The problem of miscarriage in a region with a high content of heavy metals in the soil

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Abstract. Reducing the incidence of miscarriage in order to improve the demographic situation is currently one of the most pressing problems. The article presents the results of a comparative statistical analysis of reporting forms of federal statistical observation No. 13 “Information about pregnancy with an abortive outcome”, No. 32 “Information about medical care for pregnant women, parturient women and puerperas” with an insert for it “Information about the regionalization of obstetric and perinatal care in maternity hospitals (wards) and perinatal centers”, data from the State Report "On the state of sanitary and anti-epidemic well-being of the population in the Republic of North Ossetia-Alania in 2018" and statistical yearbooks of the Republic of North Ossetia-Alania. It was revealed that in the Republic of North Ossetia-Alania from 1991 to 2018, due to the introduction of modern methods of diagnosis and treatment of women suffering from miscarriage, as part of the state's policy in the field of women's and children's health, a significant decrease in infant and perinatal mortality occurred at practically the same frequency of a miscarriage. The latter was the basis for the assumption about the negative impact of a high content of heavy metals in the soil, in particular cadmium and lead. It is concluded that it is necessary to conduct active monitoring of the content of heavy metals in the serum of women of reproductive age.

1. Introduction

For almost 30 years (from 1991 to 2018), thanks to the implementation of state policy measures in the field of maternal and child health aimed at improving the quality and accessibility of medical care for pregnant women and newborns in the Republic of North Ossetia-Alania, significant progress has been made in reducing infant mortality [1, 2] (Figure 1).

The infant mortality rate, which was 16.8 per 1000 live births in 1991, dropped to 4.6 by 2018, i.e., almost 3.7 times, which corresponds to the all-Russian trend [3].

Perinatal mortality rate, significantly increased in 2012–2013 in connection with the transition to new criteria for birth registration, began to decline from 2014, and in 2018 it was 6.40 versus 12.09 in 2013.

It should be noted that a greater contribution was made to the reduction of peri-natal mortality by one of the components of this indicator – early neonatal mortality (6.91‰ in 2012 and 2.3‰ in 2018). The stillbirth rate over the same period changed slightly (4.88‰ in 2012 and 4.20‰ in 2018).
At the same time, throughout all the analyzed years with a relatively stable mortality rate of the entire population, the birth rate has fluctuations [4]. This indicator was decreasing from 1991 until 2001; from 2002 to 2014, there was a steady increase in the birth rate, which again fell into decline in 2015 (Figure 2).

During the specified period of time, in RNO-Alania the number of induced abortions has sharply decreased and continues to decrease annually. Reducing the number of abortions per 1000 women of childbearing age, however, does not lead to an increase in the birth rate.

In order to find reserves for improving the demographic situation, indicators characterizing reproductive losses were analyzed.
2. Materials and Methods
A retrospective analysis of the data, from 1991 to the present, included in the reporting forms of the Federal State Statistical Observation and recognized by international expertise as reliable, was carried out.

3. Results and Discussion
According to official statistics, since 1991 in the Republic of North Ossetia-Alania there has been a distinct decrease in the number of pregnancies (excluding induced abortion). Since the beginning of the 2000s, an increase in the number of pregnancies has begun (excluding induced abortion). By 2009, the number of pregnancies increased compared with 2002 by 41.3%. In 2011–2013 the largest number of pregnancies (excluding induced abortion) was recorded with a maximum of 11,242. Since 2014, the birth rate has started to decline again, the number of all pregnancies by 2018 has decreased by 23%, reaching 9,109.

At the same time, the rate of miscarriage per all pregnancies (11.1% in 1991) reached 14.5% in 1998 and practically did not change over the last 10 years (11.1% in 2009 and 11.2% in 2018).

