Difference in neonatal hemoglobin levels between delayed and direct umbilical clamping

Dwi Rahmawati*, Devi Arista, Yesi Mustikasari, Niki Astria, Gustien Siahaan, Dewi Riastawati

Universitas Adiwangsa Jambi, Jambi, Indonesia

Abstract

Background: Anemia is globally considered a public health problem due to its adverse impact on physical, cognitive, motor, and behavioral development during infancy and childhood. The prevalence of anemia in the first year of life reaches 50%.
Purpose: Procedures that can be performed during childbirth to increase the iron stores of newborns and contribute to the prevention of anemia by delaying cord cutting.
Methods: This study was a quantitative study with a quasi-experimental Posttest Only Control Group Design with an uneven control group. The research was conducted in the Lubuk Kambing Health Center Working Area in February-March 2024 with a total sample of 40 full-term babies who were selected using the total sampling technique and divided into intervention groups (delayed cord clamping) and control (immediate clamping). Data analysis used the Mann-Whitney U test with a 95% confidence level (α = 0.05).
Results: The average hemoglobin level performed by Delay Cord Clamping was 17.3 g/dl with a minimum value of 12.5 and a maximum value of 21.4 g/dL and that not performed by Delay Cord Clamping was 15.3 g/dl with a minimum value of 13.5 and a maximum of 19.2 g/dL. The results of the statistical test showed a p value of 0.007 <0.05 which means that there is a significant difference in hemoglobin between Delay Cord Clamping and no Delay Cord Clamping.
Conclusion: Delayed cord clamping has a significant effect on increased neonatal hemoglobin levels. These findings confirm that delayed cord clamping practices can be integrated as part of obstetric and nursing care standards in normal childbirth to support the prevention of anemia from an early age. Nurses and midwives play a role in implementing these evidence-based procedures, conducting antenatal education for pregnant women, and ensuring optimal monitoring of neonatal conditions to improve the quality of maternal and neonatal services.

Keywords: anemia; babies; infant development; delayed cable clamping; hemoglobin levels.

Introduction

One of the most significant public health problems around the world is anemia, which is defined as a low concentration of blood hemoglobin. For public health interventions, the identification of anemia is critical. In 2011, an estimated 273 million children under the age of 5 worldwide developed anemia, with about 50% of these cases due to iron deficiency (Stevens et al., 2013).

Figure 1 illustrates the estimated global prevalence of anemia as a public health problem in infants and children aged 6-59 months in 2011 (Sundararajan & Rabe, 2021).

Anemia is a condition in which there are not enough red blood cells circulating to meet the body's oxygen and physiological needs. It affects hematological status, impairs cognitive and physical development, reduces

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Corresponding author

Dwi Rahmawati*
Universitas Adiwangsa Jambi, Jambi, Indonesia; Address: Jl. Sersan Muslim No.RT 24, The Hok, Kec. Jambi Sel., Kota Jambi, Jambi, Indonesia; Phone: 0822-4911-0002, E-mail: dwirahmawati.jmb@gmail.com

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learning capacity, and decreases productivity, making it an important indicator of poor nutrition and health (Haas & IV, 2001). Various factors such as malnutrition, infection, inflammation, blood loss, and genetic hemoglobin disorders can lead to anemia, but iron deficiency remains the most common cause globally. Iron deficiency anemia contributes to perinatal defects and complications, including stillbirth, prematurity, and low birth weight (McLean et al., 2009).

Delayed cord clamping within 1 to 3 minutes after birth allows placental transfusion and iron-rich blood flow to the newborn, which can prevent premature anemia by facilitating placental transfusion, increased circulating blood volume (up to 100 ml). It is advantageous for neonates to allow blood flow from the placenta to the newborn as the baby transitions to life outside the womb. A delay in cutting the umbilical cord can be achieved by waiting for about one to three minutes, the umbilical cord is usually clamped within fifteen seconds of birth. DCC interventions are simple, inexpensive, and can save lives if implemented correctly. In addition, placental transfusions can be performed through cord milking through a cut umbilical cord, also known as UCM. Milking is the process of manually removing blood from the umbilical cord. This is done by actively squeezing or squeezing blood through a short segment of the umbilical cord (20-30 cm) that is cut (cut the umbilical cord) or attached (intact umbilical cord) to the placenta 3-4 times at a rate of 10 cm per second before clamping the umbilical cord. In cases of hypoxian to full-term labor, UCM can serve as an alternative to DCC because it provides additional blood volume through the accelerated process of placental transfusion without interfering with timely resuscitation efforts (Kim & Warren, 2015; Tonse NK Raju, MD, DCH, 2013; Katheria, Brown, et al., 2017; Katheria, Lakshminrusimha, et al., 2017; Basile et al., 2019).

