The primary purpose of this study is to recognize the perinatal mortality rate and the vital causes of perinatal mortality to ascertain the significant maternal elements for a safe birth. A retrospective study was carried out in three large tertiary hospitals in Jeddah, Saudi Arabia, in the period from January 1, 2010, through December 31, 2015. All perinatal deaths happening during that time were analyzed. During the six-year review period, a total of 280 infant deaths were recorded with a perinatal mortality rate (PMR) of 6.6 per 1000 births. The principal causes of death among the deceased were low birth weight (LBW) (87%), lethal congenital malformation (CM) (4%), sepsis (3%), and respiratory arrest (3%). The PMR was high in 2010 at 6.8, while it declined to 6.4 at the end of the period studied. The average PMR recorded in this study was 6.6 per 1000 births. This study showed that low birth weight is the main reason for prenatal mortality, although the PMR did decline by the end of the period. A decrease in the perinatal death rate is viable when all females start to attend preconception counselling and are present at antenatal health centres.
before or during labour after 28 weeks of gestation) as well as early neonatal demises (during the 1st week following delivery) over one thousand births. It is mostly recorded on an annual basis (Zupan, 2005). Furthermore, fetal death is classified into demise before labour, known as antenatal or antepartum death, and demise during labour referred to as intranatal or intrapartum death (Bondagji and Kasim, 2012). The factors accounting for stillbirths are similar to those for early neonatal deaths (Iggerase, 2014).

Although there was a substantial increase in the survival rate of children under the age of 5 years over the past 25 years worldwide (World Health Organization, 2019), millions of children continue to die, especially in the developing countries. Over 10 million die before the fifth year of birth, 40% of them die within the first four weeks of birth and 33% before delivery (Wang et al., 2015). The majority of deaths during the first four weeks (nearly 75%) happen within the first week (the early neonatal period) (Lehtonen et al., 2017; Pathirana et al., 2016). In contrast, more than half of them occur within the first 24 hours (Lehtonen et al., 2017; Lawn et al., 2010; Oza et al., 2014). Thus, the early neonatal period is the most critical period for an infant (Lawn et al., 2016).

Despite the broad impact of PM on the community, PMRs are unfortunately neither routinely nor well documented, and there is a lack of published epidemiological studies that discuss the factors associated with PM. Also, there are no active community-based intervention programs currently exist in Saudi Arabia, targeting PM (Blencowe et al., 2016). Therefore, there is an urgent need for investigation of PM and its causes to determine which of them are preventable and avoidable and to strive to decrease the rate of perinatal deaths in Saudi Arabia. This study aimed at three goals: (1) calculating the PMR in six years at three large hospitals representing significant delivery places in Jeddah (the second largest town in Saudi Arabia), (2) determining the predominant causes of perinatal mortality and (3) suggesting ways to reduce perinatal deaths.

MATERIALS AND METHODS

A retrospective study of stillbirths and early neonatal deaths is considered the only appropriate method for recording and studying the distribution and significance of diverse causes of mortality. Such a study was conducted from March to June 2016, recording total births and perinatal deaths occurring from January 2010 to the end of December 2015, using the data of all women who gave birth (single or twin births) at three large tertiary referral hospitals in Jeddah (in the Western District of Saudi Arabia): King Abdulaziz University Hospital, Al Jedaani Hospital Gulail branch and Al Jedaani Hospital AlSafo branch. The three hospitals receive both normal deliveries and those with complications. All information was gathered from the maternal and neonatal medical records. All deaths were examined and recorded by a physician, and the underlying cause of death was obtained from the diagnosis listed on each death certificate. Mothers aged<15 or > 50 years (n =1) were excluded. All data from the three hospitals were extracted, merged and entered into Microsoft Excel software (Microsoft Corp., Redmond, WA, USA) to be summarized. The PMR was estimated for each year separately to assess if there was a difference over the years. Probable causes of death were investigated and recorded. An ethical approval with the number (H-11-30042016) was received from Ibn Sina National College–Research Center (ISNC-RC) before starting the study. It is worth noting that this is the first research-based on collecting real patient’s data conducted by students in the Pharmacy Doctor program at Ibn Sina National College in Saudi Arabia. At the same time, all other previously published research articles (Bamofleh et al., 2017; Bin-Mallouh et al., 2018) were survey-based studies.

