THE ROLE OF MATERNAL HEMOGLOBIN CONCENTRATIONS AS A BIOMARKER FOR LOW BIRTH WEIGHT

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ABSTRACT

Biomarkers have been employed to assess personal exposure to various environmental factors, forecast health impacts, and explore the related underlying mechanisms. The aim of the study was to reveal the associations between maternal hemoglobin concentrations in different trimesters of pregnancy, neonatal birth weight, and SGA (Small for Gestational Age). Data related to maternal socio-demographic status, health-related factors, antenatal visits, and neonatal birth outcomes were collected. A total of 50 women aged from 25 to 38 and their babies were included in the final analysis living for more than four years in the Helwan region (Kafer AL- Alow, Masara and AL-Tbin) during specific period (December 2020 to November 2021), the control group included 30 women, taken from places away from pollution. Maternal hemoglobin concentration was associated with birth weight in an inverted U-shaped curve and with the risks of LBW (Low Birth Weight) and SGA in extended U-shaped curves. In addition to severe anemia, maternal hemoglobin >130 g/L in the third trimester should be paid great attention to in the practice of maternal and child health care.

Keywords: maternal hemoglobin, low birth weight, small for gestational age.

INTRODUCTION

Biomarkers have been utilized to evaluate individual exposure to pollutants, predict health consequences, and investigate potential pathways by which exposure to air pollution is linked to different outcomes (Sjostrand, 2020). Of high interest is the role of maternal biomarkers as valuable tools for predicting neonatal outcomes. They provide insights into the maternal and fetal environment, helping to identify pregnancies at risk for complicated outcomes (Young *et al*., 2023).

Incomplete combustion of carbon-based molecules produces an invisible, colorless, and odorless gas which is carbon monoxide (CO). According to Coburn *et al*. (2018), low blood CO levels are physiological, while Mueller *et al.* (2015) noted that CO shared the cell signaling routes which essential for biological system control. Due to its high affinity for hemoglobin, CO after inhalation binds to erythrocyte haemoglobin to create carboxyhemoglobin (CO-Hb), which causes cellular anoxia (Simonsen *et al*., 2019). In the healthy, nonsmoking population, (CO-Hb) Blood concentrations of (CO-Hb) vary from 0.4 to 0.7%; nevertheless, values of about 2.0% have been seen in urban populations (Desquilbet and Mariotti, 2021). According to Douglas *et al*. (2019), the half-life of (CO-Hb) is 4–6 hours; however, Engel et al., 2021 found that in patients receiving 100% oxygen, the half-life is 74 minutes. Elevated blood (CO-Hb) levels, which are often regarded as > 2% (non-smokers) and 5-12% (smokers) (Hampson, 2020), are typically used to confirm cases of CO poisoning **(**Benitz, 2019). If a patient is not recognized as a smoker, false positive findings may arise. These frameworks are intended to monitor and stop CO exposure-related health impacts (Engel *et al*., 2021).

The objective of this study was to elucidate the association between maternal hemoglobin concentrations during various stages of pregnancy and outcomes such as neonatal birth weight, low birth weight (LBW), and small for gestational age (SGA).

MATERIAL AND METHODS

1. Collection of data:

The process of registering and follow up participants was conducted in Helwan City, and deliveries were completed in hospitals at the governorate level. Collection of data was done by trained Helwan maternal and child healthcare professionals. Maternal socio-demographics (age, education, job, income), reproduction history, and date of last period were collected at enrolment through face-to-face interviews. Baseline height and weight were measured through standardized facilities (Li et al., 2019).