The novelty of this study lies in an in-depth analysis of the effect of delayed umbilical cord clamping on newborn hemoglobin levels in the work area of the Lubuk Kambing Health Center, which has not been widely studied in this field. This study used a quasi-experimental approach with a Posttest Only Control Group design, which provides strong evidence of the significant benefits of this procedure in improving neonatal hemoglobin levels.

The significance of this study is to show that simple, low-cost procedures such as delayed umbilical cord clamping can significantly improve the hemoglobin status of newborns, thereby potentially reducing the prevalence of anemia in infants in the early months of their lives. Anemia in newborns can adversely affect a child's cognitive, motor, and immune development, ultimately affecting their future quality of life. By increasing hemoglobin levels through delayed cord clamping, babies have better iron reserves to support optimal brain growth and development. In addition, this study also makes an important contribution in educating health workers about the benefits of delayed cord clamping practices. The implementation of the results of this study can encourage changes in the standards of childbirth procedures in health facilities, including health centers, so as to provide long-term benefits for the health of mothers and babies. The results of this study are also relevant for the development of broader public health policies, especially in efforts to prevent iron deficiency anemia which is still a global health problem (Andersson et al., 2015; Mcdonald et al., 2014; Yoon et al., 2023; Mercer et al., 2018).

The study adds to scientific evidence supporting recommendations from international health organizations, including the World Health Organization (WHO), which advocate delayed cord clamping (DCC) to improve iron status and prevent anemia in newborns (World Health Organization, 2014). Randomized clinical trials and systematic reviews have shown that DCC significantly increases hemoglobin levels and iron reserves early in life, and has the potential to provide long-term benefits for children's neurocognitive development (Andersson et al., 2015; McDonald et al., 2014).

An initial survey of 10 infants, five receiving delayed umbilical cord clamping and five direct clamping showed that infants with delayed cord clamping had higher average hemoglobin levels, with an average difference of 2.2 g/dL. Implementing delayed cord clamping as an anemia prevention strategy requires coordination between healthcare providers and community support. This study aims to describe hemoglobin levels in newborns who receive delayed versus direct cord clamping and to determine the effect of delayed cord clamping on newborn hemoglobin levels in the Lubuk Kambing Health Center area in 2024.

Materials and Methods

Study Design

This research is a quantitative research. The research design used is Quasy Experimental with a Posttest Only Control Group Design approach.

Population, Sampling, and Sampling

This research was conducted in the working area of the Lubuk Kambing Health Center, Jambi, in February-March 2024. The research sample included all babies born in that period using the total sampling technique, so that the entire population that met these criteria was used as study respondents. The number of samples obtained was 40 infants, which were then divided into two groups, namely 20 infants in the intervention group (delayed cord clamping) and 20 infants in the control group (immediate cord clamping). The use of total sampling was chosen because the number of births during the study period was relatively limited, so all subjects who met the criteria were included to minimize selection bias and improve data representation. In addition, this sample count has met the minimum requirements of comparative analysis from two independent groups with a quasi-

Table 1. Demographic characteristics of respondents

Characteristics	Group	n	%
Equivalence	1	15	37.5
	2	25	62.5
Age	20-35	40	100
Age Pregnancy	37-38 weeks	5	5
	38-39 Weeks	21	52.5
	39-40 weeks	17	42.5
Up to Hb	<11 g/dL	6	15
	≥11 g/dL	34	85
	Quantity	40	100

Table 2.Average distribution of newborn hemoglobin levels

Variable	n	Middle	Minimum	Maximum
Delayed hemoglobin levels in newborns Cable Clamping	20	17.3	12.5	21.4
Undelayed hemoglobin levels in newborns, cord clamping	20	15.3	13.5	19.2

Table 3.Effects of delayed cord clamping on neonatal hemoglobin levels

Intervention	Means	Average Rating	P-Value
Cable Clamp Delay	17.3	25.5	0.007
No cable clamping delay	15.3	15.5	

experimental design to detect mean differences with a 95% confidence level and adequate testing strength at a significance level of 0.05.