RESULTS AND DISCUSSION

From January 1, 2010, through December 31, 2015, 42,388 Saudi and non-Saudi delivery cases were recorded at the three hospitals involved in the study. Most of them used antenatal care services. A total of 280 perinatal deaths occurred during this period, showing an average PMR of 6.6 per 1000 live births over the six years. Table 1 and Figure 1 show the yearly total number of births and perinatal deaths. Of the 280 deaths, 157 (56%) were stillbirths, while 123 (44%) died within one week of delivery (39% in the first 24 hours and 61% between 2 and 7 days after delivery). The stillbirth rate ranged from 3.2 to 4.3 within the five years (2010-2015). It was 3.7 per 1000 live births, while the neonatal mortality rate within the first week of delivery was 2.9. Table 2 points out the age distribution of these neonates. The highest total cases of deaths occurred during the first day (20%), followed by the first hour (13%) and the second day (13%). Around 40% of stillbirths and 62% of early neonatal deaths were delivered by caesarian section. The principal causes of death were found to be low birth weight (LBW), lethal congenital malformation (CM), sepsis, and respiratory arrest (Table 3). Interestingly, 87% of fatal cases were reported due to LBW. Furthermore, eva-
Table 1: Yearly number of births and Perinatal Mortality Rate

| Year | Total births (N) | Stillbirth | Stillbirth rates | Early neonatal mortality | Rate of early neonatal mortality | Perinatal deaths | Perinatal Mortality Rate (PMR) |
|------|-----------------|-----------|-----------------|--------------------------|-------------------------------|-----------------|-------------------------------|
|      | 2010            | 6806      | 25              | 3.7                      | 3.1                           | 46              | 6.8                           |
|      | 2011            | 8236      | 33              | 4.0                      | 2.7                           | 55              | 6.7                           |
|      | 2012            | 6957      | 22              | 3.2                      | 3.6                           | 47              | 6.8                           |
|      | 2013            | 6866      | 26              | 3.8                      | 2.8                           | 45              | 6.6                           |
|      | 2014            | 7429      | 34              | 3.4                      | 2.8                           | 48              | 6.5                           |
|      | 2015            | 6094      | 26              | 4.3                      | 3.1                           | 39              | 6.4                           |

| Year | Total | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|------|-------|------|------|------|------|------|------|
|      | 2010  | 6806 | 8236 | 6957 | 6866 | 7429 | 6094 |
|      | 2011  |     |     |      |      |      |      |
|      | 2012  |     |     |      |      |      |      |
|      | 2013  |     |     |      |      |      |      |
|      | 2014  |     |     |      |      |      |      |
|      | 2015  |     |     |      |      |      |      |

**Notes:**
- N includes live births as well as stillbirths from pregnancies more than gestation of twenty eight weeks;
- Stillbirth rate = (number of stillbirths/All births) * 1000;
- Early neonatal rate of mortality = (early neonatal mortality/total live births) * 1000;
- Perinatal rate of mortality = (stillbirths + mortality in the first week of life)/ 1000births

Table 2: The time distribution of early neonatal death

| Hours   | <1 | 1-2 | 3-12 | 13-23 | 1st | 2nd | 3rd | 4th | 5th | 6th |
|---------|----|-----|------|-------|-----|-----|-----|-----|-----|-----|
| Days    | No. of dead neonates | 16  | 12   | 15   | 5    | 24  | 16  | 9   | 7   | 9   | 10  |
|         | Percentage (n = 123) | 13  | 10   | 12   | 4    | 20  | 13  | 7   | 6   | 7   | 8   |

Table 3: Distribution of causes of neonatal mortality (n = 280)

| Causes            | Number of neonatal death (%) |
|-------------------|------------------------------|
| Low Birth Weight  | 244 (87%)                    |
| Congenital malformation | 10 (4%)                 |
| Sepsis            | 9 (3%)                       |
| Respiratory arrest| 9 (3%)                       |
| Others            | 8 (3%)                       |

