ANEMIA IN CENTRAL ASIA: DHS EXPERIENCE

Almaz Sharmanov, MD, PhD

Health specialist, Demographic and Health Research Division (DHS), Macro International Inc., Calverton, MD, USA

Abstract

Nationally representative anemia levels among women and children were recently determined in conjunction with the 1995 Kazakstan Demographic and Health Survey, 1996 Uzbekistan Demographic and Health Survey and 1997 The Kyrgyz Republic Demographic and Health Survey. Anemia was assessed by measurement of the hemoglobin (Hb) level in capillary blood of women age 15-49 and their children under the age of three using the photometric Hemocue technique. The numbers of women tested for anemia were 3,658, 4,333 and 3760 in Kazakstan, Uzbekistan and the Kyrgyz Republic, respectively.

The studies revealed high prevalence of anemia in all three Central Asian republic with the highest overall rates observed in the regions of Kazakstan and Uzbekistan located in close proximity to the Aral Sea area characterized by severe agrochemical pollution and other environmental and socio-economic problems. Approximately, half (49 percent) of the women in Kazakstan, 60 percent of the women in Uzbekistan and 40 percent of the women in the Kyrgyz Republic suffered from some degree of anemia. Mild anemia with Hb level 10.0 - 11.9 g/dl (10.0 - 10.9g/dl for pregnant women) was diagnosed in 37, 45 and 28 percent of the women in Kazakstan, Uzbekistan and the Kyrgyz Republic, respectively. Eleven percent of the women in Kazakstan, 14 percent of the women in Uzbekistan and 9 percent of the women in the Kyrgyz Republic had moderate anemia (Hb level: 7.0 - 9.9 g/dl. Severe anemia (Hb level less than 7.0 g/dl) was found among 1 percent of the women in all three Central Asian republics.

In Kazakstan, 69 percent of the children under the age of three suffered from some degree of anemia. About the same number of children had mild (30 percent) and moderate anemia (34 percent). A smaller, but substantial, proportion of children were severely anemic (5 percent). In Uzbekistan and the Kyrgyz Republic, the percentages of children suffering from anemia were 61 and 50 percent, respectively. The percentages of children with mild, moderate and severe anemia were 34, 26 and 1 percent, respectively, for Uzbekistan, and 24, 24 and 1 percent, respectively, for the Kyrgyz Republic.

Thre are sufficient evidence to suggest that negative iron balance is probably a major cause of anemia among both women and children in Central Asia. Our findings provide important information for development of health intervention programs to prevent iron-deficiency anemia among women of certain ethnic, educational and residential groups in this region. Based on the results of DHS as well as other geographically focused studies, UNICEF Area Office for the Central Asian Republics and Kazakstan, proposed an integrated strategy of education, supplementation, fortification and research to address the problem and called for donors support. It is expected that this approach can considerably improve maternal and child health in Central Asia.

Introduction

Anemia is a condition which is characterized by reduction in red blood cell volume and a decrease in the concentration of hemoglobin in the blood. Commonly, anemia is the final outcome of nutritional deficiency of iron, folate, vitamin B_{12} and some other nutrients. Although many other causes of anemia, such as hemorrhage, infection, genetic disorders or chronic disease, have been identified, nutritional deficiency due primarily to a lack of bioavailable dietary iron accounts for the majority of cases of anemia [1-4].

Anemia is known as having detrimental health implications, particularly for mothers and young children. Compared to non-anemic mothers, unfavorable pregnancy outcomes have been

23

reported to be more common in anemic mothers [2,5]. Women with severe anemia can experience difficulty meeting oxygen transport requirements near and at delivery, especially if significant hemorrhage occurs. This may be an underlying cause of maternal death, prenatal and perinatal infant loss [6-8]. Iron deficiency anemia among children has been demonstrated in many studies to be associated with impaired cognitive performance, motor development, coordination, language development and scholastic achievement [5,9]. Anemia increases morbidity from infectious diseases because several immune mechanisms are adversely affected.

Anemia due to iron deficiency is recognized as a major public health problem throughout the world. According to the epidemiological data collected from multiple countries by the World Health Organization, some 35 percent of women and 43 percent of young children in the world are affected by anemia [5,10]. In developing countries, about half of the women and young children are anemic [5,11,12]. In US and in Europe, the prevalence of anemia is 7 to 12 percent among women and children [13,14]. The highest overall rates of anemia is reported in southern Asia and certain regions of Africa.

