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Comprehensive Research on The Correlation of Anemia Gravidarum and Adverse Birth Outcomes

Stephanea Fransisca Anastasia Padang[1], Sulistiawati[2]*, Muhammad Ilham Aldika Akbar[3], Manggala Pasca Wardhana[3]

[1]Medical Study Program, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

[2]Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

[3]Department of Obstetric and Gynaecology, Airlangga University Hospital, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

*Corresponding author details: Sulistiawati; sulistwt@hotmail.com

ABSTRACT

In low- and middle-income countries, 42.7% of pregnant women had experienced anemia gravidarum. While in Indonesia according to Riset Kesehatan Dasar (Riskesdas) 2018, 48.9% of pregnant women in Indonesia have anemia (Kemenkes RI, 2020). This means that 5 out of 10 of these women have anemia and are at risk to experience adverse birth outcomes, namely low birth weight, preterm birth, small gestational age, stillbirth, perinatal mortality, and neonatal mortality. Due to the many earlier research around this area, this review aims to undertake a thorough investigation into anemia gravidarum and whether, based on previous research, there is a true association with these several adverse birth outcomes. This type of research is a comprehensive research by using literature review, focusing on the correlation between anemia gravidarum as a risk factor and the incident of adverse birth outcomes from earlier studies. This research found that there is a significant correlation between anemia gravidarum and the risk of adverse birth outcomes, where the lower the mothers' hemoglobin levels, the higher the chance of giving birth to adverse outcome babies (such as low birth weight, preterm birth, small gestational age, stillbirth, perinatal mortality, and neonatal mortality). This means that the current research a prove that up until today, current studies are still align with findings from previous research.

Keywords: anemia gravidarum; adverse birth outcome; low birth weight; preterm birth; small gestational age; stillbirth; perinatal mortality; neonatal mortality.

INTRODUCTION

Anemia gravidarum affected 42.7% of pregnant women in nations with lower and middle incomes. In Indonesia, anemia affects 48.9% of pregnant women, according to Riset Kesehatan Dasar (Riskesdas) 2018. According to the World Health Organization (WHO), those who have hemoglobin (Hb) levels below 11 g/dL are considered to have anemia gravidarum. According to some relevant study findings, anemia gravidarum causes 19% of preterm births and 12% of low birth-weight neonates in low- and middle-income countries. In developing nations, anemia was more likely to be the cause of adverse birth outcomes [1].

As it is stated in one study conducted in Central China, there are several adverse birth outcomes that are deprived of anemia gravidarum, namely low birth weight (neonates with birth weight <2500 grams), preterm birth (neonates born <37 weeks or <259 days completed), and small gestational age (neonates born with birth weight and gestational age that is mismatched) [4]. Another study also added stillbirth (neonates died in the span of 20-28 weeks of gestation), perinatal mortality (deaths among live-born neonates up to 7 days of life), and neonatal mortality (death of a neonate within the first 28 days after birth) [13].

The underlying causes of anemia gravidarum must be identified to further prevent the condition and improve the health of mothers and their offspring. To sum up, this study attempts to undertake a thorough investigation into anemia gravidarum and whether, based on previous research, there is a true association with these adverse outcomes.

DISCUSSION

(1) Anemia Gravidarum

A decrease in hemoglobin or total red blood cell count is the hallmark of anemia during pregnancy, also known as anemia gravidarum. The World Health Organization (WHO), using different criteria for each trimester, uses hemoglobin levels to diagnose anemia gravidarum. Hemoglobin <11 g/dL in the first trimester, hemoglobin <10.5 g/dL in the second trimester, and hemoglobin <10.5 – 11 g/dL in the third trimester are the criteria used to identify anemia gravidarum. The natural increase in blood volume that happens during pregnancy is one of the many causes of dilutional anemia.

Moreover, iron deficiency is a major clinical cause of anemia during pregnancy. Pregnancy-related iron deficiency anemia is caused by both reduced iron absorption and insufficient dietary iron intake[10].

