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Anemia Prevalence among Pregnant Women and Birth Weight in Five Areas in China

A.G. Ma[b] E. Schouten[a] Y. Wang[c] R.X. Xu[d] M.C. Zheng[e] Y. Li[a] Y.Y. Sun[b] Q.Z. Wang[b]

[a]Human Nutrition Division, Wageningen University, Wageningen, The Netherlands; [b]Institute of Human Nutrition, Medical College of Qingdao University, Qingdao, [c]Lanzhou Medical College, Lanzhou, [d]Fujian Medical University, Fuzhou, and [e]Guilin Medical College, Guilin, P.R. China

Key Words
Anemia · Prevalence · Pregnancy · Birth weight · Education

Abstract
Objectives: To investigate the current prevalence of anemia among pregnant women in different areas of China and the association with birth weight and educational level. ***Methods:*** A total of 6,413 women aged 24–37 in the third trimester of pregnancy from five areas were randomly selected from all gravidas who gave birth in the hospitals from 1999 to 2003. Blood hemoglobin concentration (Hb) was measured by the cyanomethemoglobin method; Hb <110 g/l was considered as anemia. ***Results:*** The overall prevalence of anemia was 58.6%, ranging from 48.1 to 70.5% in the five areas. There was a significant difference in the prevalence of anemia between women who have mental jobs and those who have physical jobs (52.3 vs. 61.1%, $p < 0.01$). The prevalence of anemia depended on the level of education: with 52.9, 62.4 and 66.5%, for college, secondary school and primary education, respectively, and the difference was statistically significant ($p = 0.005$). Results showed that higher birth weight was associated with Hb concentrations ranging from 90 to 140 g/l, whereas lower birth weight occurred below 80 g/l and above 140 g/l Hb. ***Conclusions:*** The prevalence of anemia in Chinese pregnant women was high both in rural areas and towns. Area of residence, education level and type of job influenced the prevalence of anemia. Low maternal Hb concentrations influenced birth weight.

Introduction

Anemia is the scourge of the Third World [1] and it remains a major problem in nearly all developing and many industrialized countries [2]. Pregnant women are at risk especially during the last trimester of pregnancy. The prevalence of anemia (hemoglobin, Hb <110 g/l) in Chinese pregnant women in the third trimester was 48% during 1995–2000 [3], and the prevalence of iron deficiency and iron deficiency anemia was 42 and 19%, respectively [4]. Notwithstanding the fact that the diagnosis of anemia is fairly simple and treatment is cheap, the prevalence of anemia remains high in developing towns, as well as in the wide countryside and poverty-stricken areas of China.

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Ai Guo Ma
Institute of Human Nutrition
Medical College of Qingdao University
38 Dengzhou Road, 266021 Qingdao (P.R. China)
Tel. +86 532 8299 1503, Fax +86 532 8381 2434, E-Mail aiguom502@hotmail.com

In pregnant women, a favorable iron status is a prerequisite for a good course of pregnancy. There is evidence that iron deficiency, even in the absence of iron deficiency anemia, may have a negative impact in nonpregnant women, e.g. in terms of decreased cognitive ability and physical performance [5]. In pregnant women it may impair fetal and infant development [6]. Low maternal hemoglobin levels are associated with increased risk of preterm delivery and low birth weight [7, 8]. Prenatal prophylactic iron supplementation deserves further examination as a measure to improve birth weight and potentially reduce health care costs [9]. A randomized controlled trial suggested that prophylactic iron supplementation begun in early pregnancy can reduce third-trimester anemia and improve birth outcomes [10]. However, a recent study showed that anemia during early pregnancy was not associated with increased risk of adverse perinatal outcomes, and anemia in later pregnancy was inversely associated with preterm birth and low birth weight [11]. Therefore, the relationship between hemoglobin concentrations and birth weight is still not clear. The purpose of this study was to investigate the prevalence of anemia in geographically different locations in pregnant women in China, and describe the associations of hemoglobin concentrations with birth weights.