Anemia has been considered to be among the leading public health problems in Central Asia for decades. According to the 1988 nutrition survey conducted by the Nutrition Institute in four regions of Kazakstan, 60 percent of non-pregnant and non-lactating women and 60 to 80 percent of pregnant women were diagnosed as having anemia based on hemoglobin and hematocrit measurement [15]. The study conducted in 1993 by Crosslink group in Muynak District of adjoining Uzbekistan, found anemia levels of over 60 percent for women of reproductive age and of approximately 80 percent for children under the age of three [16]. Because of correspondingly low serum levels of iron and ferritin, iron deficiency was recognized to be major cause of anemia among women and young children in that area. In a July 1994 study of women and children in Kazalinsk District of Kzyl-Orda Region of Kazakstan conducted by the London Institute of Tropical Medicine and Kazakstan Institute of Geography, the prevalence of anemia among women age 15-45 was estimated as 46 percent, among the children aged 6-60 months as 64 percent [17].

With the socio-economic changes taking place in the former Soviet Union in the last few years, the probability that the prevalence of anemia may have increased in Central Asia, is of great public health concern. Testing women and children for iron-deficiency anemia was one of the major efforts of 1995 Kazakstan Demographic and Health Survey (KDHS), 1996 Uzbekistan Demographic and Health Survey (UDHS), and 1997 the Kyrgyz Republic Demographic and Health Survey (KRDHS). These were the first anemia studies done in Central Asian republics on a nationally representative sample. The purpose of this presentation is to summarize the results of anemia testing and to examine the systematic differences in hemoglobin concentrations between certain population groups in Kazakstan, Uzbekistan and the Kyrgyz Republic.

Methods

The KDHS sample design

The KDHS was conducted between May 15 and August 30, 1995 by the Institute of Nutrition of the Kazakstan National Academy of Sciences. A detailed description of the survey design was published [18]. The survey employed a nationally representative and multi-stage probability sample of women between the ages of 15 and 49. The primary information for the sampling was obtained from the 1989 Census, data from the Goskomstat, National Statistical Office, and the Ministry of Health of Kazakstan. The country was divided into 5 survey regions. With the exception of capital city of Almaty, which constituted a survey region by itself, the other four survey regions were groups of contiguous oblasts located in the South, West, Central and North-East of Kazakstan.

In total, 4,480 households were selected from 176 sampling areas, which yielded 3,899 women who were eligible for the anemia testing (i.e. all women 15-49 years of age who were either usual residents or visitors and who had spent the previous night in the household). Anemia testing was done with 3,658 of these women and 739 their children born since January 1992.

The UDHS sample design

The KDHS was conducted between June 24 and October 12, 1996 by the Institute of Obstetrics and Gynecology, Ministry of Health of Uzbekistan. A detailed description of the survey design was published [19]. The survey employed a nationally representative and multi-stage probability sample of women between the ages of 15 and 49. The primary information for the sampling was obtained from from the Goskomprognozstat, National Statistical Office, and the Ministry of Health of Uzbekistan. The country was divided into 5 survey regions. With the exception of capital city of Tashkent, which constituted a survey region by itself, the other four survey regions were groups of contiguous oblasts located in the Aral Sea area, Central, Eastern and Ferghana Valley regions.

In total, 3,945 households were selected from 164 sampling areas, which yielded 4,544 women who were eligible for the anemia testing which was done with 4,333 of these women and 1,106 their children born since January 1993.

The KRDHS sample design

The KRDHS was conducted between August 8 and November 8, 1997 by the Research Institute of Obstetrics and Pediatrics of the Ministry of Health of The Kyrgyz Republic. A detailed description of the survey design was published [20]. The primary information for the sampling was obtained from the National Statistical Office, and the Ministry of Health of the Kyrgyz Republic. The KRDHS employed a representative probability sample of women aged 15 to 49. Selected survey estimates were to be produced for four survey regions. The capital city of Bishkek and Narynskaya *oblast*,

which is located in the mountainous eastern part of the Kyrgyz Republic, constituted two survey regions by themselves (Bishkek City and East). The remaining two survey regions consisted of groups of contiguous *oblasts* located in the North and South of the Kyrgyz Republic.

In total, 3,821 households were selected from 168 sampling areas, which yielded 3,954 women who were eligible for the anemia testing which was done with 3,760 of these women and 980 their children born since January 1994.

The KDHS, UDHS and KRDHS were funded by the United States Agency for International development (USAID) and technical assistance was provided by Macro International Inc. (Calverton, Maryland USA) through its contract with USAID.

Informed Consent

Prior to participating in the study, respondents in the KDHS, UDHS and KRDHS were asked to sign a consent form giving permission for the collection of a blood droplet from herself and her children under the age of three. In addition, in case if a woman was diagnosed as having severe anemia (Hb level less than 7 g/dl) she was asked to sign another consent form giving permission to the study team to inform local health care facility about her condition.

Blood collection and Hemocue analyses

For hemoglobin measurement, capillary blood was taken from the finger using Tenderlett lancets (i.e., sterile disposable instruments that allow a relatively painless skin puncture). Hemoglobin was measured in the blood using the Hemocue system, that allows to detect the level of hemoglobin within a minute. This system consists of a battery operated portable photometer and a disposable cuvette which serves as both, blood collection device and the site where reaction occurs. The procedure was performed by specially trained medical personnel and confirmed to be accurate, precise and suitable for the various field conditions.