Physiological anemia is one of the several mechanisms that can cause anemia gravidarum. Because the growing fetus and placenta need more iron, women's reproductive physiology is marked by a higher hemoglobin demand during conception and as the gestation continues. Due to the increased demand for fresh hemoglobin, the inability of women to produce it endogenously due to inadequate iron supplementation in their diet, and the depletion of reserve iron from previous recurrent menstrual loss, maternal anemia during pregnancy may occur in a considerable number of women from developing countries [15]. Iron requirements during pregnancy are significantly higher than in the non-pregnant state, even though iron losses during menstruation offer a little reprieve. This is due to an exponential increase in the amount of iron needed to maintain the growth of the fetal-placental unit, increase the volume of plasma, produce more red blood cells, and compensate for iron loss after birth. The physiological iron requirement for pregnant women is approximately 1000–1200 mg for an average weight of 55 kg. This quantity includes approximately 350 mg associated with placental and fetal development, 500 mg associated with an increase in red cell mass, and 250 mg associated with blood loss following delivery. Up to 90% of pregnant women have iron reserves of less than 500 mg, which is insufficient to fulfill their growing iron needs, and 40% of women have little to no iron stores at the beginning of their pregnancy. Throughout pregnancy, iron requirements fluctuate, but they generally tend to rise in the third trimester, with lower levels in the first trimester [11].

It is important to recognise that these pregnancy-related physiological changes may make haematologic illness diagnosis more difficult. Pregnancy increases the need for iron because, during a singleton gestation, blood volume increases by nearly 50% (1,000 mL), and total red blood cell mass increases by about 25% (300 mL). Higher plasma expansion typically resulted in lower Hb and Hct levels. The total amount of iron in the body depends on intake, loss, and storage. Overall, women's bodies contain 2.3 g of iron. The fetus and placenta are supported by the increased iron reserves (about 1 g) associated with pregnancy, as well as by the increased red blood cell mass and anticipated blood loss associated with vaginal delivery. Over 70% of iron that is present in sufficient quantities to meet needs is classified as functional iron; the remainder is stored. About 80% of the functional iron in red blood cells is contained in hemoglobin; the remaining iron is found in respiratory enzymes and myoglobin. As stated in [1], elevated blood volume is regarded as the natural anemia of pregnancy.

Also, there are numerous research that address the epidemiology of anemia gravidarum from various angles.

According to one study, the prevalence of anemia differed based on the country's economic status (45.4% in low-income nations, 39.8% in lower-middle-income countries, and 37.1% in upper-middle-income countries). In low- and middle-income nations, nearly half (42.7%) of expectant mothers were anaemic. Their analysis also revealed notable regional variations in anemia prevalence. According to a prior multi-country study, the prevalence of anemia gravidarum was higher in South Asia, Africa, and South America (48.6% and 43.5%, respectively) than in East-West Asia (39.9%). Research shows that the prevalence of anemia during pregnancy in low-income countries has barely changed since 2000 [24]. Anemia is present in 36.8% of pregnancies worldwide, which supports the earlier studies. Masut's research showed the lowest occurrence, at 7.67% in Belgium among 2503 pregnant women, whereas Saeed Haq's work showed the highest frequency, at 93.1% in Pakistan among 1000 pregnant women. According to Karami et al. (2022), the highest rates of mild anemia (70.8%), third-trimester anemia (48.8%), and anemia gravidarum (41.7%) are seen in Africa. According to the World Health Organization (WHO) 2019, Indonesia had a 40.5% prevalence of anemia gravidarum in 2015 and a 42% prevalence in 2016. A study found that the prevalence of anemia among pregnant women in North Sumatra is 40.7% higher than the national norm [18]. Another study indicated that anemia affected 48.9% of pregnant women in Central Java, Indonesia. Additionally, anemia affected 14.3% of research participants in Semarang, Indonesia; moderate and mild anemia affected 32.3% and 67.6% of the sample, respectively [20].

(2) Low Birth Weight

The term birth weight is frequently used to describe the initial weight of a newborn or fetus after birth. Prior to the onset of noticeable postnatal weight loss, the birth weight should preferably be ascertained within the first hour after delivery. Additionally, birth weight can be divided into three categories: low, very low, and extremely low. These categories overlap because they are all-inclusive. Neonatals weighing less than 2500 grammes are classified as low birth weight, those weighing less than 1500 grammes as very low birth weight, and those weighing less than 1000 grammes as extremely low birth weight (World Health Organization, 2004).

According to estimates from the World Health Organization (WHO), low birth weight affects 30 million babies worldwide each year or around 23.4% of all births. Geographical distribution affects the prevalence of low birth weight; Sub-Saharan Africa has the highest rates, with a pooled prevalence of low birth weight newborns at birth of 9.76%. The prevalence of low birth weight decreased from 17.5% in 2000 to 14.6% in 2015, according to the Lancet Global Health [30]. Southeast Asia reported LBW rates ranging from 7 to 21% in 2015, with Asia having the greatest frequency (17.3%). According to research, Indonesia ranks sixth among Southeast Asian countries with an LBW incidence rate of 5–10% (World Health Organization, 2023).

