

Effects of Iron Intake on Pregnant Women

Longxuan Lin*

School of biological engineering and Wuliangye liquor, Sichuan University of Science & Engineering, Zigong, 643002, China

*Corresponding author: 20151015635@mail.sdufe.edu.cn

Abstract. Iron not only needs to meet the metabolic process of pregnant women's own tissues, but also needs to provide the basis for fetal growth and development. Iron is involved in the composition of hemoglobin and myoglobin and is closely related to the oxygen supply of the placenta. The aim of this paper is to probe the effects of iron intake on pregnant women and its possible complications. The article analyzed iron deficiency anemia and iron deficiency hypoxic encephalopathy, two common diseases related to iron deficiency and discussed their pathogenesis, clinical manifestations and prevention measures. In addition, the paper also focuses on gestational diabetes and iron poisoning, which can be caused by excessive iron intake, analyzing the causes, incidence and potential impact on maternal and infant health of these two complications. Finally, this study discussed the strategy of reasonable intake of iron in pregnant women during pregnancy and put forward specific recommendations to help pregnant women maintain healthy iron levels, prevent related complications, and protect maternal and child health. This study not only helps to deepen the understanding of the relationship between iron and maternal health, but also provides a reference for nutritional guidance and clinical practice during pregnancy.

Keywords: Iron intake, Pregnant woman, Iron deficiency anemia, Hypoxic-ischemic encephalopathy, Gestational diabetes.

1. Introduction

Iron is one of the most important trace elements in the human body and has a crucial role in the production of red blood cells and the transportation of oxygen. For pregnant women, iron intake is particularly important, because it is not only related to the health of the pregnant woman, but also directly affects the normal development of the fetus. During the physiological process of pregnant women, the demand for iron will increase significantly to meet the needs of fetal growth and development. Iron deficiency may lead to anemia, decreased immunity, physical weakness, listlessness and other symptoms in pregnant women, and may even have adverse effects on the development of the fetus, such as fetal growth delay, premature delivery, fetal deformity and so on. For pregnant women's health and the fetus's growth, a moderate iron consumption is crucial. However, more iron is not always better. Pregnant women's risk of developing GDM is positively correlated with higher heme iron consumption and body iron status [1,2]. The purpose of this article is to investigate the different diseases caused by different iron intake in pregnant women.

2. Iron deficiency

2.1. Iron deficiency anemia(IDA)

2.1.1 Mechanism and epidemiological characteristics

Pregnancy-related physiologic anemia is caused by blood dilution, which happens when the body's increased plasma volume surpasses the increase in red blood cell count. Iron deficiency anemia is the most common anemia during pregnancy, accounting for 95% of anemia during pregnancy, and the increase in blood volume during pregnancy, the increase in the demand for iron, particularly during the latter portion of pregnancy, pregnant women's iron intake is insufficient or malabsorption caused by anemia, Pregnant women need 4g of iron per day, the daily diet contains ten to fifteen milligrams of iron, but the absorption rate is only about 10%, the second half of pregnancy, the maximum

absorption rate of iron is 40%, but still cannot meet the requirements, if patients do not supplement iron, easy to cause the loss of iron in the body, the occurrence of iron deficiency anemia. In addition, due to the frequent gastrointestinal reactions of some pregnant women during pregnancy such as morning sickness and decreased appetite, the maternal intake of folic acid, vitamin B12 and iron from food is reduced, and the maternal metabolism is high during pregnancy, which can also lead to a higher incidence of complications such as anemia during pregnancy. Negative perinatal outcomes, such as intrauterine development retardation, preterm birth, low birth weight, or neonatal anemia, are linked to anemia in pregnant women.