Table 1 provides data on the frequency of preterm birth in the republic over the past 10 years, as well as the proportion of children born with a body weight from 500 to 2500 g.

|                | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|----------------|------|------|------|------|------|------|------|------|------|------|
| Born alive     | 489  | 533  | 572  | 605  | 770  | 634  | 584  | 536  | 447  | 454  |
| prematurely,   |      |      |      |      |      |      |      |      |      |      |
| including birth|      |      |      |      |      |      |      |      |      |      |
| weight of      |      |      |      |      |      |      |      |      |      |      |
| 500-999 g      | 42   | 32   | 27   | 26   | 25   | 43   | 35   | 40   | 25   | 20   |
| 1000-1499 g    | 39   | 51   | 64   | 54   | 54   | 194  | 69   | 78   | 59   | 52   |
| 1500-2499 g    | 408  | 450  | 481  | 525  | 481  | 522  | 471  | 437  | 370  | 390  |

The data presented in the table demonstrate an increase in the frequency of preterm birth and an increase in the proportion of premature newborns since 2009, which peaked during the transition of the Russian Federation to new criteria for registration of live births recommended by the World Health Organization [5]. The dynamics of preterm labor presented in the table repeats the fluctuations of the total number of pregnancies in the indicated period. However, the number of premature babies born alive decreased from 2013 to 2018 by 41%, and the birth rate only by 23%. During the described period of time, clinical protocols, recommendations, and the procedure for providing medical care in the obstetrics and gynecology profile were introduced (with the exception of assisted reproductive technologies) approved by order of the Ministry of Health of the Russian Federation as of November 12, 2012 No. 572n "On approval of the procedure for providing medical care profile "Obstetrics and Gynecology" (except for the use of assisted reproductive technologies)" [6], which certainly improved the quality of medical care for women with possible miscarriage. The lack of correlation between these phenomena in the implementation of all standards of medical care was the basis for searching for an explanation of this fact and suggested that this imbalance may be due to the influence of an unfavorable environment.

The body of pregnant women is known to be most sensitive to the effects of various anthropogenic substances that pollute the environment, which is associated with increased gas exchange, a decrease in the rate of metabolic processes and degraded ability to neutralize toxic substances. The harmful effects of heavy metals that accumulate in the pregnant woman’s body also affect the embryo/fetus. The degree of damage to the ovum directly depends on the duration of the half-life of metal pollutants, their ability to penetrate the uteroplacental barrier and the ability to exert an embryo and fetotoxic effect.
According to the Center for Hygiene and Epidemiology in the Republic of North Ossetia-Alania [7], annually soil samples reveal an elevated content of heavy metals, in particular, cadmium, lead, etc.

Table 2. Characteristics of the soil condition (according to 2018)

| Chemical Name | Indicator (gross content) | Limit [mg/kg] | Actual content [mg/kg] |
|---------------|---------------------------|---------------|------------------------|
| Cadmium       |                           | 2.0           | 6.1                    |
| Lead          |                           | 130.0         | 320.1                  |

As follows from Table 2, the gross content of toxic substances – recognized by scientists from different countries – that have an adverse effect on the reproductive system, such as cadmium and lead, is almost three times higher than the limits.

Cadmium is a highly toxic element, the main source of which in the soil is industrial and waste water. This metal is characterized by a long biological half-life. Prolonged intake of even low doses of cadmium can be accompanied by dysfunction of various organs and systems, including reproductive, manifested in infertility, miscarriages, complications of pregnancy and childbirth, congenital malformations of the fetus [8].

High lead content in the soil is observed near the metallurgical industry, roads, in wastewater. With prolonged exposure to lead on human body suffers a decrease in resistance to infectious agents, toxic effects on the brain, kidneys, and blood [9, 10]. Manifestations of negative effects on the reproductive system are infertility, miscarriages, complicated pregnancy and childbirth, fetal malformations [11, 12].

4. Conclusions

Thus, on the basis of a retrospective analysis of statistical data characterizing the most important medico-demographic indicators in the Republic of North Ossetia-Alania in 1991-2018, it was found that with an increase in the quality of medical care for pregnant women, there was no decrease in the incidence of miscarriage.

Considering that the health of citizens is determined by many factors and, first of all by environmental pollution by anthropogenic chemicals [13]—which accounts for at least a third of the diseases in the population [14]—we found it possible to associate the lack of positive changes in the rate of miscarriage in the soil of heavy metals.

In the framework of the implementation of the Parma commitments, WHO identified experts as cadmium, arsenic, mercury, lead, etc., as priority reproductive toxicants [8].

According to foreign scientists, increasing the concentrations of cadmium and lead in the serum contributes to the habitual loss of pregnancy [15].

This preliminary study confirmed the relevance of its further development with the active monitoring of concentrations of cadmium and lead in the serum of pregnant women for the development of effective measures to prevent miscarriage.

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