Additionally, according to the 2018 Indonesian Basic Health Research Survey, the country's LBW indicator was 6% [35].

(3) Preterm Birth

The gestational period, which is measured from the first day of the previous regular menstrual cycle and manifested in whole days or weeks, is associated with preterm birth. Gestational age should be determined using the best clinical evaluation if there is no record of the last regular menstrual cycle. To prevent misunderstandings, it is advised to indicate both weeks and days. Pre-term pregnancy is defined as less than 37 weeks completed (less than 259 days), term pregnancy is defined as 37 weeks completed up to less than 42 weeks completed (259 to 293 days), and post-term pregnancy is defined as more than 42 weeks completed (more than 294 days) (World Health Organization, 2004).

A projected 13.4 million babies were born prematurely in 2020, and over a million of them died as a result of preterm birth complications, according to recent research. This means that approximately 10% of newborns worldwide are born before their due date. In 2023, WHO and UNICEF collaborated with the London School of Hygiene and Tropical Medicine to create new estimates of the prevalence of preterm births. In conclusion, it indicates that preterm birth rates have not declined globally and that 152 million vulnerable babies were born prematurely between 2010 and 2020. Additionally, it is reported that the percentage of premature births in Indonesia was between 10 to 15 percent, with about 600,000 preterm births annually, which could lead to social and economic issues for the country's healthcare system [27].

(4) Small Gestational Age

As stated above, it is unlikely to distinguish between preterm birth low birth weight, and small gestational age (SGA). Infants with birth weights and/or lengths below the standard range for gestational age are classified as SGA. Based on data obtained from a suitable reference population, a group of paediatric endocrinologists decided in 2001 to define SGA as a birth weight and/or length that is at least two standard deviations below the mean for gestational age. A smaller birth size increases the risk of type 2 diabetes mellitus (DM), hypertension, and cardiovascular disease. Excessive postnatal weight gain may increase several of these risks. Because the risk of SGA was higher for mothers who had previously given birth to an SGA infant, as well as for men and women who were born SGA themselves, SGA births tend to cluster in families [8].

The prevalence and number of babies born small for gestational age, as well as the co-occurrence of small for gestational age and preterm birth, are estimated at the national and regional levels using our data. In 2010, 43,3 million babies (36 percent of live births) were born prematurely, too small for gestational age, or both in low- and middle-income nations. 32,4 million neonates (27% of live births) are anticipated to be affected by the high burden of small-for-gestational-age babies; of these, 29,7 million were delivered at full term (≥37 weeks) and 10.6 million were born at term but with low birth weight (<2500 g). Two percent, or about 3 million babies, were born tiny for gestational age and preterm [17].

(5) Stillbirth

At least 32 stillbirth classification systems exist today, many of which are varied in complexity, contain many definitions for significant illnesses, and utilise different classification categories for causes. Because of this, neither one system is widely used [26]. Neonates die in the span of 20 weeks of gestation, although some definitions set this threshold at 28 weeks, and are considered as stillbirth. Stillbirth is a serious public health concern that often causes parents and families to face ongoing financial, social, and psychological challenges. An estimated 1.9 million mothers worldwide have a late-gestation loss (twenty-eight weeks or more) per year. Due to a lack of data, stillbirths that take place before twenty-eight weeks of gestation are not included in the most recent global estimate, which greatly underestimates the incidence of stillbirth. Despite being more prevalent in middle- and low-income nations, most stillbirths can be prevented with appropriate pregnancy and emergency obstetric treatment [9].

The availability of midwives and the frequency of C-sections were the primary factors influencing the substantial variability of maternal death (3.5 times) and stillbirth (~7 times) throughout the provinces. This is not surprising given that pregnancy outcomes are significantly influenced by the availability of human resources, particularly the number of SpOG per population and midwife [33]. According to UNICEF, 13.9 stillbirths per 1,000 live births occurred worldwide in 2021, with an estimated 1.9 million babies delivered still at 28 weeks or later. About one stillbirth occurs every 17 seconds as a result. The burden of stillbirths is not fairly divided; around 77% of all stillbirths occur in sub-Saharan Africa and Southern Asia, with the highest rates seen in nations like Bangladesh, Ethiopia, Nigeria, India, Pakistan, and the Democratic Republic of the Congo.