Previous studies have reported that the prevalence of anemia during pregnancy varies among women with different cultural backgrounds, socio-economic conditions, lifestyles or health-seeking behaviours [3]. WHO reports that 30 to 40 percent of pregnant women have ID, and the current global prevalence of IDA in pregnancy is about 42 percent. Among 18,948,443 pregnant women aged 15 to 49, 17.78% were diagnosed with Physiology Anemia of Pregnancy, including 9.04% with mild anemia, 2.62% with moderate anemia, 0.21% with severe anemia, and 5.90% with unknown degree of anemia. The search shows that in the vast majority of pregnant women, only a small number of participants developed symptoms of physiologic anemia of pregnancy. Among these participants, the majority were patients with mild anemia [4]. The overall prevalence of anemias in the third trimester of pregnancy was 35.0% in Hebei Province, the prevalence of anemias in the population with a high education level was lower than that [5]. A total of 300 children aged 0 to 6 years in Beijing from June 2013 to January 2014 were randomly selected for questionnaire survey and blood routine tests, serum iron, serum ferritin content, total iron binding capacity, etc., to observe the distribution of iron deficiency anemia in children and analyze related factors. The results showed that: Maternal anemia during pregnancy and premature birth are the key factors affecting iron deficiency anemia in children aged 0~6 years in Beijing [6].

2.1.2 Prevention and treatment

There are two main ways for treating IDA. One is increasing the intake of naturally iron-rich foods and ensuring high bioavailability of iron (by providing an enhancer of iron absorption at a meal and reducing the intake of iron inhibitors). Lean meats and seafood are the best sources of heme iron in the diet; non-heme iron can be found in nuts, legumes, vegetables, and fortified grain products. Owing to the low rate of iron absorption in plant products, it is advised to incorporate food processing techniques like fermentation, soaking, and germination that may increase the bioavailability of non-heme iron, or to supplement meals with boosters of non-heme iron absorption like ascorbic acid, citric acid, or malic acid. Another strategy is to apply oral supplements that provide various nutrients missing from the diet in higher doses to quickly combat nutritional deficiencies and associated anemias. For some populations, because the amount of iron provided in the food matrix is lower, it is a safer option in most cases and represents a more logical method that provides the best balance of risks and benefits [7].

For treatment, patients can increase their intake of foods rich in iron, folate and vitamin B12, such as red meat, poultry, fish, leafy green vegetables, legumes, nuts and whole grains. At the same time, maintain a balanced diet and consume enough vitamin C to promote iron absorption. What's more, patients can promote blood circulation and metabolism by maintaining adequate sleep, avoiding overwork, and properly taking light exercise such as walking and yoga. Last but not the least, during treatment, patients can monitor the improvement of anemia through regular blood routine tests. If symptoms of anemia continue to worsen, your doctor may adjust the treatment.

2.2. Hypoxic-ischemic encephalopathy (HIE)

The occurrence of IDA in pregnant women can lead to a significant decrease in oxygen content in the blood, resulting in fetal hypoxia, resulting in hypoxic-ischemic encephalopathy (HIE).

2.2.1 Mechanism and epidemiological characteristics

Perinatal asphyxia is the main cause of the HIE, which cause blood circulation and gas exchange between the mother and the fetus to reduce the blood oxygen concentration can cause asphyxia.

2.2.2 Incidence statistics

Research show that in developing countries, HIE occurs in 1-6 per 1000 live births and 26 per 1000 live births. The vast majority of patients have severe symptoms, which deserves everyone's attention. A clinical study, CT diagnosis of 175 patients with HIE was analyzed. Among the 175 patients with HIE, 32 were normal, 44 were mild, 52 were moderate, and 47 were severe. Among the 89 patients reviewed, 65 cases of cerebral atrophy, 51 cases of encephalomalacia, 21 cases of hydrocephalus, 8 cases of cerebral calcification, and 11 cases of no obvious abnormalities. The research shows that the effects of iron on the fetus should not be ignored.

2.2.3 Prevention and treatment

Pregnant women should have regular prenatal. checkups during pregnancy to ensure the health of the mother and child. People can also take iron supplements in moderation. Timely detection and treatment of risk factors that may prevent fetal hypoxia. After birth, newborns should pay attention to warmth, feeding and care, to avoid hypoglycemia, low blood pressure and other factors that may lead to brain hypoxia.

3. Excess Iron Intake

Pregnant women need to take iron supplements under the guidance of a doctor to ensure that the intake of iron is neither too much nor too little. Excessive iron intake can lead to a range of adverse effects, such as, gestational diabetes, acute iron poisoning. Gestational diabetes can increase health risks for pregnant women and the fetus, acute iron poisoning can lead to serious physical damage, and diarrhea can affect the absorption of nutrients in pregnant women and the normal development of the fetus.