Inclusion criteria included newborns with normal conditions and full gestational age. Exclusion criteria are infants with congenital abnormalities as well as infants who have complications such as succedaneum caput and umbilical cord circumference. The independent variable in this study was delayed cord clamping, while the dependent variable was newborn hemoglobin levels.

Instruments

All instruments used in the study "Effect of Delayed Umbilical Cord Clamping on Hemoglobin Levels in Newborns" have gone through a systematic validation process. Hemoglobin levels were measured using the EasyTouch Hb digital hemoglobinometer, which has good validity and reliability based on comparative tests with standard laboratory methods (cyanmethemoglobin method). Before use, the device is calibrated according to the manufacturer's instructions and internal quality control tests are performed to ensure the consistency and accuracy of the measurement results. Measurements are carried out by trained health workers to minimize procedural errors (measurement bias).

The observation sheets and data collection forms undergo a content validity test through assessment by a panel of experts consisting of coordinating midwives and primary service doctors. An assessment was carried out on the suitability of the indicators with the research variables, language clarity, and completeness of observation items. The results of the evaluation showed that all items were declared relevant and represented the constructed being measured. In addition, a face validity test is performed to ensure that the instrument is easy to understand and can be used consistently by enumerators. To ensure the consistency of data filling, an equitable distribution of perception (inter rater agreement) was carried out through enumerator training before the study began.

Delayed cord clamping procedures were performed in accordance with national Standard Operating Procedures (SOPs) and evidence-based practice guidelines, thereby improving the validity of the intervention and reducing treatment variation between subjects.

Procedure

The research preparation stage began with the collection of data on pregnant women with an estimated delivery date in February-March 2024 in the working area of the Lubuk Kambing Health Center, Jambi. The researchers noticed the similarities in characteristics between the intervention group and the control group through the establishment of inclusion and exclusion criteria. Respondents who met the criteria were then assigned to the intervention group (delayed cord clamping) and control group (direct cord clamping).

Before the study was conducted, the researcher explained to the baby's parents about the purpose

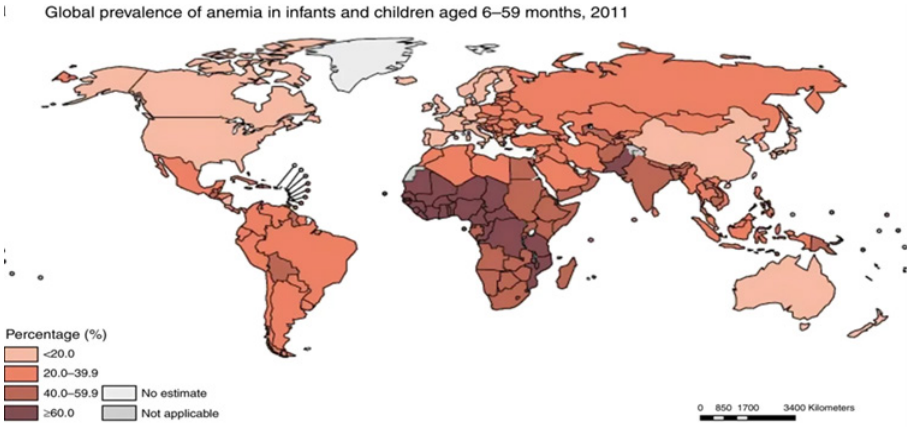

Figure 1. illustrates the estimated global prevalence of anemia as a public health problem in infants and children aged 6-59 months in 2011 (Sundararajan & Rabe, 2021).

of the research and the procedure for checking hemoglobin levels. Consent to participate is obtained through the signing of an informed consent by the respondent's parents. This research has received ethical approval from the Health Research Ethics Commission, Faculty of Medicine and Health Sciences, University of Jambi with an ethics certificate number 23/UN21.8/PT.01.04/2024.

To maintain the consistency of the research implementation, the researcher conducted a briefing to three village midwives who acted as enumerators. Perception equity includes research objectives, delayed cord clamping procedures, as well as blood sampling techniques for hemoglobin testing.

