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ORIGINAL ARTICLE

Haematological parameters in postpartum women and their babies in Poland – comparison of urban and rural areas

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Abstract

Anaemia is a serious health problem in the contemporary world which affects 24.8% of the total human population. It is especially frequent among pregnant women and children. Anaemia is considered as a risk factor of an unfavourable outcome of pregnancy. More than a half of the cases of anaemia, especially among pregnant women, are caused by iron deficiency. The prevalence of anaemia worldwide is especially high among the rural population. It is estimated that the incidence of anaemia after delivery is 4-27%. Anaemia occurring in pregnant women is the cause of anaemia in newborns after birth. The objective of the study was analysis of the haematological parameters of postpartum women and newborns, with particular consideration of the comparison between urban and rural areas. The studies were conducted with the use of questionnaire forms based on the project undertaken in the USA: Pregnancy Risk Assessment Monitoring System (PRAMS). The survey was carried out on a single day, during the period 9-13 August 2010, in all hospitals in Poland where mothers were hospitalized with their newborns. The presented study was based on the replies concerning the results of whole blood count tests in mothers and their babies. The results of the study did not confirm any significant differences between Hct, Hb and RBC values between urban and rural mothers. In both cases, the Hct levels were at the lower limit of normal. Also, no differences with respect to the above-mentioned values were noted among the newborns, although the babies of urban mothers had a higher Hb level. The results of the studies indicate the lack of differences in the health of mothers and their newborn babies with respect to the urban or rural place of residence. Despite this, anaemia is associated with complications which are life-threatening for the mother and the baby; therefore, efforts should be undertaken in order to minimize this problem.

Key words

anaemia, pregnancy, newborns, haemoglobin, postpartum

INTRODUCTION

Anaemia is a global public health problem. According to the World Health Organization [1] 1.62 billion people worldwide, i.e. 24.8% of the total population suffer from this disorder. Anaemia is a problem in both the developing and developed countries. It affects individuals at any age; however, is most prevalent among pre-school age children (47.4% i.e. 293 million), pregnant women (41.8% – 56 million), and non-pregnant women (30.2% – 468 million) (Table 1). The WHO estimates [1] that with respect to the above-mentioned groups, anaemia is most prevalent in the African region (47.5–67.6%), while the greatest number of the population afflicted by this disorder is noted in south-eastern Asia. In this region, 315 million population (95% CI: 291–340) from the above-mentioned groups suffer due to anaemia. The same studies indicate that in Poland 371,000 women, i.e. 25.3% are afflicted by this disorder. The WHO also pays attention to the fact that there is no country where anaemia would be at least a mild public health problem with respect to the three population groups in the study. With respect to pregnant women, it is estimated that in more than 80% of countries anaemia constitutes a moderate or severe problem for public health [1]. In Poland, anaemia has been ascribed the status of a moderate health issue.

Table 1. Global prevalence of anaemia and number of population afflicted by this disorder [1]

Population group	Prevalence of anaemia		Population afflicted	
	%	95% CI	No. (mln)	95% CI
Pre-school age	47.4	45,7-49,1	293	283-303
School age	25.4	19.9-30.9	305	238-371
Pregnant women	41.8	39.9-43.8	56	54-59
Non-pregnant women	30.2	28.7-31.6	468	446-491
Males	12.7	8.6-16.9	260	175-345
Elderly	23.9	18.3-29.4	164	126-202
Total number of population	24.8	22.9-26.7	1,620	1,500-1,740

Anaemia is defined as a decrease in the number of circulating red blood cells, haemoglobin and haematocrit levels below the lower limit of normal. The normal value is specified for gender, age, and also for the period of pregnancy. According to the World Health Organization, during pregnancy anaemia is defined as the value of haemoglobin level (Hb) <11g/dl in the first and third trimesters, whereas <10.5g/dl in the second trimester [2]. Anaemia is an indicator of both inadequate