(6) Perinatal Mortality

The number of deaths among live-born children up to seven full days of life and the number of fetal deaths after 22 (or 28) weeks of pregnancy are combined to form perinatal mortality. Per 1000 live births and stillbirths, the perinatal death rate is reported. Perinatal mortality directly reflects the quality of prenatal, intrapartum, and neonatal care and is a significant outcome indicator for the nation's socioeconomic status and quality of life [7].

In low- and middle-income regions, perinatal death is a public health and development issue. In 2019, there were 4.3 million perinatal deaths worldwide or one every seven seconds. 95% of these premature fatalities took place in South Asia and sub-Saharan Africa, while the number of perinatal deaths fell from 5.7 million in 2000 to 4.1 million in 2015. With the highest rate of 34.7 fatalities per 1000 live births,

perinatal mortality has remained the most prevalent issue in sub-Saharan Africa [7]. According to the SKDI 2002-2003 study, Indonesia's current perinatal mortality rate is 24 per 1000 births, which accounts for roughly 77% of neonatal deaths, with neonatal deaths accounting for 58% of all newborn fatalities [23].

(7) Neonatal Mortality

Neonatal mortality, as defined by the World Health Organization, is the death of a baby within the first 28 days after birth (WHO). Neonatal mortality can be classified into three categories: very early, early, and late. Very early and early neonatal mortalities are the deaths that take place on the first day of life and within the first 7 days of life. Deaths that take place after the seventh day of life but before the 28 days are referred to as late neonatal mortality. The most critical time for a child's survival is during the neonatal period; most neonatal deaths take place within the first day and week, with around one million deaths on the first day and more than one million deaths over the following six days. The neonatal mortality rate (NMR), which is defined as the number of neonatal deaths per 1,000 live births in a given year, is one of the most sensitive measures of the socioeconomic status of a community and the accessibility and availability of healthcare services in the nation [32].

In 2019, there were around 6,700 neonatal deaths each day globally, with 2.4 million deaths occurring in the first 28 days. About one-third of neonatal deaths happen within the first day of life, and over three-quarters happen within the first week, per a recent study [32]. According to a study, the percentage of preterm mortality in Indonesia is higher at 44% than the global average of 35%. Their data also indicates a greater percentage of mortality from IPRE than the global average, 39% versus 24%, similar to preterm birth. Additionally, they discovered that 79% of the 259 neonates passed away in the first week following delivery, and roughly 83% and 74% of them were born and passed away at a medical facility, respectively [6].

(8) Anemia Gravidarum and Adverse Birth Outcome

There are a number of theories regarding how anemia gravidarum could result in adverse delivery outcomes. According to a study, disturbed gas exchange is the primary factor linking anemia gravidarum to low birth weight and preterm birth. They went on to say that one of the possible causes could be the decreased hemoglobin levels in anaemic states, which further lower the amount of oxygen delivered to the fetus. This implies that the fetus may have had problems and that the mother's gas exchange was disturbed, which made it faster for the newborn to get into a hypoxic state that could develop into asphyxia neonatum. Fetal discomfort or unsettling fetal heart rate tracing may result from a drastic reduction in oxygen delivery to the fetus. According to [34], low hemoglobin levels associated with anemia might change placental angiogenesis, which limits the fetus's access to oxygen and may cause intrauterine growth restriction.

In the majority of IUGR pregnancies, the fetus's blood flow is restricted, depriving it of oxygen and nutrition. In developing countries, maternal undernutrition and/or malnutrition are the root causes of IUGR, while in affluent nations, placental insufficiency is the main cause of IUGR newborns. The placenta facilitates waste elimination and provides a vital route for nutrients and oxygen between the mother and the fetus. Insufficient vascular adaptation at the uteroplacental interface is the contributory factor of placental insufficiency, which ultimately leads to hypoxia and hypoglycemia in the fetus and ensuing development limitation [37]. Due to a shortage of oxygen, nutrition, and other nutrients necessary for fetal development, these growth limitations will ultimately result in a number of adverse birth outcomes.

- *Anemia Gravidarum and Low Birth Weight*

According to a review, babies born to pregnant women who suffered from anemia were more likely to experience LBW. Various systematic reviews and meta-analyses conducted in various countries are consistent with the current conclusion that neonates born to women with normal Hgb levels were 78% less likely to suffer LBW [3]. By selecting a subsample from a national survey conducted in Bangladesh, various causes of low birth weight were examined, and it was found that 20% of babies were underweight. Maternal illnesses and malnutrition were the most prevalent risk factors. Compared to children from lower socioeconomic classes, newborns born to moms from higher socioeconomic classes had a reduced low birth weight ratio [29].