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2. Study population:

Fifty (50) pregnant women and their newborns were aged 25 to 39 from Helwan region during the period from December 2020 to November 2021. The control group included (30) women, taken from places away from pollution. The pregnant women from both groups had been in good health before gravidity, were non-smokers, and were professionally unexposed to harmful materials. We followed the pregnant women of each trimester pregnancy from registering at the hospital for Hb, hematocrit, and gestational diabetes mellitus for the first two trimesters of pregnancy however in the third trimester we gathered blood samples for Hb, hematocrit, gestational diabetes, and carboxyhemoglobin test. Birth weights were determined through hospital records as a routine procedure after delivery SGA was defined by the guidelines for fetal growth and development as birth weight less than the 10th percentile of sex and gestational age. Covariates taken into account for this study were primarily divided into two categories based on previously published research (Maroti et al., 2017): sociodemographic characteristics, such as the mother's age at registration (<25/25–34/≥35 years), the gestational age during registration (≤12 weeks/>12 weeks), the body mass index (BMI) during registration (underweight < 18.5/normal weight 18.5–23.9/overweight 24.0–27.9/obesity ≥ 28.0 kg/m2), prenatal visits frequency (≤5/>5), and micronutrient supplementations (folic acid/folic acid + iron/folic acid + vitamin B complex), among others.

Medical records included information on neonatal birth data, like gender, birth weight, birthday, and gestational age. Trained township mother and child healthcare workers entered all the data into a web-based surveillance system, and regular data quality checks were performed.

3. Biochemical analysis:

Hemoglobin concentration(g/L) was determined by regular tests that proceeded using automated hematology analyzer with participants blood samples. According to Sjostrand (2020), The measurement of maternal hemoglobin was carried out during maternity visits at Helwan hospitals. Carboxyhemoglobin CO -Hb assessed in serum samples.

4. Measurement of the levels of carbon monoxide (CO) in Ambient Air Pollution:

Monthly, an air quality detector measures the levels of carbon monoxide (CO)in the ambient air. This study was approved by the hospital administration in Helwan. Additionally, each newborn's birthdate, gestational age, and mother's age were mentioned based on the commencing pregnancy's gestational age and date of birth in Helwan between 2020 and 2021, the pregnancy date was calculated.

5. Statical analysis:

Statistical analyses were carried out using the SPSS v25.0 software package (SPSS Inc., Chicago, USA), and the comparison of the average values of galled and healthy stems was based on two-tailed unpaired t-tests at P≤ 0.05.

In this study, factors, and the concentration of maternal hemoglobin during the three trimesters of pregnancy showed consistent effects. Along with the 95% confidence intervals (CI) for the accompanying sociodemographic and health factors (parity, BMI at registration, gestational age at registration, micronutrient supplementation and antenatal visit numbers), mother age, education, and occupation, they are ready to estimate changes in birth weight and RR for LBW/ (Small for Gestational Age (SGA), (binomial distribution and log link function). When determining the relationships between maternal hemoglobin and birth weight/LBW. The concentration of maternal hemoglobin throughout the pregnancy trimesters and variables exhibited constant effects in this investigation. They are prepared for estimating changes in birth weight and RR for LBW/SGA (binomial distribution and log link function), along with the 95% confidence intervals (CI) for the accompanying sociodemographic and health factors (parity, BMI at registration, gestational age at registration, micronutrient supplementation and antenatal visit numbers), maternal age, education, and occupation.

These models used maternal hemoglobin in various trimesters to represent the independent variable (x-axis) and birth weight/LBW/SGA represent the dependent variable (y-axis). The reference value was defined as hemoglobin of 110 g/L, or the lowest possible hemoglobin concentration. The total relationship of maternal hemoglobin and outcomes of birth was assessed using the p-value, while any nonlinear associations between maternal hemoglobin and birth outcomes were assessed using the nonlinear association *p*-value.

Further analysis was carried out based on concentration of maternal hemoglobin and maternal characteristics (age, education level, income level, parity, antenatal visits times, micronutrient supplementation and BMI at enrolment) to determine the associations between maternal hemoglobin during pregnancy and birth weight in various groups. For statistical significance, $p < 0.05$ was chosen.

RESULTS

1. Carboxyhemoglobin Levels in pregnant

Table (1) cleared that, the carboxy-hemoglobin level between normally pregnant and those exposed air pollution differ significantly ($P < 0.01$) where the level of Carboxy-hemoglobin was 109.524 n/ml in normally pregnant women and in those exposed to CO was 779.54ng/ml.