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nutrition and poor health status. It is considered as a factor contributing to unfavourable pregnancy outcomes, causes an increased mortality of mothers and babies, increased risk of pre-term delivery and delivering a baby with a low birth weight [3]. There are many causes of anaemia, including loss of blood, which is the most frequent cause of death among newborns [4], haemolysis, disorders of bone marrow function, parasitic infestations, as well as acute and chronic infections. The most important cause of anaemia is that resulting from nutritional deficits, with iron deficiency occupying the first position. It is assumed that a half of all cases of anaemia are caused by iron deficiency; however, this percentage may vary among various populations and in various regions according to local conditions. Pregnant women are among the population groups at the highest risk, and the deficiency of this component is the most frequent cause of anaemia in this group of patients. During pregnancy, the demand for iron clearly increases, which is due to the necessity for an increase in the mass of red blood cells, increase in plasma volume, as well as the demand of the developing foetus for this component [5]. In addition, it is estimated that <50% of women possess insufficient iron reserves to cover the demand for this microelement resulting from pregnancy [6,7]. In 2002, the WHO considered iron deficiency anaemia as one of the most important factors contributing to the global disease burden [8]. It also has a negative effect on the development of cognitive functions and the physical development of children, as well as physical efficiency – especially productivity of work among adults [9]. Other microelements, the deficit of which may lead to the development of anaemia, are: folic acid, vitamin B12, and vitamin A.

An additional factor resulting in an increased risk of anaemia is poverty. The studies conducted by the Centres for Disease Control and Prevention (CDC) among women with low income show that the occurrence of anaemia increases four times from the first to the third trimester of pregnancy [6]. This probably results from a diet low in digestible forms of iron and lack of dietary supplementation.

The effect of haemoglobinopathy is also not without importance for the prevalence of anaemia. This factor matters in some populations.

In the developing countries, the level of iron in pregnant women is frequently low as a result of an inadequate diet, infection, or frequent pregnancies occurring shortly after one another [10].

There are few studies evaluating the prevalence of anaemia among women in rural areas. Nevertheless, based on the reports available, it may be noticed that this problem is more important in this population group. Among the rural inhabitants of KwaZulu-Natal (Republic of South Africa) a high prevalence of anaemia is observed among pregnant women – 57% [11]. According to the studies by Lama Al-Mehaisen in Jordan [12], the prevalence of anaemia among pregnant women living in the rural areas was 34.7%, whereas in Egypt – 32%-55%, according to the stage of pregnancy and potential intervention [13]. In the rural areas of Bangladesh, the prevalence of anaemia among women during pregnancy is 50% [14].

In the case of a pregnant woman the problem is the occurrence of anaemia after childbirth. According to CDC [15], this disorder occurs when the level of haemoglobin in a woman aged between 12 and 15 decreases below 11.8 g/dl, whereas in those aged over 15 - <12g/dl. This is a commonly occurring problem which concerns many countries. In the majority of cases, self-healing occurs within a week and medical intervention is not needed [16]. Despite this, it is estimated that the problem concerns 4-27% of women [17,18,19]. This results in a prolonged hospitalization time, sometimes in difficulties with breast feeding and care of the baby. The problem is especially serious in poor countries, where post-partum anaemia is among the main causes of morbidity and mortality among women [20,21,22,23]. This results primarily from an inadequate diet, parasitic infestations, and malaria in the endemic regions. These are additional factors increasing the risk of development of anaemia, which in the case of high loss of blood during delivery, or even a natural tendency towards anaemia in pregnancy, result in a considerably higher prevalence of anaemia in these areas [24]. According to estimations by the WHO, 1/5 of deaths of mothers are associated with anaemia [24]. CDC and ACOG recommend the performance of examinations for anaemia between weeks 4 and 6 after delivery only in women in whom the risk of its occurrence after childbirth is high. The factors, which to a great extent influence this process, are: anaemia occurring in the third trimester of pregnancy, excessive blood loss during delivery or multiple pregnancy [15]. During this period, cases are also noted of the occurrence of severe anaemia. According to the studies conducted by Broche [25], the percentage of women in whom this type of anaemia was diagnosed was 5%. The strongest risk factor for the occurrence of anaemia after birth is anaemia during pregnancy [19].

Anaemia during pregnancy also has an effect on the developing foetus. Considering the fact that the level of iron in the foetus depends on its level in the blood of the mother, it is understandable that its deficiency in a pregnant woman would cause its lower content in the organism of a newborn after birth [26]. Anaemia in this period of life is defined as a decrease in the level of haemoglobin and haematocrit by more than two standard deviations below the mean reference value for age after birth [27]. Anaemia due to iron deficiency in the mother is among the causes of the development of anaemia in a newborn baby. Other causes may be divided into the following three groups: anaemia resulting from blood loss, decreased production of red blood cells, and anaemia caused by increased erythorcytes damage [28]. Table 2 presents the standards developed by the American Academy of Pediatric (AAP) for haemoglobin, haematocrit and erythrocytes in newborns and infants after birth [29].