Diagnostic criteria

Levels of anemia were classified as severe, moderate, and mild based on the hemoglobin concentration in the blood and according to criteria developed by the World Health Organization (11). Severe anemia was diagnosed when hemoglobin concentration was less than 7.0 g/dl; moderate anemia when the hemoglobin concentration is 7.0 - 9.9 g/dl, and mild anemia when hemoglobin concentration is 10.0 - 11.9 g/dl (10 - 10.9 for pregnant women and children under age three).

Hb high altitude adjustments

The hemoglobin concentration in the blood is negatively regulated by the level of saturation of arterial blood with oxygen. The decline in the oxygen partial pressure with altitude is accompanied by decline in the saturation of arterial blood with the oxygen and increased concentration of

hemoglobin in the blood. Based on these relationships Hurtado et al. developed altitude hemoglobin level adjustments for the CDC Pediatric Nutrition Surveillance System (21).

For the population of The Kyrgyz Republic, which lives at altitudes that range from 488 meters (1,600 feet) in the Ferghana valley to a high of more than 3,000 meters (10,000 feet) in some areas of Narynskaya *oblast*, the high altitude is an important factor that could affect the level of hemoglobin in the blood and therefore should be considered in the calculation of anemia rates. For this reason, in the KRDHS, the rates of anemia were calculated using high altitude adjustment equations, according to which:

$$\textit{Adjusted level of altitude} = \textit{observed level} - \textit{adjustment coefficient}$$

Adjustment coefficient is calculated as follows:

$$\textit{Adjustment coefficient} = -0.032 \times (\textit{altitude}) + 0.022 \times (\textit{altitude}^2)$$

Altitude is measured as:

$$[\textit{altitude in meters}/1{,}000] \times 3.3$$

Ferritin assessment

In order to evaluate body iron stores the level of serum ferritin was tested in a small subsample of women of Almaty City with Hb values less than 10 g/dl. The blood for the ferritin testing was taken by venopuncture. The serum ferritin determined in duplicates with a commercially available enzyme immunoassay (ELISA) kit (Ramco, Laboratories Inc., Houston, USA) using a Titertek Multiscan R plus (EFLAB; Labsystems, Helsinki, Finland).

Statistical procedures

Data were entered and edited on microcomputers using the software package Integrated System for Survey Analysis (ISSA). Tabulations also used the ISSA package. In order to correct for differences in selection probabilities between the different survey regions, sampling weights have been applied to the data.

Results

Table 1 shows the results of anemia testing of women in Kazakstan. Almost half (49 percent) of women in Kazakstan were anemic. More than eleven percent of them had moderate or severe anemia with hemoglobin level less than 10 g/dl. The group with the highest prevalence of anemia were women of Western region of Kazakstan. Among them, nineteen percent were diagnosed as having moderate or severe anemia. The rates of moderate and severe anemia were higher among ethnic Kazaks as compared to ethnic Russians, and among rural women as compared to urban. Women with higher education were less frequently anemic than women with primary or secondary education. There were no significant differences in anemia rates across women's age except low frequency of the moderate anemia among the women of 15-19 year old.

As seen in table 2, 60 percent of the women in the UDHS survey had some degree of anemia. The great majority of these women had either mild (45 percent) or moderate anemia (14 percent). One percent had severe anemia. Differences in anemia status of women by age, residence, ethnicity and education were minor. However, differences by region were more marked. High rates of moderate and severe anemia were found in the Aral Sea region and in Ferghana Valley (23 and 25 percent, respectively), while Tashkent City had the lowest rate of moderate anemia (7 percent). No cases of severe anemia were diagnosed in Tashkent City.

Table 3 presents anemia rates for women in the Kyrgyz Republic. Thirty eight percent of the women in the KRDHS survey had some degree of anemia. Nine percent of these women had moderate anemia, and two percent were found to have severe anemia. High rate of moderate and severe anemia was found among women living in the South of the Kyrgyz Republic (12 percent). The rates of moderate and severe anemia were higher among rural women as compared to urban, and among ethnic Kyrgyz and Uzbek as compared to ethnic Russians or women of other ethnic groups.

Figure 1 shows the prevalence of moderate and severe anemia among pregnant, breastfeeding, and non-pregnant, non-breastfeeding women. In all three countries, among pregnant women, moderate and severe anemia was almost two to three times as prevalent than among nonpregnant women (breastfeeding or non-breastfeeding).

Figure 2 illustrates hemoglobin distributions of non-pregnant and non-lactating women. The entire hemoglobin distribution for women in each of three Central Asian countries is shifted downward (to the left) as compared to the distribution for healthy non-anemic U.S.women from the sample of the U.S. National Health and Nutrition Examination Survey (NHANES-II). The NHANES-II distribution can be used as a reference since individuals with abnormal MCV, transferrin saturation were excluded from distribution (Dr. Ray Yip, personal communication) [10].