Subjects and Methods

Subjects

A cross-sectional study was designed. Because China has a large population and geographical area, five areas were randomly selected: rural areas of Qingdao in the east, Fuzhou in the southeast, urban areas of Lanzhou in the northwest and Guilin in the southwest, and a suburban district of Liaocheng in central China during 1999–2003. Also 6,413 subjects were randomly enrolled by the order of registration number, 1, 5, 10, 15, 20, etc. for routine pregnancy examination from the local population of pregnant women. With respect to geographical and other conditions like lifestyle, they can be regarded as representative of the large variation present in China, except for remote areas. Subjects included in the study were healthy pregnant women who gave birth after 35–42 weeks of gestation without delivery complications, such as hypertension. Furthermore, subjects did not experience abnormal bleeding, take iron and multivitamin supplements, smoke tobacco products, or drink alcoholic beverages during pregnancy. Demographic data were collected by questionnaires that were used routinely nationwide on admission to hospital for delivery. Venous blood samples were collected from the 6,413 subjects within 1–2 weeks before delivery for hemoglobin analysis.

The protocol was approved by the ethics committees of local hospitals in five sites. Informed consent was obtained from each of the pregnant women recruited.

Method and Criteria for Diagnosis of Anemia

Blood hemoglobin concentration was measured by the cyanomethemoglobin method within 2–4 h [12]. Based on the report of the International Anemia Consultative Group [13], Hb <110 g/l was considered as anemia.

Statistical Analysis

Differences were tested using Student's t test and the χ^2 test. The SPSS (11.0) statistical software was used. The percentile distributions of hemoglobin concentrations were compared among the five sites. The association of hemoglobin concentrations and birth weight was described by simple line (summarized for groups of cases). Two-paired $p < 0.05$ was considered statistically significant.

Results

Among the 6,413 pregnant women screened, the overall prevalence of anemia was 58.6%. The prevalence within the five centers ranged from 48.1 to 70.5% as shown in table 1 and figure 1. Higher rates of anemia were observed in Qingdo and Fuzhou (69.9 and 70.5%, respectively) than in Liaocheng, Lanzhou and Guilin (55.6, 51.3, 48.1%, respectively), and the difference was statistically significant ($p < 0.001$). Prevalence of anemia was less in women who had a mental job (52.3%) than in those with manual jobs (61.1%, $p < 0.01$). Also, the prevalence of anemia was significantly different according to educational level: 52.9, 62.4 and 66.5%, respectively for college, secondary and primary education (table 2).

The mean ages in the anemic and nonanemic groups were similar (27.0 and 27.1 years). Results showed that higher birth weight was associated with hemoglobin concentrations ranging from 90 to 140 g/l (fig. 2). However, lower birth weight was observed at 80 g/l and above 140 g/l Hb.

Discussion

In this study we observed a very high prevalence of anemia in the third trimester of pregnancy, indicating that anemia in pregnant women is still a severe problem particularly in rural areas. Probable explanations include an unbalanced diet and poor nutritional education [14]. People living in rural areas have lower income and less varied diets than those living in urban areas.

Anemia during pregnancy is defined according to WHO guidelines as Hb <110 g/l, while nutritional anemia includes iron-deficiency anemia, cobalamin-defi-