Table 2. reference standards for newborns and infants up to 6 months of life [29]

Age	Hgb (g/dl)	Hct (%)	RBC (mln/mm^3)
0-3 days	15.0-20.0	45-61	4.0-5.9
1-2 weeks	12.5-18.5	39-57	3.6-5.5
1-6 months	10.0-13.0	29-42	3.1-4.3

In Poland, a rural area is defined by the Act of 29 August 2003 concerning official names of localities and physiographic objects as a settlement unit with dense or dispersed development and existing agricultural functions, or services and tourism related to them, which does not have municipal rights or the status of a city [30]. According to this Act, a city is a settlement unit with a majority dense development and non-agricultural functions which has municipal rights or the status of city [31]. In the USA, an

urban area is most often defined as a settled area with the population of more than 2,500 inhabitants, having a density of at least 1,000 persons per square mile [32]. The remaining places are called rural areas. In the majority of the European countries, rural areas are defined by law according to the population density and number of inhabitants [32].

OBJECTIVE

1) Analysis of haematological parameters in women after delivery, with comparison of urban and rural areas.
2) Analysis of haematological parameters in newborns, with comparison of urban and rural areas.

MATERIAL AND METHODS

In 2009, following the Pregnancy Risk Assessment Project (PRAMS), a surveillance system collecting data on maternal attitudes and experiences before, during, and shortly after pregnancy – which has been carried out in the USA since 1987 – for the first time monitoring studies in this area were conducted in Poland. The studies were of a pilot character, and covered a randomized group of Polish mothers and their newborn infants. The survey was conducted in all hospitals in Poland where mothers were hospitalized after giving birth (lying-in women) with their newborn babies, on one day in the second week of June 2009. The date of the study was announced by a regulation by the Chief Sanitary Inspector. The survey was carried out by trained surveyors – employees of Provincial Sanitary-Epidemiological Stations. The surveyors were trained by public health experts from the Chief Sanitary Inspectorate and Regional Sanitary-Epidemiological Stations in a cascade system, in the first half of 2009. The regulation by the Chief Sanitary Inspector contained the main methodological assumptions of the study. The studies were conducted with the use of questionnaire forms. The questionnaire form was developed by the Chief Sanitary Inspector, consulting questionnaire items with experts in this area in Poland. The questionnaire was divided into two sections. The first section of the survey contained questions concerning the following:

– mother's age, place of residence, education level, marital status, and social status;
– reproductive history (previous deliveries, miscarriages, potential problems getting pregnant);
– risky health behaviours of the mother prior to and during pregnancy (tobacco smoking, alcohol consumption, narcotics and psychoactive substances).

The second section of the questionnaire contained questions concerning the following:

– state of a newborn after birth, as evaluated according to Apgar Scale;
– the newborn's gender, birth weight, height, date of delivery;
– type of delivery and potential labour complications;
– congenital defects of a newborn.

The survey was conducted by employees of Provincial Sanitary-Epidemiological Stations by the direct face-to-face method. Mothers hospitalized after delivery provided replies to the questions in the first section of the questionnaire, while the second section was completed by medical staff (physician or nurse) providing care for the mother and her baby, based on medical records (pregnancy chart and hospitalization history). Consent for the study was obtained from the Bioethical Commission. In each hospital, consent for conducting the study was obtained from its manager. The survey was preceded by sending obstetricians a letter supporting the study, signed by the National Consultant for the Matters of Obstetrics and Gynaecology. Of the total number of 402 Polish hospitals where deliveries took place, consent for the study was expressed by 382 hospitals (95%), 3,346 mothers (81.6%) after delivery provided answers to questions posed in the survey, and 3,280 questionnaire forms were qualified for statistical analysis (98%). The total number of mothers who after delivery stayed in hospitals with their newborn babies was 4,100.

On 9-13 August 2010, a survey was conducted among pregnant women according to the methods of 2009, with the following changes:

– a method was applied for completing the questionnaire form independently, both by the mother and the medical staff in the ward where she was hospitalized with her newborn baby;
– the first section of the questionnaire was expanded by questions concerning body weight, nutrition prior to and during pregnancy, frequency of consumption of meals, their quality, supplementary diet, taking vitamins and medications, arterial hypertension and diabetes prior to and during pregnancy, physical activity;
– the questionnaire was also expanded by questions concerning the performance by the women examined of prophylactic check-up examinations for breast and uterine cancer, vaginal purity, and the women's knowledge concerning cancer prevention.