Table (1) Carboxyhemoglobin level (ng/ml) between pregnant exposed to CO and control in third trimester.

Groups	**N**	**Mean Std. Deviation**	**t-value**
Pregnant normal	30	109.52±56.75	**14.40****
Pregnant exposed to air pollution	50	779.54±337.11	

**** = Significant at (P< 0.01)**

2- Gestational Age (GA)of the pregnant normal and pregnant exposed to CO

Our results observed in Table (2) cleared that, the period of pregnancy between normally pregnant and those exposed air pollution differ significantly ($P < 0.01$) where the pregnancy period of normally pregnant women was 39.30 weeks and those exposed to CO was 34.07 weeks.

Table (2): Gestational Age in normal pregnant women (control group) and pregnant women exposed to CO (study group).

Groups	**N**	**Mean Std. Deviation**	**t-value**
Pregnant normal	30	39.34±1.43	11.54**
Pregnant exposed to CO (study group).	50	34.07±3.02	

****= Significant at (P < 0.01)**

3-Concentration limit of CO and monthly average in Helwan

Table (3). t-test to show the difference between Normal Concentration limit of CO and monthly average of CO in the polluted area in Helwan.

Variables	**Mean**	**SD**	**t**	**p-values**
monthly average of CO	6783.33	1783.61	5.406	< 0.001 HS
Normal Concentration limit of CO	4000.00	0.00		

HS: High significant

using t-test to show the difference between Normal Concentration limit of carbon monoxide and monthly average of gas in the polluted area in Helwan Table3.

Table (4) characteristics of Maternal baseline and outcomes of neonatal birth (N= 50).

Characteristics	**Mean ± SD or N (%)**
Socio-demographic characteristics:	
Age (years)	30.04±4.67
<25	15 (30)
25–34	25 (50)
≥35	10 (20)
Education	
high school or below	28 (56)
College or above	22 (44)
Health-related characteristics	
Gestational age at enrolment (weeks)	14.8 ± 4.3
≤12	20 (40)
>12	30 (60)
Height (cm)	165 ± 2.5
Weight at enrolment (kg)	58.5 ± 4.6
BMI at enrolment (kg/m^2):	
Underweight (<18.5)	10(20)
Normal weight (18.5–23.9)	25 (50)
Overweight (24.0–27.9)	10 (20)
Obesity (≥28.0)	5 (10)
Micronutrient supplementation:	
Folic acid	30 (60)
Folic acid + iron	12 (24)
Folic acid + vitamin B complex	8 (16)
Gestational age at delivery (weeks)	39.4 ± 1.5
Gender, male	28 (56)
LBW	8 (16)
SGA	6 (12)
More than five antenatal visits	30 (60)

- SGA means small for gestational age.
- LBW means low birth weight.
- BMI means body mass index.

While 39.4 ± 1.5 weeks was the average gestational age at birth. Eight (16%) and six (12%) newborns were classified as LBW and SGA, respectively.

4-Hemoglobin in Different Trimesters of Pregnancy:

The concentrations of maternal hemoglobin in pregnancy's three trimesters re-tested. As shown in Table 3, the maternal anemia prevalence was equal to 10 (20%), 15 (30%), and 22 (44%) in the three trimesters; hemoglobin rates ≥130 g/L were equal to 18 (36%), 9 (18%), and 4 (8%), respectively.