Table 4 presents anemia rates for children in Kazakstan. A high national rate of anemia (69 percent) is seen among the children under the age of 3. One third of all children of Kazakstan are diagnosed as having moderate anemia. Five percent of children have developed severe anemia. Similarly to women, the highest prevalence of anemia was observed among the children of Western

region of Kazakstan. Almost half of them were moderately anemic, and 8 percent were severely anemic. The most pronounced differentials are observed in terms of the rates of severe anemia. The rate of severe anemia for ethnic Kazak children was 9 percent, while no ethnic Russian children were found to be severely anemic, and the rate for other ethnic groups was 1 percent. Similarly, rates of severe anemia for children of mothers with a primary/secondary education and for children residing in the Southern, Western and Central regions of Kazakstan were two to five times higher than rates for other groups of children. Children residing in rural area had severe or moderate anemia more frequently than urban children.

Table 5 presents anemia rates for children in Uzbekistan. Sixty-one percent of children under the age of three had some degree of anemia. Twenty-six percent had moderate anemia. One percent of children were severely anemic. Differences in overall rates of anemia by sex of the child, residence and education of the mother were relatively minor. However, as is the case with women, differences by region were substantial. More than half of the children (53 percent) living in the Aral Sea region were diagnosed as having moderate or severe anemia. Prevalence of moderate and severe anemia was also high in the East and Ferghana Valley (26 and 28 percent, respectively).

Table 6 presents anemia rates for children in the Kyrgyz Republic. Fifty percent of the children under the age of three had some degree of anemia. Twenty four percent had moderate anemia. One percent of children was severely anemic. Differences in overall rates of anemia by sex of the child, ethnicity, residence and education of the mother were relatively minor. However, as was the case with women, differences by region were substantial. Thirty two percent of the children living in the North and 24 percent of children living in the South and East of the Kyrgyz republic were diagnosed as having moderate or severe anemia. In Bishkek City, the prevalence of moderate anemia among children was relatively low (13 percent).

Certain relationships are observed between the prevalence of anemia among mothers and their children. Figure 3 shows cumulative data from Kazakstan, Uzbekistan and The Kyrgyz Republic on the prevalence of moderate or severe anemia among children according to the anemia status of their mothers. Among children of mothers with severe anemia, 68 percent were severely or moderately anemic. The percentages of children with moderate or severe anemia born to the mothers with moderate anemia were 46 percent, while for those children born to the mothers with mild anemia the percentage was 30. Only 24 percent of children born to non-anemic mothers were suffering from moderate or severe anemia, which is almost three times as low as among the children born to the mothers who were diagnosed as severely anemic at the time of the surveys.

Discussion

Nationally representative anemia levels among women and children were recently determined in conjunction with the three demographic and health surveys in Kazakstan (1995 KDHS), Uzbekistan (1996 UDHS) and The Kyrgyz Republic (1997 KRDHS). Anemia was assessed by measurement of the hemoglobin level in capillary blood of women age 15-49 and their children under the age of three using the photometric Hemocue technique. The studies showed that approximately, half (49 percent) of the women in Kazakstan, 60 percent of the women in Uzbekistan and 40 percent of the women in the Kyrgyz Republic had some degree of anemia. The percentages of children diagnosed as having anemia in Kazakstan, Uzbekistan and The Kyrgyz Republic were 69, 61 and 50 percent, respectively. There were some socio-economic, residential, demographic and ethnic differentials in the prevalence of anemia in each of these countries.

The highest overall rates of anemia were found in the Aral Sea region of Uzbekistan which includes authonomous Republic of Karakalpakstan and Khorezm oblast: 72 percent of women and 61 percent of children were anemic. This region of Uzbekistan is considered as part of the area of Aral Sea environmental crisis which is characterized by severe agrochemical pollution, lack of water and food supply, as well as number of other socio-economic problems. The rates of anemia in Western region of Kazakstan, which is also located in close proximity to the Aral Sea, were 59 percent among women and 81 percent among children.

Approximately half of children living in the Aral Sea region of Uzbekistan and Western region of Kazakstan have been diagnosed as having moderate anemia. Significant proportion of these children (more than 5 percent) were severly anemic. Usually patients with the severe anemia require medical assistance which is provided in clinical settings, while treatment of the moderate anemia can be accomplished by using public health approaches such as iron fortification or iron supplementation programs.

High rates of anemia found by the DHS anemia study in the Aral Sea areas of Uzbekistan and Kazakstan are in accordance with data from the two other recent studies: the 1993 Crosslink study in Muynak District of Uzbekistan (Morse, 1994), and the study done by the London School of Hygiene and Tropical Medicine in Kzyl-Orda oblast of Kazakstan (London School of Hygiene and Tropical Medicine, 1994). Both studies showed similarly high rates of anemia among women and children living in the area of environmental crisis around the Aral Sea.