The second section of the questionnaire form completed by the medical staff was expanded by questions concerning the following:

– results of blood test or other biological material performed in pregnancy, during delivery and shortly after delivery in the mother, and possibly in her newborn baby;
– congenital defects with a precise specification of their external symptoms.

Among the total number of 398 hospitals where deliveries took place, 373 managers of these facilities expressed their consent to participate in the survey (94%). 3,064 lying-in mothers hospitalized with their newborns completed the questionnaire forms (77%), of this number, 2,972 completed questionnaires were qualified for statistical analysis (97%). On the day of the study, 3,979 lying-in mothers with their babies were hospitalized in Poland. The results of the survey conducted were subsequently introduced by the surveyors on-line into answer sheets on the server managed by the Institute of Rural Health and subjected to statistical analysis.

In the studies, as rural inhabitants were considered women who in the question concerning place of residence indicated the answer – rural area. Urban inhabitants were those who to this question marked the reply – urban area, irrespective of its size.

The structure of the sample was as follows: mean age of the patients – 28.3 (SD 4.99) from 16-48; 57.6% of urban and 42.4% of rural inhabitants.

Statistical analysis was conducted with Statistica 8.1PL package. Mean values differences were tested by analysis of variance according to normal hematological variables distribution.

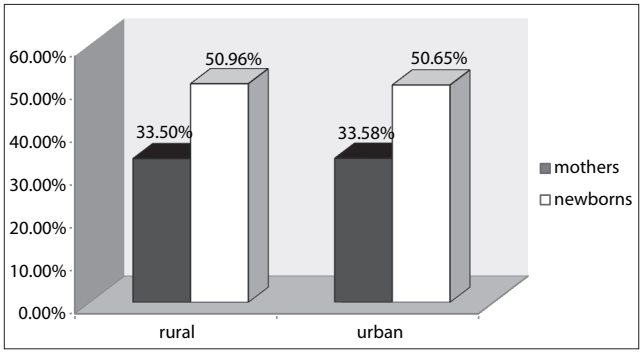

Figure 1. Comparison of mean haematocrit value in mothers and newborns from rural and urban areas

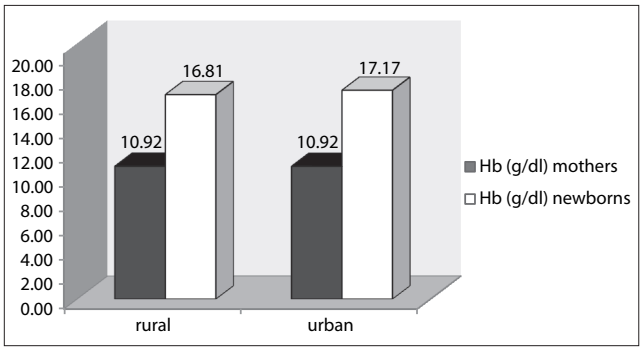

Figure 2. Comparison of mean haemoglobin level in blood of mothers and newborns from rural and urban areas

RESULTS

Correctly completed questionnaire items concerning haematocrit value were obtained from 1,751 post-partum women – 1,007 (57.51%) urban and 744 (42.49%) rural inhabitants. The mean haematocrit value among postpartum women living in the urban areas was 33.58%, while among rural mothers – 33.50% (ANOVA p value = 0.7331). With respect to newborns, a correctly completed questionnaire item concerning this parameter was obtained for 906 newborn babies. As many as 520 (57.4%) mothers of these babies were urban, and 386 (42.6%) rural inhabitants. In the blood of babies born by mothers living in the rural areas the mean haematocrit value was 50.65%, whereas with respect to newborns of rural mothers the value of this parameter was 50.96% (ANOVA p value = 0.5510). These results are shown on Figure 1.

The subsequent parameter examined was haemoglobin (Fig. 2). In this case, correctly completed questionnaire items were obtained from 1,718 mothers – 988 (57.51%) urban and 730 (42.49%) rural inhabitants. The mean concentration of haemoglobin in blood collected from mothers living in the urban areas was 10.92 g/dl, and the same mean level was noted in the blood of mothers living in the rural areas (ANOVA p value = 0.9449). The correct answer to this question was obtained with respect to 895 newborns; 513 (57.32%) of their mothers living in urban, and 382 (42.68%) in rural areas. The mean value of haemoglobin concentration in the blood of newborns of urban mothers was 17.17 g/dl, while this value in babies of mothers from the rural areas was 16.81 g/dl (ANOVA p value = 0.0773).

