syndrome
SIGN	Scottish Intercollegiate Guidelines Network
SUDI	Sudden unexpected death in infancy
TOP	Termination of pregnancy
UK	United Kingdom
USS	Ultrasound scan
VTE	Venous thromboembolism
WHO	World Health Organization

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