Although many causes of anemia, such as hemoglobinopathies, parasitic infestation, chronic bleeding, folic acid and vitamin C deficiencies, have been identified, there is sufficient evidence to suggest that the majority of cases of anemia in Kazakstan are due to negative iron balance. Special study conducted in subsample of women living in Almaty City with Hb level below 10 g/dl (data not presented), showed that 41 out of 44 of these women also had low level of ferritin in their blood (ferritin level below 12 ng/dl).

Anemia represents only the severe end of iron deficiency, and the real magnitude of iron

deficiency in a population is greater than that reflected by hemoglobin measurement alone. Iron deficiency results primarily because of low consumption of food products containing bioavalable iron and promoters of iron absorption, such as animal protein and ascorbic acid. In a series of dietary assessment studies done by the Kazakstan Nutrition Institute during the last decade, an overall decrease of consumption of animal protein, essential vitamins and microelements by various population groups in Kazakstan has been documented [22]. Deficiencies of iron and other nutrients are especially critical during pregnancy and growth in early childhood.

When iron deficiency is the main etiologic factor of anemia, population groups with high iron requirement are disproportionately affected and more frequently develop anemia. Negative iron balance due to an imbalance of iron requirements versus iron intake often occurs during pregnancy and growth. For this reason, when iron deficiency is highly prevalent in a population, pregnant women, who provide the fetus with a considerable amount of iron, are at greater risk of developing anemia than non-pregnant women. In Central Asia, the prevalence of anemia among pregnant women is two-three times greater than among non-pregnant/non-lactating women. Our data also showed that percent distribution of non-pregnant and non-lactating women by the level of hemoglobin shifted towards the lower concentration of hemoglobin in the blood compared to the corresponding reference sample population of healthy US women.

Negative iron balance is probably also a major cause of anemia among young children in Central Asia. The highest rate of anemia among children in Kazakstan is found among age group of 12-24 months, which can be explained by rapid rate of growth during this period and the relatively low iron content of the diet. This is in accordance with several physiological studies which showed that the iron stores are more likely to become depleted between six months and two to three years of age [2,23-25]. In addition, relatively low consumption of meat products, a major source of bioavailable iron, plus the custom in Central Asia to give children tea, which inhibits iron absorption, could also lead to the depletion of iron stores and development of anemia. For example, according to supplemental foods assessment done in KDHS, UDHS and KRDHS, tea was given in the last 24 hours of interview to 21, 49 and 34 percent of infants 0-3 months of age in Kazakstan, Uzbekistan and the Kyrgyz Republic, respectively (18-20).

There are also some demographic predisposing factors which increase the likelihood of anemia in children. They include the age group 12-23 months, high birth order, birth interval of 24-47 months (data not presented). Our results also showed that having anemic mother increases the risk of moderate and severe anemia among children.

It is unlikely that hemoglobinopathies contribute substantially to the high prevalence of anemia in these regions. In the study by the Crosslink group, only 0.14% of individuals residing in Muynak district of Karakalpakstan were diagnosed as having hemoglobinopathy (thalassemia was not determined) (17). Considering common genetical features of people of Kazak and Karakalpak origin, the prevalence of hemoglobinopathies among the Kazaks is also probably low. However, without focused studies of the prevalence of hemoglobinopathies and α and β thalassemias it is difficult to exclude their role as etiologic factors of anemia in such regions as Ferghana Valley and Samarkand Oblast

of Uzbekistan, as well as Southern region of the Kyrgyz Republic, which characterized by high ethnic admixture and historically intensive migration process, and therefore, high chance of blood disorders among population.

The KDHS, UDHS and KRDHS findings, as well as other geographically focused studies, provide an important information base for development of health intervention programs to prevent many severe complications of pregnancy and delivery related to iron-deficiency anemia among women of certain ethnic, educational, and residential groups in Kazakstan, Uzbekistan and The Kyrgyz Republic. These data are important as a background for public health policy decisions that pertain to the iron fortification of food in these Central Asian republics of the former Soviet Union.

Since anemia represents only the severe end of the iron deficiency spectrum, it is assumed that the total proportion of iron deficient individuals in the population is greater than that reflected by the prevalence of anemia detected by hemoglobin measurement alone. It can be assumed that in Central Asia where the prevalence of anemia tested by hemoglobin measurement is higher than 40 percent among both, women and their children, the real magnitude of iron deficiency is greater, and therefore universal iron fortification or supplementation may be justified. Another solution would be to provide certain population groups, such as pregnant women and young children with selective supplementation of iron.