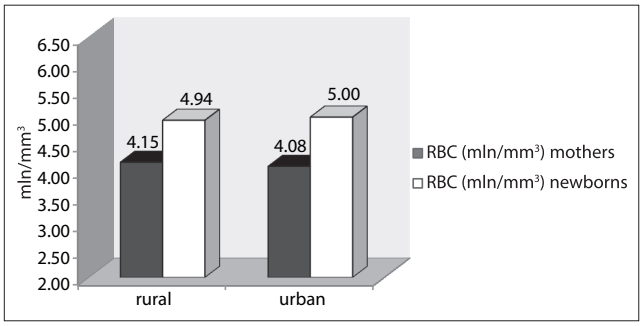

Figure 3. Comparison of mean red blood cells value (RBC) in mothers and their newborns from rural and urban areas

Another parameter examined in the presented study was the mean value of red blood cells in the blood of the mother and her newborn (Fig. 3). Considering this parameter, correct answers were obtained with respect to 1,752 women – 1,009 (57.59%) urban, and 743 (42.41%) rural inhabitants. In urban mothers, the mean value of red blood cells was 4.08 (mln/mm^3), while in mothers from the rural areas this value was 4.15 (mln/mm^3) (ANOVA p value = 0.5025). Comparison of this value was possible in a group of 885 newborns with 509 (57.51%) of their mothers living in the urban, and 376 (42.49%) in the rural areas. Among urban newborns the mean value of red blood cells was 5.00 (mln/mm^3), whereas in the babies of rural mothers the mean erythrocytes value was 4.94 (mln/mm^3) (ANOVA p value = 0.2150).

DISCUSSION

During pregnancy, a number of changes take place in the body of the mother, including the blood. The plasma volume begins to increase in week six of pregnancy, and reaches even 140% of plasma volume in non-pregnant women. Initially, it is not accompanied by an increase in the mass of red blood cells [33]. A decrease is observed in plasma viscosity, which provides better placental perfusion, and oxygen transport to the developing foetus [34]. An increased plasma volume with the lack of an adequate increase in erythrocytes mass results in a decrease in haemoglobin level and the development of anaemia, which is defined as dilution anaemia. The increase in plasma volume reaches its highest value at the end of the second trimester of pregnancy. The consequence of this process is an increased production of erythropoietin, which results in a gradual increase in the mass of erythrocytes by 15-25%. The situation stabilizes in the third trimester of pregnancy when a relative increase is observed in haemoglobin and hematocrit levels [33]. A decrease in the plasma volume, and subsequent increase in erythrocytes mass, causes changes in the levels of haemoglobin and hematocrit. Considering these changes taking place in the body of the woman it was necessary to establish special standards for pregnant women, which would allow the actual diagnosis of anaemia. In this case, making a diagnosis of anaemia based on the criteria for non-pregnant women would be a mistake. The level of haemoglobin below which anaemia is diagnosed in non-pregnant women is 12 g/dl [9]. The WHO also specified criteria of diagnosing anaemia in pregnant women according to the stage of pregnancy, which results from the changes in the plasma volume and erythrocytes mass. These values are for the first and third trimester (Hb) <11g/dl, respectively, while for the second trimester - <10,5g/dl [2]. Anaemia in pregnancy is associated with unfavourble outcomes of delivery, especially if it is difficult. These are: increased maternal and foetal mortality,

an increased risk of premature delivery, and low birth weight of a newborn [3].

The most frequent causes of postpartum anaemia is iron deficiency occurring in the third trimester of pregnancy, and loss of blood during delivery. Postpartum haemorrhage by definition means the loss of blood higher than 500ml within 24 hours after delivery, whereas a severe haemorrhage is blood loss higher than 1,000-1,500ml. These haemorrhages occur in 18% and 3% of deliveries, respectively [25,35]. The risk of the development of anaemia due to iron deficiency rapidly increases when the BMI from before pregnancy increases from 24kg/m^2 to 38kg/m^2. Other risk factors of iron-deficiency are also postpartum haemorrhage and high birth weight of a newborn, as well as the lack of iron supplementation. Anaemia occurring between weeks 24-29 of pregnancy, or in the third trimester of pregnancy before delivery, considerably contributes to the development of anaemia after delivery. The risk increases also in the case of multiple pregnancy [36]. This study presents haematological parameters in mothers after delivery and their newborn babies in Poland, with the consideration of rural and urban place of residence. No significant differences in haematocrit values in mothers after delivery were observed between the rural and urban areas. It is noteworthy that the mean values of this parameter for the urban areas were 33.58%, while for the rural areas – 33.5%. For haematocrit, the boundary value below which anaemia is diagnosed is the value of 33% [9]; thus, the mean values obtained remained within the standard value, but in its lower limit. In the studies conducted by Nicol et al. [37], considering the entire group of the women examined, a mean haematocrit value was obtained of 33.6%, i.e. very close to that obtained in the presented study. Combs et al. [38], who carried out studies on a large group of women, obtained a value of 33.7%. The standard values proposed by Klajnbard et al. [39], based on the studies concerning the examination of blood collected in 801 pregnant women at various stages of pregnancy and during the period until the 2nd day after delivery, are slightly lower with respect to haematicrit. Here, anaemia was defined as a decrease of haematocrit value below 31%. In this case, the values obtained in the presented study differ from the lower limit; nevertheless, evaluation of the size of the group of women in whom a haematocrit value of <33% would be desirable.