Table (5) Different Maternal hemoglobin status through pregnancy trimesters

Hemoglobin (g/L)	**Mean ± SD or N (%)**
First trimester	18.7 ± 2.3
Average hemoglobin concentration	
Anemia (<110)	10 (20 %)
Severe anemia (<70)	0 (0.0)
Moderate anemia (70–99)	3 (6 %)
Mild anemia (100–109)	6 (12%)
Normal (110–129)	13 (26%)
Hemoglobin ≥ 130	18 (36 %)
Second trimester	14.6 ± 3.1
Average hemoglobin concentration	
Anemia (<110)	15 (30 %)
Severe anemia (<70)	0 (0.0)
Moderate anemia (70–99)	3 (6%)
Mild anemia (100–109)	5 (10 %)
Normal (110–129)	18 (36 %)
Hemoglobin ≥ 130	9 (18 %)
Third trimester	13.8 ± 3.9
Average hemoglobin concentration	
Anemia (<110)	22 (44 %)
Severe anemia (<70)	12 (6%)
Moderate anemia (70–99)	5 (10%)
Mild anemia (100–109)	6 (12%)
Normal (110–129)	10 (20%)
Hemoglobin ≥ 130	4 (8%)

RR, CI, SD and LBW stand for relative risk, confidence interval, standard deviation, and low birth weight respectively. They adjusted for health-related variables (such as parity, BMI and gestational age at enrollment, prenatal visits number, and micronutrient supplementation) and sociodemographic data (such as maternal age, education, occupation, and per capita annual family income). Models that estimated the relationships between maternal hemoglobin and birth weight/LBW also considered the gender of the newborn and the gestational age at delivery.

Dose response connections between maternal hemoglobin through various pregnancy trimesters and the outcomes of birth were also estimated using RCS functions with four knots (maternal hemoglobin at 70, 100, 110, and 130 g/L). There was no evidence of a dose-response association in the first or second trimester. The concentration of maternal hemoglobin and newborn birth weight, LBW, and SGA were shown to have dose-response associations in the third trimester **Figure (1).**

The concentration of Maternal hemoglobin in the third trimester and neonatal birth weight were shown to be correlated with an inverted U-shaped curve (p values for both the overall and non-linear relationship were less than 0.001). The mothers who had hemoglobin concentrations close to 100 g/L had the comparatively greater neonatal birth weight. When a mother's hemoglobin level was less than 70 g/L, her newborn's weight increased significantly; when her hemoglobin level was between 70 and 100 g/L, birth weight continued to rise as her hemoglobin level increased; when her hemoglobin level was greater than 100 g/L, her newborn's weight decreased significantly; and when her hemoglobin level was greater than 130 g/L, the weight of her newborn was greater than 100 g lower than when her hemoglobin level was 100 g/L **(Figure 2).**

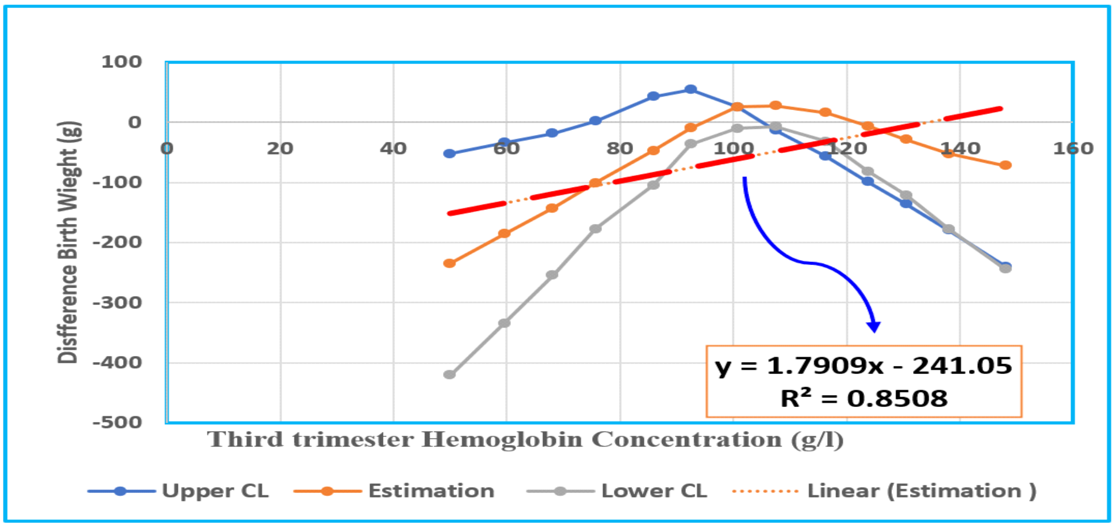

Figure (1) Third Trimester Hemoglobin Concentration (g/l)