3.1. Gestational Diabetes

Studies have shown that high iron intake can increase the risk of gestational diabetes in pregnant women. A study compared 107 patients with 214 healthy women and found that during the first three months of pregnancy, women with the highest levels of ferritin had more than twice the risk of developing gestational diabetes compared with women with the lowest levels of ferritin. A control study included 142 patients with gestational diabetes as the observation group and 108 normal pregnant women as the control group. Both groups received their first prenatal examination at 12 weeks of gestation, confirmed gestational diabetes (24-28 weeks of gestation), measured their body mass, and detected serum iron metabolism, blood sugar and insulin levels. And it turns out, Serum iron (14.12 μ mol/L) and serum ferritin (177.45 μ g/L) levels in observation group were higher than those in control group (9.85, 127.36), fasting blood glucose, fasting insulin and HOMA-IR levels were higher than those in control group (all $P < 0.05$). It is suggested that pregnant women should reduce iron load to prevent the occurrence of gestational diabetes [8].

3.1.1 Mechanism and epidemiological characteristics

Iron is an oxidizing agent, and when consumed in excess, it can damage the pancreas, especially affecting the synthesis and secretion of insulin in the pancreas. Insulin is a key hormone that regulates blood sugar, and if its synthesis or secretion is interfered with, it can lead to abnormal blood sugar control, which increases the risk of diabetes in pregnant women. Some studies believe that patients with iron deficiency anemia during pregnancy may lead to premature rupture of membranes, hypertensive diseases during pregnancy, puerperal infection and other undesirable maternal and infant outcomes or pregnancy complications.

3.1.2 Incidence statistics

In the year 2017, the International Diabetes Federation (IDF) reported that 14% of cases worldwide are related to gestational diabetes, with rates as high as 9% in Africa, 12.6% in North America, and 21% in Asia. China had an 11.91% prevalence of gestational diabetes, significantly greater than that of Japan, South Korea, and Thailand, which had prevalence rates of less than 8.0%, according to a review looking into the prevalence of the disease across East and Southeast Asia. Due to changes in lifestyle and increasing Westernization, including dietary habits and physical inactivity, as well as increased awareness of gestational diabetes screening, China has seen a sharp increase in the prevalence of gestational diabetes [9]. In the fourth to sixth months of pregnancy, the gap can reach nearly four times. An investigation of the risk relationship between baseline ferritin concentrations and total and cause-specific mortality was reported in the Copenhagen Heart Study of 8,988 participants. The data reported to date suggest that increased ferritin concentrations represent an increased iron load in the body, which is common but by all means benign.

3.1.3 Prevention and treatment

During pregnancy, pregnant women should regularly consult a medical professional to learn about their nutritional needs and supplement plans. The doctor will give personalized advice and guidance according to the physical condition and nutritional status of the pregnant woman to ensure that the iron intake is within a reasonable range.

3.2. Iron Poisoning

Iron poisoning is generally due to thalassemia, active bone marrow hematopoietic, repeated blood transfusion, nutritional deficiency, drinking, taking medicine, eating too much iron-containing food and other reasons to cause damage to intestinal epithelial cells, intestinal epithelial cells are damaged. Iron is the main cause of poisoning death in young children. Since perinatal iron treatments are common, these iron supplements can be dangerous to the mother and fetus at home. Failure to recognize the seriousness of iron poisoning can lead to adverse and poor levels of intervention.

3.2.1 Mechanism

Toxic in and of itself is iron. During typical reductive oxidation processes, iron can acquire a broad spectrum of reductive oxidation potentials and can take part in numerous electron transport reactions. When the body requires more iron than it can metabolize, a low molecular weight iron reservoir known as a mobile iron reservoir arises. This reservoir affects the body's natural respiratory products, including hydrogen peroxide and superoxide anions. Fe^{2+} in the Fenton reaction (the first reaction) or the Haber-Weiss reaction (the second reaction), or free ions or oxygen linked to the $\text{Fe}^{2+}/\text{Fe}^{3+}$ complex, catalyzes the extremely dangerous hydroxyl radical ($\bullet\text{OH}$). Ascorbic acid or O_2^- (third reaction) can decrease Fe^{3+} to release additional free radicals [10]. Iron intake can cause direct burns to the gastrointestinal mucosa, leading to nausea, vomiting, abdominal pain, and diarrhea. A large amount of fluid and blood loss can lead to low blood volume. Iron poisoning remains a significant toxicological problem with significant effects on the gastrointestinal tract and circulatory system.