Delayed cord clamping intervention is performed by waiting for 2 minutes after the baby is born spontaneously before clamping is performed. Blood sampling is done on the first day after birth, along with a congenital hypothyroid screening examination as a standard procedure in newborns. The researchers conducted observations during and after the intervention to minimize potential bias. In the final stage, the results of the hemoglobin level examination were compared between the infant group with delayed umbilical cord clamping and the group with immediate clamping.

Data Analysis

The researcher conducted data analysis using IBM SPSS Statistics for Windows software (IBM Corp., Armonk, NY, USA), version 26.0, with the official license of the institution in force at the time of the study. The analytical test used was the Mann-Whitney U test to compare the differences in hemoglobin levels between the two independent groups. The confidence level is set at 95% with a limit of statistical significance $\alpha = 0.05$.

Results

Univariate Analysis

Respondent Characteristics

Based on table 1, it is known that the characteristics of most of the respondents have parity of 2 as many as 25 (62.5%) of respondents, 100% of non-risk age 20-35 years, gestational age of 21 (52.5%) respondents and hemoglobin levels ≥11 g/dL of 34 (85.0%) respondents.

Overview of hemoglobin levels in newborns

Based on the distribution of hemoglobin levels in newborns carried out with Delay Cord Clamping 2024, it is known that the average hemoglobin level is 17,320 g/dl with a minimum value of 12.5 and a maximum of 21.4 g/dL. Hemoglobin levels in newborns who did not undergo Delayed Umbilical Clamping are known to have an average hemoglobin level of 15,340 g/dL with a minimum value of 13.5 and a maximum of 19.2 g/dL

Bivariate Analysis

Based on the results of the analysis, it is known that the average hemoglobin level carried out by Delay Cord Clamping is 17,320 g/dl with an average rating of 25.48 g/dl while in the Delay Cord Clamping record the average homoglobin level is 15,340 g/dl with an average rating of 15.53 g/dl. The results of the statistical test found that the p-value was 0.007 <0.05, so it can be concluded that there is a significant difference between delay cable clamping and no delay cable clamping.

Discussion

This study evaluated neonatal outcomes after DCC in full-term pregnancy. Our study showed that the

International Organization Statement on the Right Time for Rope Clamps

Organizations and/ or Associations of Professions and Scientific Groups	Statement	References
World Health Organization	In preterm infants, delaying cord clamping for 30-120 seconds appears to be associated with less need for blood transfusions and less intraventricular bleeding. The beneficial effects of delayed cord clamping can result in the greatest benefits in settings where access to health care is limited "For full-term babies:" To reduce the risk of postpartum bleeding in mothers, the WHO recommends cord clamping after observation of uterine contractions about three minutes after birth. For babies, there is growing evidence that delayed cord clamping is beneficial and can improve iron status up to six months after birth. This may be especially relevant for babies living in low-resource environments with less access to iron-rich foods.	(World Health Organization, 2004)
Canadian Association of Obstetricians and Gynaecologists	If possible, delaying cord clamping for at least 60 seconds is better than premature clamping in preterm infants (< 37 weeks of pregnancy) because there is less intraventricular bleeding and less need for transfusions in babies with late clamping.	(Leduc et al., 2009)
European Neonatology Panel Consensus Guidelines	If possible, delay cord clamping for at least 30-45 seconds with the baby held under the mother to correct the placenta-fetal transfusion: Level of evidence, A	(Sweet et al., 2010)
International Liaison Committee for Resuscitation	Newborns who do not require resuscitation are advised to delay cord clamping for at least one minute.	(Perlman et al., 2010)

DCC of full-term infants who received delayed cord clamping had better mean hemoglobin levels of 17,320 g/dl with a minimum value of 12.5 and a maximum of 21.4 g/dl compared to neonatal without DCC of 15,340 g/dl with a minimum value of 13.5 and a maximum of 19.2 g/dl.

As soon as the baby cries loudly and until the umbilical cord is no longer throbbing inside the baby, pinching the umbilical cord can increase the blood volume by about fifty milliliters. On the other hand, pinching the umbilical cord ten to fifteen seconds after birth can prevent most of the iron from entering the baby's body (Bersalin et al., 2016).

If the umbilical cord is not cut immediately, the baby can still receive a placental transfusion in the form of an additional blood of about 50 to 100 milliliters. Delaying cord cutting can increase the baby's blood volume by up to 30% and the number of red blood cells by up to 60%. The blood flow of fetoplasente will continue through the umbilical cord until the pulse stops, giving the baby the opportunity to obtain iron reserves derived from erythrocytes and hemoglobin (Garabedian et al., 2016).