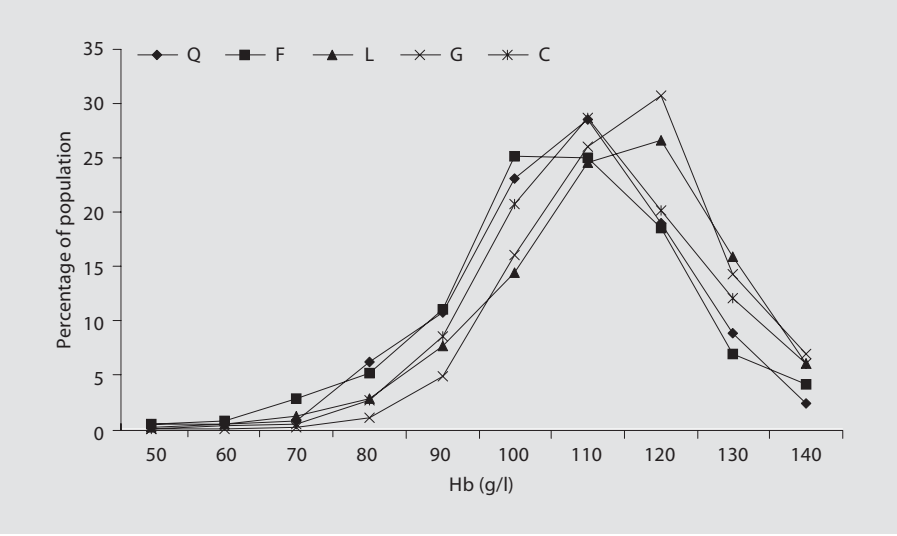

Fig. 1. Distribution of hemoglobin concentrations in five geographical areas (percentage of the population). In Lanzhou (L) and Guilin (G) hemoglobin values peak at about 115 g/l, while in Qingdao (Q), Fuzhou (F) and Liaocheng (C) peaks are in the range of 95–105 g/l. The difference among the peaks is about 10–20 g/l.

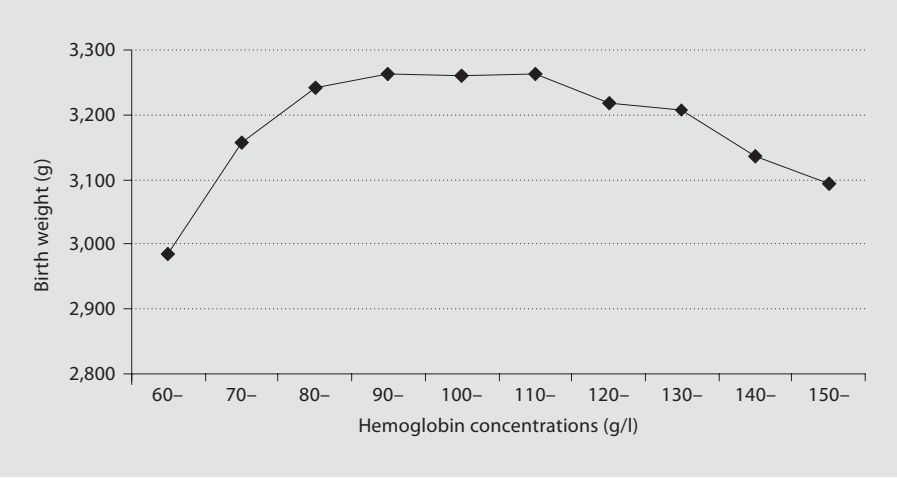

Fig. 2. Association of average hemoglobin concentrations with birth weight in 6,413 pregnant women. Higher birth weight correlates with Hb concentrations of 90–140 g/l. However, lower birth weight is associated with Hb values <80 g/l and >140 g/l.

Table 1. Prevalence of anemia and Hb distribution in five sites

Sites	Total number	Anemia %	Hb distribution, g/l		
			70–≤90	>90–<110	≥110
Qingdao	1,085	69.9	19.6	50.3	30.1
Fuzhou	1,023	70.5	20.3	50.2	29.4
Liaocheng	2,363	55.6	11.1	44.5	44.4
Lanzhou	1,003	51.3	7.7	43.6	48.7
Guilin	939	48.1	5.2	42.9	59.1
Total	6,413	58.6	12.7	46.4	40.9

Table 2. Prevalence of anemia according to work type and education in pregnant women

	Total number	Anemic number	Prevalence, %	p value
Work types (n = 6,140)				
Mental	1,339	700	52.3	<0.001
Physical	4,801	2,942	61.1	
Educational level (n = 4,624)				
College	665	352	52.9	
Secondary school	2,307	1,439	62.4	<0.005
Primary school	1,652	1,098	66.5	