Based on the results of DHS anemia studies in Kazakstan and Uzbekistan, UNICEF Area Office for the Central Asian Republics and Kazakstan (UNICEF CARK), proposed an integrated strategy of education, supplementation, fortification and research to address the problem and called for donors support. The proposed strategy considered intervention approach and includes the following elements:

a) National and area-wide education and training efforts aimed at affordable and acceptable change in the environments of economic transition;

b) Fortification of cereal flour with iron

c) A major expansion for a period of two years of iron supplementation (weekly) to encompass women of reproductive age, children of 6-24 months of age, pregnant women;

d) For all persons found to be suffering from severe anemia current treatment practices would be retained;

e) A research agenda of key studies and monitoring activities by the Ministries of health and other institutions, beginning with a study of weekly supplementation effectiveness in all groups and action research on channels, messages and other factors that will be developed as part of the program.

Acknowledgments:

The author thanks Dr. Jeremiah M. Sullivan for his help in analysis of the anemia data, Mr. Trevor Croft for assistance with the tabulations, Ms. Thanh Lê for the KDHS sampling design, and all KDHS, UDHS and KRDHS fieldstaff for the anemia testing.

References

1. Hercberg S, Galan P: Nutritional anaemias. Baillièire's Clin Haematol 5:1:143, 1992

2. International Nutritional Anemia Consultative Group: Iron Deficiency in Women. INACG, World Health Organization. Geneva, Switzerland. 1989

3. International Nutritional Anemia Consultative Group: Iron Deficiency in Infancy and Childhood. INACG, World Health Organization. Geneva, Switzerland. 1979

4. Yip R, Dallman PR: The roles of inflammation and iron deficiency as causes of anemia. Am J Clin Nutr 48:1295-1300, 1988

5. Scrimshaw NS: Functional consequences of iron deficiency in human populations. J. Nutr Sci. Vitaminol. 30:47-63, 1984

6. Fleming AF: Maternal anaemia in northern Nigeria: causes and solutions. World Health Forum 8:339-343, 1987

7. Omar MM et al: Maternal health and child survival in relation to socioeconomic factors. Gynecol Obstet Invest 38:107-112, 1994

8. Thonneau P et al: Risk factors for maternal mortality: results of a case-control study conducted in Conakry (Guinea). Int J Gynecol Obstet, 39:87-92, 1992

9. Lozoff et al: Long-term development outcome of infants with iron deficiency. N Engl J Med 325:10:687-694, 1991

10. Yip R: Iron deficiency : contemporary scientific issues and international programmatic approaches. Symposium: Clinical nutrition in developing countries. 1479S-1490S, 1994

11. DeMaeyer E et al: Preventing and controlling iron deficiency anaemia through primary health care: A guide for Health administrators and programme managers. World Health Organization. 1989

12. Florentino RF, Guirriec R: Prevalence of nutritional anemia in infancy and childhood with emphasis on developing countries. Iron Nutrit Infancy Childhood. 61-74, 1984

13. Dallman PR et al: Prevalence and causes of anemia in the United States, 1976 to 1980. Am J of Clin Nutrit 39:437-445, 1984

14. Hallberg L: Iron nutrition in women in industrialized countries. Biblthca Nutr. Dieta, 30:111-123, 1981

15. Izmukhambetov T: Iron deficiency anemia and health of the population of Kazakstan. In: Iron deficiency anemia as regional problem in Kazakstan: epidemiological and nutritional aspects. 3-9, Alma-Ata, 1990

16. Morse C: A study of the prevalence and causes of anemia, Muynak district, Karakalpakistan, the Republic of Uzbekistan. Impact: Food Security and Nutrition Monitoring Project, USAID, Washington DC. 1994

17. Preliminary report of a survey on anaemia in the Kzyl Orda region of Kazakhstan by the London Institute of Tropical Diseases. IMPACT Project, USAID, Washington, 1994

18. National Institute of Nutrition of Kazakstan and Macro International Inc. 1996. *Kazakstan Demographic and Health Survey , 1995*. Calverton, Maryland: National Institute of Nutrition of Kazakstan and Macro International Inc.

19. Institute of Obstetrics and Gynecology, Ministry of Health of Uzbekistan and Macro International Inc. 1996. *Uzbekistan Demographic and Health Survey , 1996*. Calverton, Maryland: Institute of Obstetrics and Gynecology, Ministry of Health of Uzbekistan and Macro International Inc.

20. Institute of Obstetrics and Pediatrics, Ministry of Health of the Kyrgyz Republic and Macro International Inc. 19967. *Kyrgyz Republic Demographic and Health Survey, 1997, Preliminary Report*. Calverton, Maryland: Institute of Obstetrics and Pediatrics, Ministry of Health of the Kyrgyz Republic and Macro International Inc.