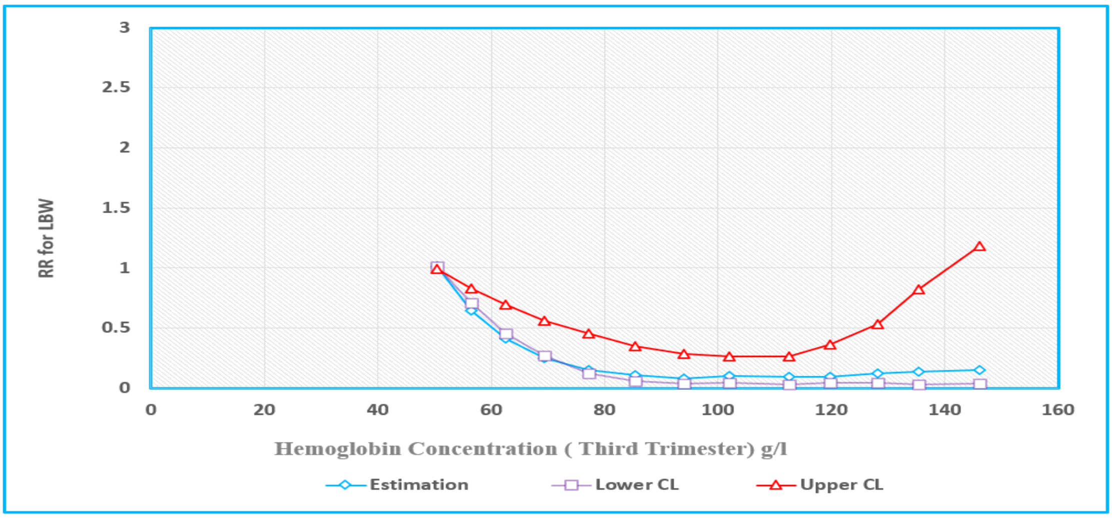

Figure (2) Hemoglobin Concentration (Third Trimester) g/l

5-Hemoglobin in third trimester and Birth Weight-Related:

We chose hemoglobin (100 g/L) in the third trimester as a cut-off for splitting women into 2 groups based on hemoglobin concentration and maternal characteristics. We then performed subgroup analyses based on the characteristics of the mothers in each group. Maternal hemoglobin and neonatal birth weight are positively, but not significantly, correlated in third trimester among women with hemoglobin < 100 g/L. Maternal

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hemoglobin was substantially inversely correlated with newborn birth weight in mothers with hemoglobin levels ≥100 g/L. The odds of LBW/SGA were adversely correlated with maternal hemoglobin in the third trimester among women with hemoglobin <100 g/L. Maternal hemoglobin was positively correlated with probability of SGA with hemoglobin ≥100 g/L in women.

The World Health Organization (WHO) classifies pregnant women as anemic if their hemoglobin levels are <10.5 g/dl in the second trimester and <11.0 g/dl in the 1st and 2nd trimesters **Table (6**).

Table (6) Hb adjustments of each trimester by (WHO)

Trimester of pregnancy	**Hemoglobin (g/dl)**
First	• 11.0
Second	• 10.5
Third	• 11.0

The WHO defined low birth weight (LBW) whose birth weights are < 2500 g.

Pregnant women who had hemoglobin levels in 1st and 2nd trimesters of less than 10 g/dl According to WHO/UNICEF/UNO. IDA (1998), women who had anemia in the third trimester of pregnancy and had hemoglobin values of 8.1–10g/dl, 6.5-8 g/dl, or less than 6.5 g/dl were classed as having mild, moderate, or severe anemia, respectively. According to Table (7), pregnant women who had hemoglobin levels below 10.1 g/dl, which is called anemia, gave birth to neonates weighing 2.6 kg, whereas pregnant women who had levels above 10.1 g/dl, which is deemed normal, gave birth to newborns that were bigger and normal (3 kg). These results demonstrated that both the neonatal birth weight and the hemoglobin level of pregnant mothers rose.