No differences between urban and rural mothers were also noted with respect to the haemoglobin level, which was 10.92 g/dl in each case. In a retrospective study by Broche et al. [25], where women were divided into two groups according to the term of delivery, the following mean haemoglobin values were obtained: in the first group – 10.73 g/dl, in the second group – 11.2 g/dl, and 5.05% of the women suffered from severe postpartum anaemia.

A slightly lower erythrocytes level was observed among women living in the urban areas - 4.08 mln/mm^3, while in the rural areas the mean erythrocytes level was 4.15 mln/mm^3. This, however, is only a slight difference which is not of much importance, as both values remain within the standard.

The blood volume of a newborn is subject to some changes directly after birth. Within the first 72 hours after delivery the plasma volume decreases. Erythrocytes mass increases directly after birth. During the first three days of life, the blood volume of a newborn stabilizes on the level of 80-95 ml/kg [37]. The most frequent cause of anaemia in newborns is blood loss, which may be of an acute or chronic character [4].

While comparing haematocrit values in newborn babies whose mothers live in the urban and rural areas, slight differences may be observed. The babies born by urban mothers had a mean haematocrit value of 50.65%, while the babies of mothers from the rural areas – 50.96%. Ozyurek et al. [41], who in his study compared the blood count of newborns small for gestational age (SGA), with babies appropriate for gestational age (AGA), obtained the following haematocrit values on the first day after delivery: in the group of SGA babies this value was 53.3% +/- 0.8%, while in the group of AGA babies – 47.1% +/- 1%. According to the reference values developed by the AAP, normal haematocrit values for newborns between birth and day 3 after birth are 45%-61% [29].

Differences were also observed in the level of haemoglobin. Its mean level in the blood of urban mothers was 17.17 g/dl, while in babies of mothers living in the rural areas – 16.81 g/dl. In his studies Ozyurek et al. [41] obtained the following Hb values in newborns on the first day after delivery: in the group of SGA babies – SGA 18.2g/dl +/- 0.3 g/dl, and in the group of AGA babies – 17.0 g/dl +/- 0.4 g/dl.

With respect to the level of red blood cells in newborns, the differences between the urban and rural areas were minimal, and in both cases differed from the boundary value specified by the AAP. These values were close to those obtained by Ozyurk et al. [41], who in the group of SGA babies obtained the number of red blood cells of 5.1 mln/mm^3 +/- 0.8 mln/mm^3, while in the group of AGA babies – 4.7 mln/mm^3 +/- 0.1 mln/mm^3.

CONCLUSIONS

1. No significant differences with respect to haematologic parameters were observed between urban and rural mothers after delivery. The differences noted are slight and do not significantly affect the occurrence of the differences in health between urban and rural women. The mean haematocrit value in the entire group of the mothers examined is the only matter for concern. This value is close to the boundary value specified by the WHO as 33%. It is necessary to distinguish the group of mothers with test results below this value, and to evaluate the potential differences occurring between the urban and rural areas.
2. No significant differences were also noted between the newborns whose mothers lived in urban and rural areas. The difference between urban and rural newborns was observed only with respect to haemoglobin level which was 0.36 g/dl, this value being slightly higher in urban babies. However, this had no effect on the health of the children, and both values remained within the normal values.
3. The results of the study may indirectly indicate that knowledge concerning counteracting anaemia and the access to medical services is comparable in both groups analyzed. However, the problem cannot be ignored, and emphasis should even be placed on the development of new strategies of anaemia control and the identification of risk factors, because the complications resulting from the development of anaemia are life threatening for the mother and her baby.

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