According to a study conducted in Pakistan, the lowest and maximum prevalences of anemia during pregnancy were 46.7% and 91%, respectively. However, as the majority of Punjabi studies measured prevalence in urban settings, a greater frequency was reported in a subgroup analysis of pregnant women in Punjab Province. This could be because of changes in food and lifestyle. Pregnant women from lower socioeconomic classes were more common than those from middle-class backgrounds, which may be because of the usage of nutritional supplements or appropriate prenatal care that makes women aware of their iron status [19]. From these studies that have been mentioned above, we can conclude that there is a higher risk of giving birth to low birth weight babies when anemia gravidarum is present in their mothers, as is supported by several earlier studies.

- *Anemia Gravidarum and Preterm Birth*

According to eight studies found by a comprehensive review and meta-analysis, neonates born to mothers with normal Hgb levels had a 78% lower chance of having PTB [3]. According to another study, iron deficiency more than quadrupled the chance of premature birth, while anemia from other sources did not increase that risk. When vaginal bleeding happened at or before admission to care, the probability of an

early delivery was five times higher for iron-deficiency anemia and quadrupled for other anemias. The likelihood of poor pregnancy weight growth was higher for people with iron-deficiency anemia and anemias of other causes. However, for a minority inner-city population, where iron deficiency has been clinically related to the bulk of anemias, the prevalence of iron-deficiency anemia (3.5%) was lower than anticipated [28].

A higher risk of preterm birth is linked to maternal anemia, especially in the early stages of pregnancy. According to a meta-analysis, the relative risk of preterm delivery for maternal anemia during pregnancy is 1.56, with the largest risk occurring in the first trimester (relative risk of 1.65) [25]. Another study explains how the degree of anemia is also very important. For example, light anemia had an adjusted odds ratio (aOR) of 1.37, moderate anemia of 1.54, and severe anemia of 4.03 for preterm birth [4]. Based on the aforementioned studies and a number of prior research findings, we may conclude that mothers who have anemia gravidarum are at a higher risk of giving birth to premature birth kids.

• *Anemia Gravidarum and Small Gestational Age*

According to one study, the 9 or 8 g/dL group was linked to a 53% increase in the newborn's probability of having SGA, but the 11 and 10g/dL categories did not significantly correlate with SGA. This indicates that while there was no correlation with milder anemia, moderate to severe anemia (9 or 8 g/dL) was strongly linked to SGA. The meta-analysis's findings may provide more justification for focussing on moderate to severe maternal anemia in underdeveloped nations, where both anemia and SGA are quite common [14].

Moderate and severe iron deficiency anemia in the early third trimester was found to be strongly linked with SGA in a study that included 4,800 pregnant women. SGA was found to be 3.8 times higher in the severe anemia group and 2.4 times higher in the moderate anemia group when compared to the control group. Compared to just 4.9% in the control group without anemia, the rates of SGA were 18.7% in the severe anemia group and 12.1% in the moderate anemia group [5]. The relationship between maternal anemia in the first trimester of pregnancy and an elevated risk of SGA is covered in another study. According to a meta-analysis, there is a distinct gradient of risk linked to the severity of anemia, with mild anemia having an adjusted odds ratio (aOR) of 1.37, moderate anemia having an aOR of 1.54, and severe anemia having an aOR of 2.61 for SGA outcomes [2]. From these studies that have been mentioned above, we can conclude that there is s higher risk of giving birth to small gestational-age babies when anemia gravidarum is present in their mothers, as it is supported with several earlier studies.

• *Anemia Gravidarum and Stillbirth*

According to a racial factor study, moderate maternal anemia was linked to a higher risk of stillbirth in non-Black women but not in Black women, but mild maternal anemia was not linked to the risk of stillbirth. Overall, there was a substantial correlation between moderate anemia and stillbirth in non-Black women, however, this correlation was stronger for those with moderate anemia evaluated between weeks 13 and 27 of pregnancy. Black women with a high hemoglobin concentration measured at less than 28 weeks gestation had a twofold, but not statistically significant, higher risk of stillbirth than those with a normal hemoglobin concentration. Additionally, those with a high hemoglobin concentration measured at 0–12 weeks gestation had a more than 3.5-fold higher risk of stillbirth [31].