Table (7) Classification of Anemia (Hemoglobin for Trimesters)

{Source: WHO (World Health Organization)}

Trimesters	**Classification of Anemia**	**Levels of Hemoglobin Concentration (g/dl)**	**Birth Weight (g)**
First	Moderate	6.5 - 8	2511 ± 230
	Mid	8.1 - 10	2632 ± 348
	Normal	> 10.1	3032 ± 489
Second	Moderate	6.5 - 8	2540 ± 337
	Mid	8.1 - 10	2500 ± 441
	Normal	> 10.1	3055 ± 265
Third	Moderate	6.5 - 8	2503 ± 582
	Mid	8.1 - 10	2656 ± 530
	Normal	> 10.1	3032 ± 370

DISCUSSION

When calculating the correlations between birth weight/LBW and maternal hemoglobin, models were further modified for gestational age at the birth and gender of newborn. The dose and response relation between the maternal hemoglobin concentration in several pregnancy trimesters and the outcomes of birth was also estimated using the restricted cubic spline (RCS) function (Benitz, 2019**).** Maternal hemoglobin of 70, 100, 110, and 130 g/L selected as set of four nodes into the RCS based on the hemoglobin cut-offs that were used to categorize the gestational anemia severity (Radford & Drizd, 2019) and the cut-off which explains high concentration of maternal hemoglobin.

According to Crozier et al. (2023), pregnant women were chosen, and the relationship between changes in hemoglobin concentration throughout the course of three trimesters and the neonates birth weight was examined.

According to Ng *et al.* (2015), we started by looking at this correlation to determine the optimal strategy to address age in our model after finding that COHb concentrations in mothers were significantly correlated with postnatal age in pilot research.

Elevated COHb values are typically used for measuring the extent of CO poisoning and to validate the participants' CO exposure (Piantadosi 2002).

Research including exposure to CO from fuel burning inside (Benitz, 2019) revealed average COHb values ranging from 0.9 to 17.16%. After being exposed to external exhaust, smokers' average COHb levels were 2.4% and non-smokers' average 0.6%.

Ng et al. (2015), found that the mother's hemoglobin concentration was reversed throughout the third trimester.

Exhibited extended U-shaped relationships with LBW and SGA risks in addition to a U-shaped correlation with neonatal birth weight. An LBW and SGA risk reduction as well as a comparatively greater birth weight were noted at hemoglobin concentrations of 100–110 g/L. Reduced birth weight and elevated risks of LBW and SGA were significantly correlated with maternal hemoglobin levels of less than 70 g/L or more than 130 g/L (Roux, 2007).

Sixty percent of the patients in our research in Helwan experienced anemia during pregnancy. We found that a higher percentage of our participants were farmers in Helwan, who had lower levels of education and income. These individuals were also less likely to reach a balanced diet and adequate nutrition intake through pregnancy, which further contributed to the poor nutritional status and induced maternal anemia. This could be the reason for the high prevalence of anemia in our population. On the other hand, it is noteworthy that almost 50% of the subjects had hemoglobin levels > 130 during their pregnancies, suggesting that the study population had both high and low hemoglobin levels through pregnancy (Roux, 2007).

In the current study, we discovered that maternal hemoglobin in the third trimester was linked in an extended U-shaped curve to the risks of LBW and SGA, as well as to neonatal birth weight in an inverted U-shaped curve. Pregnant women who had hemoglobin > 130 g/L or severe anemia had considerably lower newborn birth weights and higher odds of both SGA and LBW. Our findings showed a more complex relationship between maternal hemoglobin and birth weight-related outcomes than those of other *studies* (Pena-Rosas et al., 2012; Coburn et al., 2018; Piantadosi, 2019). This is because both low and high hemoglobin value in the 3^{rd} trimester may have a negative impact on fetal growth.