3.2.2 Incidence statistics

In one study of 40 children hospitalized for iron poisoning, children whose mothers gave birth to siblings were nearly twice as likely to be hospitalized for iron poisoning within six months of birth as children whose mothers did not give birth to siblings. The postpartum year was associated with a consistently elevated risk, including a nearly four-fold increase in the risk of iron poisoning in the first month postpartum [11]. The risk of iron poisoning immediately after delivery is almost four times higher, which may reflect the family dynamics of caring for a newborn. Alternatively, it may be related to the different nature of maternal iron treatment after delivery, and the treatment may be specifically used to treat postpartum anemia.

3.2.3 Prevention and Treatment

Pregnant women should avoid taking calcium and iron supplements at the same time when supplementing nutrients. Because calcium and iron compete for absorption in the gut, simultaneous intake may affect each other's absorption, increasing the risk of iron overload. The iron content of foods may change over long periods of storage, especially iron-rich foods. Pregnant women should try to eat fresh ingredients and avoid storing or eating expired food for a long time. Pregnant women should pay close attention to their body's reaction during iron supplementation. If patients have nausea, vomiting, diarrhea, abdominal pain and other uncomfortable symptoms, patients should seek medical attention and inform your doctor about your iron supplementation. In cases of severe poisoning, intravenous removal of feloxamine is required, along with supportive care and special attention to maintaining intravascular volume.

When there is evidence of gastrointestinal bleeding, other critical actions include replenishing blood components and treating coagulation and acidosis issues. Rarely, surgical removal may be necessary if there is a significant amount of iron present in the gastrointestinal tract. Furthermore, treatments like blood transfusions and hemodialysis have to be saved for unusual poisonings that have not responded to more cautious approaches. Rarely, late consequences of iron toxicity can include gastrointestinal scarring with obstruction and liver damage [12]. Pregnancy is a major risk factor for the development of iron poisoning in young children, and the period after childbirth is the greatest risk. In all cases where young children are hospitalized for iron poisoning, placing iron out of reach of young children can reduce the incidence by half, and is the main preventive measure [13].

4. Conclusion

Iron intake has a significant impact on the health of pregnant women and infants. For pregnant women, iron is a key element in maintaining healthy blood and is essential for preventing anemia, ensuring maternal health and normal fetal development. During pregnancy, due to the growth and development of the fetus and the increase in maternal blood volume, the demand for iron in pregnant women will increase significantly. Therefore, a moderate intake of iron is necessary to maintain the health of pregnant women and the development of the fetus.

However, if pregnant women consume too much iron, it may cause a series of health problems. Excessive iron intake increases a pregnant woman's risk of developing gestational diabetes, which may need to be managed with medication and dietary control. At the same time, iron overload can also lead to acute iron poisoning, a serious condition that requires urgent medical intervention. In addition, excessive iron may also cause diarrhea, nausea, vomiting and other gastrointestinal symptoms, affecting the quality of life of pregnant women.

For babies, iron is a crucial nutrient for growth and development. However, similar to pregnant women, excessive iron intake in infants may also have adverse consequences. Excessive iron intake may lead to nausea, vomiting, diarrhea and other gastrointestinal symptoms in infants, and in severe cases, iron poisoning may occur, affecting the health and development of infants. In addition, excess iron may also affect the baby's appetite and immune function, increasing the risk of infection.

Therefore, whether pregnant women or infants, iron intake should be strictly controlled and carried out under the guidance of a doctor. Pregnant women and families of infants should pay attention to their eating habits and ensure that they consume iron-rich foods while avoiding excessive iron intake. For pregnant women and infants at risk of iron deficiency or iron overload, regular blood tests should be performed so that problems can be detected and dealt with in a timely manner. Moderate iron intake helps maintain their health, while excessive iron intake can have a range of adverse consequences. Therefore, when guiding the dietary arrangements of pregnant women and infants, doctors need to pay special attention to the intake of iron to ensure that their health is protected to the greatest extent.