Table 4: Distribution of perinatal mortality causes by year

| Causes                        | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | Total |
|-------------------------------|------|------|------|------|------|------|-------|
| Low body weight               | 41   | 49   | 39   | 41   | 38   | 36   | 244   |
| Congenital malformation       | 2    | 0    | 3    | 1    | 3    | 1    | 10    |
| Sepsis                        | 0    | 2    | 3    | 1    | 2    | 1    | 9     |
| Respiratory arrest            | 2    | 2    | 0    | 2    | 3    | 0    | 9     |
| Others                        | 1    | 2    | 2    | 0    | 2    | 1    | 8     |
| Total                         | 46   | 55   | 47   | 45   | 48   | 39   | 280   |

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tion of annual statistical data revealed little variation from year to year and displayed that the rate of mortality was highest among the low birth weight babies (Table 4). The perinatal mortality rate was highest at 6.8 in 2010, while it declined to 6.4 in 2015.

Figure 1: Number of perinatal deaths per year from 2010-2015

Fetal or neonatal death is a heart-breaking experience for both the mother and family and also for the obstetrician. PMR is high in developing countries like Saudi Arabia. Considerable progress in decreasing the mortality rate in kids under five has been achieved between 1990 and 2011, but neonatal death still represents 40% of those deaths (Lozano et al., 2011).

A study conducted at the hospital in Tabuk, Saudi Arabia (Jelly et al., 1998), found that neonatal deaths represented 65.6% of infant deaths. WHO in 2006 showed that the PMR is 10/1000 total births in high-income countries compared to 50/1000 births in low-as well as middle-income countries (Guevvera, 2006). And this study found that PMR is 6.6 over six years in Saudi Arabia, which is a high-income country. A six-year study from January 2001 to December 2006 at the hospital in the Southern District of Saudi Arabia found that the stillbirth rate was 53.7 per 1000 births, and PMR was 9.1 per 1000 births (Al-Nemri and Al-Fifi, 2011). Our study, on the other hand, showed that the stillbirth rate was 3.7/1000 births and the PMR was 6.6/1000 births. This decrease in rates may be an indication of socio-economic improvement and enhanced healthcare services in the Saudi community (Lawn et al., 2016). Also, the stillbirth rate observed in this study agrees with what was recently published stating that in high-income countries, like Saudi Arabia, stillbirth rates vary from 1.3-8.8/1000 total births (Manjavidze et al., 2019). The early neonatal mortality rate was 2.9 per 1000 births, a little higher than what was illustrated in a Qatari study in 2013 that found the early neonatal mortality rate was 2.05 per 1000 births (Eltinay et al., 2013).

The time distribution of early neonatal death in this study illustrated that 39% of the early neonatal deaths happened throughout the 1st day of life, with this percentage differing from what was recently reported globally, where it was reported that most neonates (50–65%) die in the first day of life and the rate of mortality decreases with time since birth (Lehtonen et al., 2017; Patel et al., 2000). These lower ratios may be due to the appropriate healthcare services provided before delivery and within the first days of neonatal life in high-income countries which unlike to low-income countries.

Studies have found numerous and various causes of perinatal mortality depending on maternal health status and the availability of antenatal care. Studying such causes and investigating the factors that may be related to perinatal death is important to help in developing focused and evidence-based healthcare intervention programs to increase perinatal survival rates. The current study identified four major causes of perinatal mortality: LBW, congenital malformation, sepsis and respiratory arrest. Four other studies performed in Saudi Arabia reported similar results (Al-Nemri and Al-Fifi, 2011; Majeed-Saidan et al., 2008). LBW was the leading cause of death in this study. This was in line with two studies that were carried out in Saudi Arabia at King Abdulaziz University Hospital, Jeddah (Milaat and Florey, 1992), and King Fahad Hospital, the large one in Riyadh (Al-Mejhim and Al-Najashi, 1998). They reported that the leading causes related to perinatal mortality were LBW and complications during labour. Another study (Majeed-Saidan et al., 2008) performed at Riyadh Military Hospital in Saudi Arabia reported the primary reasons were prematurity and its complications, and congenital malformations. Besides, a study (Al-Nemri and Al-Fifi, 2011) performed at the Armed Forces Hospital, Khamis Mushayt, kingdom of Saudi Arabia reported that prematurity and its related complications, multiple congenital anomalies, and perinatal asphyxia were the primary reasons for death.