The findings showed that there may be an inverted U-shaped association between neonatal birth weight and the risk of low birth weight (LBW) and a U-shaped relationship between maternal hemoglobin levels throughout pregnancy (Peng et al.,2022).

According to a prospective cohort research conducted in Pakistan and India in 2022, the mean neonatal birth weight increased when the mother's hemoglobin during pregnancy was between 110 and 129 g/L, while it declined when it was less than 110 g/L or more than 130 g/L. A systematic review and meta-analysis revealed an extended U-shaped link between maternal hemoglobin and the risk of SGA (Radford & Drizd, 2019). The study also showed a U-shaped association between maternal hemoglobin and LBW risk (Hampson, 2020).

One of the reasons for the conflicting results in earlier investigations was the variation in the time of the maternal hemoglobin measurement. We measured the concentration of maternal hemoglobin in each trimester, and only in the third trimester did we observe significant associations between maternal hemoglobin and risks of LBW and SGA. These findings were partially consistent with the 2019 systematic review and meta-analysis conducted by Zhu et al. (2020).

According to this research, low maternal hemoglobin concentration did not substantially correlate with SGA in any trimester, however it was strongly linked to an elevated risk of LBW in first and third trimesters. The lack of a significant link in the first trimester was not seen in our study, which may have been caused by the lower frequency of anemia in our group compared to populations studied in earlier studies, as well as the varied severity of anemia. Furthermore, this analysis demonstrated the scant data supporting high maternal hemoglobin concentrations during LBW/SGA and pregnancy.

Up addition to partially filling up the research gap, our study offered fresh proof that elevated and low maternal hemoglobin concentrations during the third trimester were linked to higher chances of LBW/SGA. The following is one possible reason for our findings. The third trimester, or around 35 weeks of gestation, is when fetal weight growth velocity hits its peak and fetal nutritional need sharply increases (Desquilbet, 2021). A very low mother food supply to the fetus can result from severe anemia or a relatively high hemoglobin concentration at this time, which can have a major negative impact on fetal weight growth and raise the risk of LBW and SGA (Engel *et al*., 2021; Engel *et al*., 2021; Shane & Stoll, 2013).

The following are some potential processes that might be at play in the link between fetal weight development and hemoglobin concentrations, either high or low.

In the third trimester, severe anemia causes a reduction in the body's ability to produce oxygen and poor placental growth, which impacts the mother's ability to feed the fetus with nutrition and oxygen.

The detrimental effects of elevated maternal hemoglobin concentration on fetal development might be ascribed to insufficient expansion of the plasma volume.

In the third trimester, a high hemoglobin content might be a sign that the plasma volume is not expanding properly. Pregnancy-related insufficient plasma volume expansion raises blood viscosity, which in turn causes a drop in the viscosity placental blood flow and nutrient delivery capacity, all of which have an impact on fetal growth and development (Douglas et al., 2019; Benitz, 2019; Coburn et al., 2018; Lin et al., 2018).

Our findings that superior birth weight-related outcomes were achieved when maternal hemoglobin concentration in the third trimester was 100–110 g/L are also explained by the plasma volume expansion. The proper nutrition transmission from mother to fetus is achieved by the slightly reduced hemoglobin concentrations in the third trimester, which may indicate an acceptable plasma volume expansion and thereafter support fetal growth and development (Engel et al., 2021).

The current study was the first investigation to identify nonlinear correlations between birth weight-related outcomes in EGYPT and maternal hemoglobin concentration in the third trimester. We stated that maternal hemoglobin > 130 g/L in the third trimester might be heavily focused on in addition to severe anemia in maternal and child health care. We also disclosed that both low and high hemoglobin concentrations may be damaging to fetal weight growth and raise the risks of LBW and SGA. However, it is important to recognize a few of the current study's shortcomings.