References

- [1] Pai RD, Chong YS, Clemente-Chua LR, Irwinda R, Huynh TNK, Wibowo N, Gamilla MCZ, Mahdy ZA. Prevention and Management of Iron Deficiency/Iron-Deficiency Anemia in Women: An Asian Expert Consensus. *Nutrients*. 2023 Jul 13;15(14):3125. doi: 10.3390/nu15143125. PMID: 37513543; PMCID: PMC10383547.
- [2] Petry CJ. Iron Supplementation in Pregnancy and Risk of Gestational Diabetes: A Narrative Review. *Nutrients*. 2022 Nov 12;14(22):4791. doi: 10.3390/nu14224791. PMID: 36432476; PMCID: PMC9695730.
- [3] Wu Ling, Li Jiabi, Feng Yinzong, Li Ling. Clinical characteristics and risk factors of iron deficiency anemia in pregnant women. Department of Obstetrics, Jiangmen Maternal and Child Health Hospital, Jiangmen 529030, Guangdong, China. *Modern Medicine and Health Research*. 2022 Vol.6 No.2; doi: 2096-3718.2022.02.0112.04
- [4] Shi H, Chen L, Wang Y, Sun M, Guo Y, Ma S, Wang X, Jiang H, Wang X, Lu J, Ge L, Dong S, Zhuang Y, Zhao Y, Wei Y, Ma X, Qiao J. The severity of anaemia during pregnancy and adverse maternal and fetal outcomes. *JAMA Netw*. February 1, 2022;5(2):e2147046. doi: 10.1001/jamanetworkopen.2021.47046. PMID: 35113162; PMCID: PMC8814908.
- [5] Tian ML, Ma GJ, Du LY, Xiao YG, Zhang YK, Tang ZJ. Prevalence and adverse perinatal outcomes of anaemia in the third trimester of pregnancy in Hebei Province, China. *Int Health*. 2024 Jan 2;16(1):91-96. doi: 10.1093/inthealth/ihad028. PMID: 37093789; PMCID: PMC10759283.
- [6] Yang Wei, Guo Sumei, Wang Xuemei. Investigation and influencing factors of iron deficiency anemia in 300 children aged 0~6 years in Beijing. *Chinese Journal of Woman and Child Health Research*. 2015, V01.26 No.1. doi: 10.3969 / j.issn.1673-5293.2015.01.017
- [7] Skolmowska D, Głabska D, Kołota A, Guzek D. Effectiveness of Dietary Interventions in Prevention and Treatment of Iron-Deficiency Anemia in Pregnant Women: A Systematic Review of Randomized Controlled Trials. *Nutrients*. 2022 Jul 23;14(15):3023. doi: 10.3390/nu14153023. PMID: 35893877; PMCID: PMC9332092.
- [8] Lin Yuju, Xie Dong, Lin Mei. Relationship between body mass index, serum iron metabolism and insulin resistance in patients with gestational diabetes mellitus [J]. *Chinese Journal of Family Planning*, 2019, 30(8):1762-1765.
- [9] Juan J, Yang H. Prevalence, Prevention, and Lifestyle Intervention of Gestational Diabetes Mellitus in China. *Int J Environ Res Public Health*. 2020 Dec 18;17(24):9517. doi: 10.3390/ijerph17249517. PMID: 33353136; PMCID: PMC7766930.
- [10] Rafati Rahimzadeh M, Rafati Rahimzadeh M, Kazemi S, Moghadamnia AR, Ghaemi Amiri M, Moghadamnia AA. Iron; Benefits or threatens (with emphasis on mechanism and treatment of its poisoning). *Human & Experimental Toxicology*. 2023;42. doi:10.1177/09603271231192361
- [11] Juurlink DN, Tenenbein M, Koren G, Redelmeier DA. Iron poisoning in young children: association with the birth of a sibling. *CMAJ*. 2003 Jun 10;168(12):1539-42. PMID: 12796332; PMCID: PMC156684.
- [12] Banner W Jr, Tong TG. Iron poisoning. *Pediatr Clin North Am*. 1986 Apr;33(2):393-409. doi: 10.1016/s0031-3955(16)35010-6. PMID: 2870463.
- [13] Haddad LM. Iron poisoning. *JACEP*. 1976 Sep;5(9):691-3. doi: 10.1016/s0361-1124(76)80101-3. PMID: 14273.