According to research carried out in China between 1993 and 1996, one-third (33%) of pregnant women experienced anemia at some point. They discovered that a little lower risk of stillbirth was linked to hemoglobin levels in the third trimester between 9 and 10 g/dL. There was no correlation between maternal anemia and the probability of newborn death. All three investigations carried out in Chinese communities found no correlation between maternal anemia and perinatal mortality, indicating that the relationship between the two conditions is still unclear. Maternal anemia is still a major public health concern because of its high prevalence and role in causing unfavourable outcomes, particularly stillbirth [36]. 46% of pregnant women experienced anemia at some stage during their pregnancy, according to another study done in England. Those with moderate to severe anemia had a considerably increased risk of stillbirth than those with normal hemoglobin levels. According to [21], women who had hemoglobin levels below 11 g/dL were five times more likely to have a stillbirth. From these studies that had been mentioned above, we can conclude that there is s higher risk of giving birth to stillbirth when anemia gravidarum is present in their mothers, as it is supported with several earlier studies.

• *Anemia Gravidarum and Perinatal Mortality*

Low maternal Hb (n = 11) was linked to higher risks of perinatal mortality when data from cutoffs and time points (including trials with unclear timing) were merged. There was a dose-response relationship for LBW, PTB, stillbirth, and perinatal death, and correlations with low Hb were almost twice as robust when using the lowest cutoffs (≤70 or 80 g/L) as opposed to the total estimate (<110 g/L) [35].

The highest rate of anemia in pregnant women is found in Africa. According to studies, the risk of stillbirth and infant death is considerably increased by severe anemia. For example, anemia is associated with a 23% rise in indirect causes of maternal death in certain African nations, which is correlated with a higher rate of perinatal mortality. Some of the highest prevalence rates of anemia in pregnant women are reported in countries such as the Philippines (56.2%) and Laos (57.1%). Perinatal mortality and maternal anemia are strongly correlated [16]. Based on the aforementioned research, we may draw the conclusion that the presence of anemia gravidarum in women increases the chance of stillbirth, which is corroborated by a number of previous studies.

• *Anemia Gravidarum and Neonatal Mortality*

Low Hb was linked to higher risks of LBW, PTB, and neonatal mortality during the first trimester, according to a study (results were nonsignificant but followed similar trends for total estimates for other outcomes) [35]. When discussing neonatal mortality and maternal anemia, they cannot be separated into an increased risk of preterm birth and low birth weight. Despite conflicting findings in a few other research, these are the leading causes of neonatal and infant death in LMICs. Preterm births and low birth weight are more common when anemia during pregnancy lowers the mother's gestational age, which can result in neonatal death. Maternal anemia is seen as a persistent public health concern in LMICs due to the increased negative maternal and birth outcomes among anaemic maternal women [13].

Studies reveal a clear correlation between elevated newborn mortality and severe maternal anemia. In rural India and Pakistan, for example, research found that women with severe anemia had neonatal mortality rates of 72.6 deaths per 1,000 live births, while moms with normal hemoglobin levels had neonatal mortality rates of 24.7 deaths per 1,000 live births. The incidence of severe anemia was linked to notable increases in the risks of stillbirth and neonatal mortality in this cohort study of pregnant women in rural areas. For instance, the study found that moms who were anaemic had a significantly higher total infant mortality rate [22]. According to a different study, the newborn mortality rate for pregnant women who were anaemic was almost 8.5% of the 200 cases examined [12].

CONCLUSIONS

There is a notable correlation between anemia gravidarum and adverse birth outcomes such as low birth weight, preterm birth, small gestational age, stillbirth, perinatal mortality, and neonatal mortality. One of the theories that support how anemia gravidarum may lead to several adverse birth outcomes is due to hypervolemia, physiological anemia during pregnancy, and/or iron depletion. It is also found that in lower-income countries malnutrition is one of the highest causes of anemia gravidarum, while in higher-income countries placental factors are more apparent. To sum up, this research found that there is a significant correlation between anemia gravidarum and the risk of adverse birth outcomes, where the lower the mothers' hemoglobin levels, the higher the chance of giving birth to adverse outcomes babies (such as low birth weight, preterm birth, small gestational age, stillbirth, perinatal mortality, and neonatal mortality). This study also supports earlier findings and is aligned with several findings regarding the correlation although further research is needed to determine the causes of anemia gravidarum and how to minimize the occurrences. Furthermore, to have a better understanding of how these outcomes might or might not be related to one another, more research is necessary.

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