The results of the statistical test found that the p value was 0.007 <0.05, so it can be concluded that there is a significant difference between Delay Cord Clamping and no Delay Cord Clamping. Compared to premature clamping, delayed cord clamping can give the newborn's lungs more time to breathe and thus provide a smoother transition to neonatal breathing (Dekker et al., 2018).

Several studies in babies less than one month old have shown that DCC increases infant hemoglobin at birth and reduces the incidence of anemia (Yoon et al., 2023; Mohammad et al., 2021; Ofojebe et al., 2021; Enyinna et al., 2024). In full-term infants, a delay in clamping the umbilical cord for 1 minute after birth leads to an additional volume of up to 80 ml of blood from the placenta into the baby's circulation, which increases to 100 ml within 3 minutes of birth (World Health Organization, 2014). Delaying cord clamping for about 3 minutes provides an additional blood volume of 40 ml per Kg of body weight through placental transfusion with the potential to donate up to 75 mg of iron to a baby weighing 3 Kg, thus preventing iron deficiency in the first 6 months of the baby's life (McDonald et al., 2014).

Iron is essential for brain development, playing a key role in synaptogenesis, myelination, energy metabolism, and neurotransmitter production. If a deficiency occurs during a critical period of brain development, it can lead to permanent changes in brain structure and function that cannot be restored despite supplementation. Infants with perinatal iron deficiency have been shown to have delayed levels of nerve conduction, sleep pattern disorders, cognitive memory impairments, motor deficits and lower global developmental scores that may arise from the neonatal period and continue into adulthood (German & Juul, 2021).

The impact of iron deficiency anemia on infant and child mortality under the age of 5 Worldwide, the mortality rate has declined by nearly 50% from 12.4 million in 1990 to 5.9 million in 2015 (Liu, 2016). However, despite the worldwide decline,

the number of deaths is still highest during the neonatal period, or the first 28 days of life (Liu et al., 2015). Complications of preterm birth (0.965 million, 15.4%) and intradelivery complications (0.662 million, 10.5%), The leading causes of infant mortality are infectious diseases, including pneumonia and diarrhea (3.257 million, 51.8%) (Liu, 2016). Anemia contributes to child mortality through malnutrition and increased susceptibility to infection (Majid Ezzati et al., 2004).

The impact of iron deficiency anemia on brain development starts from delays in children's physical and mental development, decreased hearing and visual function. Anemia affects intelligence, perhaps with irreversible and lifelong consequences, with a deficit of 5-10 points in intelligence (Andersson et al., 2015; Pasricha et al., 2013). In addition, iron deficiency anemia at an early age can be associated with irreversible cognitive impairment, even after iron stores have been replenished (World Health Organization, 2011). Lozoff has shown that iron deficiency, in addition to causing hematologic abnormalities, also causes long-term neurocognitive impairment, with a negative impact on the psychomotor development of the baby. Iron is essential for learning and memory, including optimal brain processing speeds. Developing hippocamps are particularly susceptible to iron deficiency at an early age, which is one of the mechanisms that can lead to the negative effects of iron deficiency (Peter et al., 1999; Batra, 2005).

DCC serves as a low-cost intervention to reduce the risk of iron deficiency anemia (World Health Organization, 2014; Ashish et al., 2017). At 4 months of age, full-term infants who receive DCC have higher levels of ferritin and an increase in myelin in brain areas that are important for early functional development in life. A positive association between maternal iron stores reflected in plasma ferritin and infant plasma ferritin concentrations in the first 6 months was observed (Mercer et al., 2018). Results In a similar RCT of 276 mother-infant pairs, DCC at 3 minutes significantly increased serum ferritin levels in full-term infants at 6 months of age compared to the preterm clamping group with a 3-fold higher incidence of IDA among infants who received early cord clamping. In addition, DCC, when compared to early clamping, improves fine motor function at age 4, suggesting that optimizing cord clamping time has a positive impact on nerve development. Full-term infants benefit from increased Hb, increased iron stores, and better motor outcomes at age 4. The WHO recommends delayed cord clamping to reduce anemia in infants. DCC serves as a means of delivering iron, potentially reducing or eliminating the cost of iron supplementation (Sundararajan & Rabe, 2021).