ciency anemia, folate-deficiency anemia, copper-deficiency anemia, etc. Nutritional anemia is considered to be related to deficiencies of multinutrients [15], and iron-deficiency anemia alone or iron deficiency combined with folate or other nutrient deficiencies account for more than 85% of nutritional anemias [16]. The purpose of our study was to investigate the prevalence of overall anemia, and the status of multinutrients in addition to iron deficiency. A study by Ma et al. [17] showed that subjects with iron-deficiency anemia had much higher rates of vitamin C, folate and vitamin B_{12} deficiencies than nonanemic subjects, and especially the deficient rates of ascorbic acid and folate in the anemia (Hb <110 g/l) group reached 64.04 and 22.70%, respectively, and decreasing hemoglobin concentrations were accompanied by decreases in serum levels of vitamin A, ascorbic acid, folate and vitamin B_{12}. So multiple vitamin deficiencies, especially ascorbic acid, retinol and folic acid, may be associated with anemia or iron deficiency in pregnant women in the last trimester. So the study suggested that anemic pregnant women in China should be supplemented with iron and multiple vitamins simultaneously [17].

The level of education may influence the health and nutritional status of individuals as reported by Abel et al. [18] and a combination of education and iron supplementation could improve the hematological status of pregnant women in a rural community during each of the three trimesters. Our finding that the prevalence of anemia among pregnant women increased with lower level of education confirmed the report by Abel et al. [18]. Other researchers reported that there were no statistically significant differences in iron-deficiency anemia and iron-related dietary practices based on education, and relatively few differences based on where participants live, their available financial resources, or their position (pregnant women or young women) [19]. Bondevik et al. [20] found that the risk of anemia increased with the duration of pregnancy. Work within the service professions, higher education and higher body mass index were associated with a lower risk of anemia. A similar study about the effect of nutritional education on anemia and malnutrition of infants and children in rural China was carried out in the past 5 years. After 1 year, the mothers in the education group showed significantly higher nutrition knowledge and reported better infant feeding practices than the control group. Type of job was also related to the prevalence of anemia. A likely explanation might be that women with a mental job have better education, incomes and living conditions.

Strong evidence exists for an association between maternal hemoglobin concentration and birth weight as well as between maternal hemoglobin concentration and preterm birth [21]. Although high hemoglobin (>120 g/l) during the second and third trimesters significantly increased the risk of low birth weight (RR = 3.11) [3], mild and moderate anemia did not increase the risk of preterm delivery and low birth weight statistically [22]. The lowest incidence of preterm delivery and low birth weight was found among pregnant women with Hb levels at 90–99 g/l. The risk for preterm delivery and low birth weight increased with either increasing or decreasing hemoglobin concentrations. Women with severe anemia (Hb <70 g/l) had an 80% higher risk of preterm delivery and a 4-fold higher risk of low birth weight compared with women with an Hb value of 90–99 g/l. In addition, women with a high Hb concentration (Hb >130 g/l) had a 20% higher risk of preterm delivery and a 50% higher risk of low birth weight [22]. Moreover, in this study, the distribution of hemoglobin concentrations showed that both lower (Hb <80 g/l) and higher hemoglobin concentrations (Hb >140 g/l) might result in deviations from normal birth weight (2,500–4,000 g). Birth weight correlates negatively with maternal hemoglobin concentration. Anemia (by causing hypoxia) and iron deficiency (by increasing serum norepinephrine concentrations) can induce maternal and fetal stress, which stimulates the synthesis of corticotropin-releasing hormone (CRH). Elevated CRH concentrations are a major risk factor for preterm labor, pregnancy-induced hypertension and eclampsia, and premature rupture of membranes. CRH also increases fetal cortisol production, and cortisol may inhibit the longitudinal growth of the fetus. An alternative mechanism could be that iron deficiency increases oxidative damage to erythrocytes and the fetoplacental unit. Iron deficiency may also increase the risk of maternal infections, which can stimulate the production of CRH and which are a major risk factor for low birth weight and preterm delivery [23]. Association between maternal hemoglobin concentration and birth weight needs more attention because reducing the incidence of low birth weight not only lowers infant mortality rates but also has multiple benefits over the life cycle [24].

Conclusion

The high prevalence of anemia in pregnant women is still a nationwide nutritional problem in China. In rural areas the situation seems to be less favorable than in ur-

ban areas, partly because of lower socioeconomic status, low education and training. Because this study showed that high hemoglobin concentration might increase or decrease birth weight, further study is needed to reconfirm this finding.

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