In another Arabian Gulf country, Oman, a study reported that prematurity and its complications were the leading causes of death (Abdellatif et al., 2013). In line with previous studies, a recent study performed in 2019 in a high-income European country, Georgia, found that preterm delivery (58%) and congenital malformations (23%) were the primary reasons for early neonatal death (Manjavidze et al., 2019). Several studies identified a robust association between low birth weight and increased mortality (Basso et al., 2006; Titaley et al., 2008), and
our study has reconﬁrmed this ﬁnding. Many of the causes of death in this study are preventable with available low-cost interventions since the date of birth is estimated in advance, and most complications occur late in pregnancy and during birth or in the ﬁrst days of life. Treating maternal complications, providing adequate perinatal care and avoiding harmful care practices, such as using infected materials in the umbilical cord stump, can help improve the perinatal survival rate. Various studies have discussed the factors that are related to the increased risk of perinatal death and have found that low socio-economic status, lack of knowledge of family planning, lack of maternal literacy, primigravida, maternal obesity, poor maternal health and nutrition, and substandard care during pregnancy and childbirth have a signiﬁcant impact on increasing mortality (Khan et al., 2017; Sujata and Agarwal, 2008). Establishing and expanding interventions that can help in decreasing millions of these deaths are recommended, such as providing maternal and neonatal care services, education and communication activities to raise the awareness of the community, working with women’s groups to promote home-care practices, increasing mother’s access care and the use of multivitamins (Bhutta et al., 2014; Zupan, 2005). It is also recommended to start awareness programs for healthcare providers about the value of recording and documenting the causes of stillbirth and neonatal deaths.

Some strategies that may help to improve perinatal outcome and to reduce perinatal mortality rates include: performing proper regular antenatal checkup, educating mothers about the danger signs and the proper time to seek health care services and holding workshops for healthcare workers about neonatal resuscitation and evaluating high-risk cases. Also building a proper and strong governmental referral system and continuing in delivering a free maternal and perinatal care programs will help in reducing the preventable perinatal deaths (Bajracharya et al., 2019).

Limitations

Information in the patients’ ﬁles was frequently not fully complete. Besides that, it was not possible to ensure if the registration methods had changed at all over the six years. Moreover, there was no data to distinguish mothers who were living in Jeddah from those residing elsewhere. Furthermore, the mortality rate may be underestimated in some cases as the registration of birth may be recorded in one of the three hospitals involved in this study, while the registration of a death may have been in a different hospital. Finally, there were some data missing of important variables like gravidity or parity and previous stillbirths or neonatal death.

CONCLUSION

The PMR in the current study is a little bit lower than the PMR in the Southern Region of Saudi Arabia (9.1 per 1000 births). Besides, this rate is considered low compared to the PMR found in some high-income countries. However, these results need further conﬁrmation because some neonatal deaths have not been registered, and methods of registration changed through the time. The leading cause of death was low birth weight. It is recommended to start awareness programs to educate pregnant women about factors affecting their health and the importance of follow-up with a physician both during pregnancy and after delivery, especially in the ﬁrst weeks of birth. Moreover, medical programs should be developed that target improving the quality of healthcare services provided for the sake of both women and neonates. Overall, there is still a necessity for more investigation of the perinatal mortality rates and causes in various regions of Saudi Arabia.

Abbreviations list

CM-Congenital Malformation, LBW-Low Birth Weight, PM-Perinatal mortality, PMR-Perinatal Mortality Rate.

ACKNOWLEDGEMENT

The authors would like to thank all hospitals’ staff who helped in collecting data for this trial.

Funding Support

The authors declare that they have no funding support for this study.

Conﬂicts of interest

The authors are university staff and students, and have not been involved in drug companies or received any ﬁnancial support from them, so the authors declare that they have no conﬂict of interest.

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