Because this study was carried out in Helwan, the findings mostly represented the relationship between maternal hemoglobin levels during pregnancy and the outcomes of delivery in women from socio-demographic poor backgrounds. This may have limited the applicability of the findings to other groups. Secondly, although though we controlled for several possible confounders throughout the analytic process, such as sociodemographic and health-related variables, we were still unable to thoroughly analyze several confounders that were either unobserved or unknown **(**Ilano & Raffin2021)

The possible processes involved could not be elucidated because the current study only evaluated the association between maternal hemoglobin and birth weight-related outcomes; it did not evaluate the impacts of the expansion of maternal plasma volume or the status of iron of mothers and newborns. To investigate the underlying processes and create a more thorough and accurate dietary intervention plan, more extensive and well-designed research is advised.

As a result, in contrast to other research, it appears that the prevalence of iron deficiency anemia is lower in this one. The non-anemic group's hemoglobin levels decreased in the second trimester, according to the data. Hemoglobin levels rose once more in the third trimester, and it was discovered that they were comparable to those in the first. The mean hemoglobin levels found in early pregnancies (12–16 weeks) and late pregnancies (37 weeks) are higher than those found in mid-pregnancy (28–33 weeks), which is comparable to the mean hemoglobin levels reported in pregnancy in other studies (Tabrizi et al., 2015).

CONCLUSIONS AND RECOMMENDATIONS

There was an extended relationship between the concentrations of maternal hemoglobin in the third trimester and the risks of both SGA and LBW, and an inverted U-shaped relationship with neonatal birth weight. During this time, both low and high hemoglobin concentrations may have a negative impact on the growth of the fetal weight and raise the risk of LBW and SGA, respectively. Maternal hemoglobin more than 130 g/L in the third trimester should also be closely monitored in the practice of maternity and child health care, in addition to severe anemia. The substantial variation in COHb levels across and between people is highlighted by the raw data itself. Pregnant women should avoid exposure to tobacco smoke, ensure proper ventilation in indoor spaces, and avoid using gas stoves or heaters in indoor spaces without adequate ventilation. Interest in maternal hemoglobin and its ratio during the three stages of pregnancy is recommended due to its effect on birth weight.

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دور تركيزات الهيموجلوبين لدى الأم كمؤشر حيوي لانخفاض الوزن عند الولادة

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المستخلص

تلعب المؤشرات الحيوية دورا هاما فى تقييم التعرض الشخصي للعوامل البيئية مختلفة، والتنبؤ بالتأثيرات الصحية، واستكشاف الآليات الأساسية ذات الصلة. تهدف هذه الدراسة الى الكشف عن مدى الارتباط بين تركيزات هيموجلوبين الأم في فصول الحمل المختلفة ونقص الوزن عند الولادة والصغر مقارنة بعمر الحمل .المواد والطرق :بناءً على المعلومات المتعلقة بالحالة الاجتماعية والديموغرافية للأم، والعوامل المرتبطة بالصحة، والزيارات السابقة للولادة، ونتائج ولادة الأطفال حديثي الولادة تم ادراجالتحليل النهائي ل 50 امرأة وأطفالهن والذين عاشوا لأكثر من أربع سنوات في منطقة حلوان) كفر العلو، المعصرة ،التبين (خلال الفترة من ديسمبر 2020 إلى نوفمبر .2021 وفي الثلث الثالث من الحمل، ارتبط تركيز الهيموجلوبين للأم بالوزن عند الولادة في منحنى عكسي ومع مخاطر نقص الوزن عند الولادة والصغر مقارنة بعمر الحمل في منحنيات ممتدة على شكل حرفU .

يمكن أن تكون كل من تركيزات الهيموجلوبين المنخفضة والمرتفعة في الثلث الثالث من الحمل ضارة لنمو وزن الجنين وتزيد من مخاطرنقص الوزن عند الولادة والصغر مقارنة بعمر الحمل .بالإضافة إلى فقر الدم الشديد، وعليه يجب إيلاء اهتمام كبير لتركيز هيموجلوبين الأم في الثلث الثالث من الحمل ضمن ممارسة الرعاية الصحية للأم والطفل.

الكلمات المفتاحية :هيموجلوبين الأم، نقص الوزن عند الولادة ، الصغر مقارنة بعمر الحمل