Reported Benefits of Delayed Cord Pinching: Full-Term Infants (Raju & Singhal, 2012)

Hemoglobin is higher at the age of 4-12 months; Increased serum ferritin during the first year; Increased overall body iron storage at one year of age; Improved malaria survival in endemic areas; Lowers circulating lead levels in areas with high air pollution

Reported Benefits of Delayed Pinching of the Belly Button: Premature Babies (Raju & Singhal, 2012)

Higher blood circulation volume for 24-48 hours; Reduces blood transfusions; Increased systemic blood pressure; Reduces the need for inotropic support; Increased blood flow in the superior vena cava; Increased output of the left ventricle; Higher cerebral oxygenation index; Lower frequency of intracranial bleeding; No IVH weight difference.

Babies born prematurely (before 37 weeks of pregnancy) have a high risk of death and severe morbidity due to immaturity of organs and body systems. Delayed cord clamping is an effective intervention to reduce mortality in preterm infants, with meta-analysis of data from our paired individual participants suggesting that delayed cord clamping reduces the likelihood of death before discharge compared to direct clamping (Wood, 2023; Ohuma et al., 2023). For premature babies, the transition from fetal breathing to neonatal breathing may take longer compared to full-term babies. Compared to premature clamping, delayed cord clamping can give more time for the newborn's lungs to breathe and thus provide a smoother transition to neonatal breathing. However, some babies, especially those born very prematurely (born before 28 weeks of gestation), may need immediate help with lung aeration or further resuscitation, which may be logistically difficult if the umbilical cord is still intact. In practice, many umbilical cord clamping strategies are available, including different times to clamp or milk the umbilical cord, this has led to recommendations in international guidelines to wait at least 60 seconds before clamping the umbilical cord in newborns who do not require respiratory assistance, whereas if stabilization or resuscitation is required, umbilical cord clamping is recommended immediately. In addition, a recent meta-analysis comparing different clamping strategies showed an effect on increased survival the most when clamping was delayed for 2 minutes or more (Dekker et al., 2018; de Pas et al., 2024).

According to the researchers' assumptions, delayed cord clamping can be done by placing the baby next to the mother because the lower position of the baby's placenta can increase blood flow from the placenta faster which is expected to increase the hemoglobin levels in the baby for 2 minutes, then IMD can be performed after the umbilical cord is severed. A baby's hemoglobin levels are not only affected by cord delay but can also be affected by several other factors such as blood loss, increased erythrocyte damage, or decreased erythrocyte production. Efforts that can be made to increase newborn hemoglobin levels must be

made starting from pregnancy where mothers who get balanced nutrition during pregnancy and do not experience anemia during pregnancy tend to get adequate nutritional intake, so pregnant women need to maintain a balanced diet and consume at least 90 tablets to increase blood during pregnancy, To increase knowledge to pregnant women, It is hoped that health workers can conduct counseling or counseling for pregnant women.

Research Limitations

The researcher should provide a detailed and repeated explanation of the hemoglobin test performed in conjunction with congenital hypothyroid screening. This study only used a sample of 20 respondents from each group, so it could not provide an accurate picture of the baby's hemoglobin levels due to delayed cord cutting. Researchers also need enumerators because of the long distance traveled and limited time. In addition, crying babies make mothers unfocused, so researchers have to wait for the baby to finish crying and until the condition is calm or conducive.

Conclusions

The study showed that delayed cord clamping (DCC) significantly increased neonatal hemoglobin levels compared to direct clamping, thus acting as a simple, low-cost intervention to increase initial iron stores and reduce the risk of iron deficiency anemia. In line with controlled clinical trial evidence and WHO recommendations, improved hemoglobin and ferritin status early in life has the potential to support long-term neurocognitive and motor developmental outcomes. Clinically, these findings support the integration of DCC (1-3 minutes in stable full-term neonates) into evidence-based obstetric and nursing practice standards, strengthening obstetric-neonatal protocols, and antenatal education on its benefits. Widespread implementation in primary services and hospitals can be a sustainable prevention strategy against early anemia. Large-scale research is needed to evaluate physiological aspects such as the position of the baby relative to the placenta, as well as its application to multiple pregnancies and premature neonatal to expand generalizations and clinical guidelines.

Declaration of Interest

The authors report no competing interests.

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Data Availability

None.

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