21. CDC Criteria for anemia in children and childbearing-aged women. MMWR, 38:400-404, 1989

22. Kazakstan National Nutrition Policy. Institute of Nutrition of the National Academy of Sciences, UNDP, UNICEF, WHO. Almaty, 1996

23. Cook JD, Bothwell TH: Availability of iron from infant foods. Iron Nutrition in Infancy and Childhood. 119-145, 1984

24. Lönnerdal B: Iron and breast milk. Iron Nutrition in Infancy and Children. 95-117, 1984

25. Oski FA: Iron deficiency in infancy and childhood. The N Engl J Med 329:3:190-193, 1993

Table 1 Anemia among women in Kazakstan

Percentage of women classified as having iron-deficiency anemia by background characteristics, KDHS 1995

Background characteristic	Percentage of women with:			Women measured	
	Severe anemia [a]	Moderate anemia [b]	Mild anemia [c]	Weighted	Un-weighted
Age					
15-19	0.4	6.4	38.8	657	650
20-24	0.6	11.4	39.0	557	566
25-29	0.9	10.5	35.8	514	518
30-34	2.1	11.8	39.4	539	536
35-39	1.5	12.2	37.4	552	546
40-44	0.8	10.1	34.0	521	486
45-49	2.0	13.8	33.0	344	356
Residence					
Urban	0.7	9.0	36.5	2,058	1,958
Rural	1.7	12.6	37.8	1,626	1,700
Region					
Almaty city	1.1	9.4	27.7	249	564
South	0.8	10.6	38.9	1,177	901
West	2.5	16.4	40.0	459	801
Central	0.7	8.0	35.1	354	718
North-East	1.1	9.5	36.8	1,445	674
Education					
Primary/Secondary	1.3	11.6	37.8	1,352	1,364
Secondary-Special	1.0	10.7	37.9	1,681	1,584
Higher	1.1	8.2	33.5	651	710
Ethnicity					
Kazak	1.9	14.3	40.7	1,654	1,885
Russian	0.7	7.2	33.8	1,283	1,141
Other	0.3	8.2	34.7	747	632
Total	1.1	10.6	37.1	3,684	3,658

[a] Hemoglobin level less than 7g/dl
[b] Hemoglobin level 7 - 9.9 g/dl
[c] Hemoglobin level 10 - 11.9 g/dl (10 - 10.9 g/dl for pregnant women)

Table 2 Anemia among women in Uzbekistan

Percentage of women classified as having anemia by background characteristics, UDHS 1996

Background characteristic	Percentage of women with: Severe anemia [a]	Moderate anemia [b]	Mild anemia [c]	Women measured: Weighted	Women measured: Un-weighted
Age					
15-19	0.6	10.4	45.3	964	916
20-24	0.9	16.6	45.0	792	791
25-29	0.6	16.4	45.5	697	679
30-34	1.2	16.3	45.8	615	603
35-39	1.6	14.6	47.0	551	557
40-44	0.8	11.5	45.4	414	423
45-49	1.1	13.3	41.5	300	305
Residence					
Urban	0.9	12.8	45.5	1,625	2,181
Rural	0.9	15.1	45.2	2,709	2,093
Region					
Aral Sea region	2.1	21.3	48.1	461	961
Central	0.3	10.0	33.7	1,049	922
East	0.4	8.5	44.7	1,243	751
Ferghana Valley	1.8	23.1	53.4	1,224	909
Tashkent City	0.0	6.7	50.2	357	731
Education					
Primary/Secondary	1.0	13.8	45.8	2,787	2,478
Secondary-Special	0.8	16.6	44.7	1,095	1,247
Higher	0.5	10.8	43.7	451	549
Ethnicity					
Uzbek	0.9	14.6	45.9	3,594	3,259
Other	0.8	12.1	42.3	739	1,015
Total	0.9	14.2	45.3	4,333	4,274

[a] Hemoglobin level less than 7g/dl
[b] Hemoglobin level 7 - 9.9 g/dl
[c] Hemoglobin level 10 - 11.9 g/dl (10 - 10.9 g/dl for pregnant women)

Table 3 Anemia among women in the Kyrgyz Republic

Percentage of women classified as having anemia by background characteristics, KRDHS 1997

Background characteristic	Percentage of women with: Severe anemia [a]	Moderate anemia [b]	Mild anemia [c]	Women measured: Weighted	Women measured: Un-weighted
Age					
15-19	0.7	5.9	25.2	720	718
20-24	0.8	8.9	24.3	642	631
25-29	1.3	7.4	28.4	525	543
30-34	2.7	11.2	30.3	618	605
35-39	1.0	10.3	30.3	566	549
40-44	2.8	10.2	26.1	396	402
45-49	1.5	10.5	31.1	300	312
Residence					
Urban	0.8	6.5	24.8	1,250	1,430
Rural	1.8	10.2	29.1	2,517	2,330
Region					
Bishkek City	0.6	5.0	23.5	500	862
North	1.4	8.5	26.6	1,157	997
East	0.5	7.0	22.6	211	756
South	1.9	10.5	30.0	1,898	1,145
Education					
Primary/Secondary	1.1	10.1	27.6	2,018	1,892
Secondary-Special	2.3	8.4	28.9	1,128	1,156
Higher	1.3	6.5	25.5	621	712
Ethnicity					
Kyrgyz	1.9	9.6	27.6	2,347	2,518
Russian	0.3	3.9	20.7	391	470
Uzbek	1.1	10.8	34.2	680	432
Other	0.7	7.1	23.3	349	340
Total	1.5	9.0	27.7	3,767	3,760

[a] Hemoglobin level less than 7g/dl
[b] Hemoglobin level 7 - 9.9 g/dl
[c] Hemoglobin level 10 - 11.9 g/dl (10 - 10.9 g/dl for pregnant women)

Table 4 Anemia among children in Kazakstan

Percentage of children under three years classified as having anemia by background characteristics, KDHS 1995

Background characteristic	Percentage of children with:			Children measured	
	Severe anemia [a]	Moderate anemia [b]	Mild anemia [c]	Weighted	Un-weighted
Residence					
Urban	4.5	26.9	32.3	293	275
Rural	6.1	38.2	28.6	422	464
Region					
Almaty city	1.5	20.0	26.2	29	65
South	7.4	32.8	32.7	319	253
West	7.7	47.3	26.0	93	173
Central	5.1	40.0	21.7	73	153
North-East	2.0	27.9	31.7	200	95
Education of mother					
Primary/Secondary	6.7	35.3	25.7	261	270
Secondary-Special	5.3	32.9	33.8	340	346
Higher	3.0	31.7	29.5	113	123
Ethnicity					
Kazak	8.9	40.6	28.2	420	487
Russian	0.0	27.5	31.0	159	137
Other	1.3	19.0	35.1	135	115
Total	5.5	33.6	30.1	714	739

[a] Hemoglobin level less than 7g/dl
[b] Hemoglobin level 7 - 9.9 g/dl
[c] Hemoglobin level 10 - 10.9 g/dl

Table 5 Anemia among children in Uzbekistan

Percentage of children under three years classified as having anemia by background characteristics, UDHS 1996

Background characteristic	Percentage of children with: Severe anemia [a]	Moderate anemia [b]	Mild anemia [c]	Children measured: Weighted	Un-weighted
Sex					
Male	1.8	27.5	31.8	557	512
Female	0.6	23.7	36.2	549	506
Residence					
Urban	0.9	23.8	32.8	310	400
Rural	1.4	26.3	34.4	795	618
Region					
Aral Sea region	5.2	48.2	27.5	122	251
Central	0.5	17.6	29.6	294	249
East	0.5	25.8	26.9	335	197
Ferghana Valley	1.4	26.9	50.2	307	223
Tashkent City	0.0	7.1	22.4	48	98
Education of mother					
Primary/Secondary	1.1	26.8	35.1	709	584
Secondary-Special	1.9	23.6	31.4	293	322
Higher	0.4	23.1	33.4	104	112
Ethnicity					
Uzbek	1.0	25.0	34.6	980	840
Other	3.2	30.2	29.3	126	178
Total	1.2	25.6	34.0	1,106	1,018

[a] Hemoglobin level less than 7g/dl
[b] Hemoglobin level 7 - 9.9 g/dl
[c] Hemoglobin level 10 - 10.9 g/dl

Table 6 Anemia among children in The Kyrgyz Republic

Percentage of children under three years classified as having anemia by background characteristics, Kyrgyz Republic 1997

Background characteristic	Percentage of children with: Severe anemia [a]	Moderate anemia [b]	Mild anemia [c]	Children measured: Weighted	Un-weighted
Sex					
Male	2.1	28.1	22.9	511	500
Female	0.7	20.5	25.4	510	480
Residence					
Urban	2.2	15.9	20.4	227	244
Rural	1.2	26.7	25.2	793	736
Region					
Bishkek City	0.8	12.7	17.8	69	118
North	2.1	30.0	19.9	284	249
East	3.6	20.0	24.9	69	245
South	0.9	23.4	26.7	599	368
Education of mother					
Primary/Secondary	1.2	25.5	24.5	535	499
Secondary-Special	1.8	24.0	24.4	359	344
Higher	1.1	19.8	21.8	126	137
Ethnicity					
Kyrgyz	1.4	25.5	26.0	664	709
Russian	0.0	22.5	10.8	45	55
Uzbek	0.9	20.3	24.4	240	151
Other	3.5	27.4	13.8	71	65
Total	1.4	24.3	24.1	1,021	980

[a] Hemoglobin level less than 7g/dl
[b] Hemoglobin level 7 - 9.9 g/dl
[c] Hemoglobin level 10 - 10.9 g/dl