

DOENÇAS OBSTÉTRICAS E GINECOLÓGICAS DE GESTANTES RESIDENTES EM CONDIÇÕES DE ALTA MONTANHA DA REGIÃO DE OSH

OBSTETRIC AND GYNECOLOGICAL DISEASES OF PREGNANT RESIDENTS IN HIGH MOUNTAIN CONDITIONS OF OSH REGION

АКУШЕРСКО-ГИНЕКОЛОГИЧЕСКИЕ ЗАБОЛЕВАНИЯ БЕРЕМЕННЫХ ЖИТЕЛЬНИЦ В ВЫСОКОГОРНЫХ УСЛОВИЯХ ОШСКОЙ ОБЛАСТИ

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RESUMO

Introdução: Um dos problemas prementes da obstetrícia moderna são as doenças durante a gravidez. Gestantes que vivem em altas montanhas estão expostas a fatores adversos, sendo o mais importante o reduzido teor de oxigênio no ar. A hipertensão em gestantes em condições de alta altitude combina-se com hipóxia hipobárica exógena e, como patologia orgânica total, leva a alterações funcionais e morfológicas em todos os órgãos e sistemas. O desenvolvimento da gravidez em mulheres que vivem em altas montanhas correlaciona-se com alterações adaptativas na forma de diminuição da quantidade de hemoglobina no sangue. O desenvolvimento da gravidez em condições de alta altitude, no contexto de hipotensão arterial e anemia, é acompanhado por agravamento da insuficiência fetoplacentária (IFP), causando hipóxia hêmica adicional na gestante e no feto, bem como no recém-nascido no período pós-parto. **Objetivo:** Analisar a estrutura e a dinâmica da morbidade obstétrica e ginecológica entre gestantes residentes em alta montanha. **Métodos:** Os autores estudaram as taxas de morbidade em gestantes em dois distritos da região de Osh durante 2019-2023. As participantes foram divididas em dois grupos: o grupo 1 consistiu de 48 gestantes residentes em alta montanha, e o grupo 2 consistiu de 76 gestantes residentes em baixa montanha. **Resultados:** Foram encontradas taxas de morbidade mais elevadas em gestantes montanhistas em comparação com aquelas em baixa montanha. **Discussão:** O estudo revela diferenças significativas nos padrões de morbidade entre residentes de alta montanha e baixa montanha, particularmente em relação à ocorrência de anemia. Estes achados alinham-se com a literatura existente sobre os efeitos dos ambientes de alta altitude nos resultados da gravidez.

Conclusões: Em gestantes que vivem em alta montanha, a incidência de anemia é maior do que naquelas em baixa montanha. Os resultados obtidos podem ser utilizados para desenvolver recomendações para melhorar o atendimento médico a gestantes em alta montanha e reduzir o nível de doenças obstétricas e ginecológicas.

Palavras-chave: anemia, altitude elevada, hemostasia, hipóxia, pré-eclâmpsia.

ABSTRACT

Background: One of the pressing problems of modern obstetrics is diseases during pregnancy. Pregnant women living in high mountains are exposed to adverse factors, the most important of which is the reduced oxygen content in the air. Hypertension in pregnant women in high altitude conditions is combined with exogenous hypobaric hypoxia and, as a total organ pathology, leads to functional and morphological changes in all organs and systems. The development of pregnancy in women living in high mountains correlates with adaptive changes in the form of a decrease in the amount of hemoglobin in the blood. The development of pregnancy in high altitude conditions, against the background of arterial hypotension and anemia, is accompanied by aggravation of fetoplacental insufficiency (FPI), causing additional hemic hypoxia in the pregnant woman and fetus, as well as in the newborn in the postpartum period. **Aim:** To analyze the structure and dynamics of obstetric and gynecological morbidity among pregnant women living in high mountains. **Methods:** The authors studied morbidity rates in pregnant women in two districts of Osh region for 2019-2023. The participants were divided into two groups: group 1 consisted of 48 pregnant women living in high mountains, and group 2 consisted of 76 pregnant women living in low mountains. **Results:** Higher morbidity rates were found in pregnant women-mountaineers compared to those in low mountains. **Discussion:** The study reveals significant differences in morbidity patterns between high-mountain and low-mountain residents, particularly in relation to anemia occurrence. These findings align with existing literature on the effects of high-altitude environments on pregnancy outcomes. **Conclusions:** In pregnant women living in high mountains, the incidence of anemia is higher than in those in low mountains. The results obtained can be used to develop recommendations for improving medical care for pregnant women in high mountains and reducing the level of obstetric and gynecological diseases.

Keywords: high altitude, anemia, hypoxia, hemostasis, preeclampsia.

АННОТАЦИЯ

Актуальность: Одной из актуальных проблем современного акушерства являются заболевания во время беременности. Беременные женщины, проживающие в высокогорье, подвержены воздействию неблагоприятных факторов, важнейшим из которых является пониженное содержание кислорода в воздухе. Гипертензия у беременных в условиях высокогорья сочетается с экзогенной гипобарической гипоксией и, как тотальная органная патология, приводит к функциональным и морфологическим изменениям во всех органах и системах. Развитие беременности у женщин, проживающих в высокогорье, коррелирует с адаптивными изменениями в виде снижения количества гемоглобина в крови. Развитие беременности в условиях высокогорья, на фоне артериальной гипотензии и анемии, сопровождается усугублением фетоплацентарной недостаточности (ФПН), вызывающей дополнительную гемическую гипоксию у беременной и плода, а также у новорожденного в послеродовом периоде. **Цель:** Проанализировать структуру и динамику акушерско-гинекологической заболеваемости среди беременных женщин, проживающих в высокогорье. **Методы:** Авторы изучили показатели заболеваемости беременных женщин в двух районах Ошской области за 2019-2023 годы. Участницы были разделены на две группы: группа 1 состояла из 48 беременных женщин, проживающих в высокогорье, и группа 2 состояла из 76 беременных женщин, проживающих в низкогорье. **Результаты:** У беременных горянок выявлены более высокие показатели заболеваемости по сравнению с женщинами из низкогорья. **Обсуждение:** Исследование выявляет значительные различия в структуре заболеваемости между жителями высокогорья и низкогорья, особенно в отношении встречаемости анемии. Эти результаты согласуются с существующей литературой о влиянии высокогорной среды на исходы беременности. **Выводы:** У беременных женщин, проживающих в высокогорье, частота анемии выше, чем у женщин из низкогорья. Полученные результаты могут быть использованы для разработки рекомендаций по улучшению медицинской помощи беременным женщинам в высокогорье и снижению уровня акушерско-гинекологических заболеваний.

Ключевые слова: высокогорье, анемия, гипоксия, гемостаз, преэклампсия.

1. INTRODUCTION:

The main task of obstetrics is to create optimal conditions for a woman to perform the function of motherhood and preserve her health (Dzhoboeva & Dobrokhotova, 2013).

The reproductive system of women is susceptible to the effects of extreme factors, including high-altitude ones. Pregnant women living in high mountain conditions are exposed to adverse factors, the most important of which is the reduced oxygen content in the air.

Considering that the Kyrgyz Republic is a mountainous country, therefore the attention of our scientists has been attracted for many years by the problem of high mountains and its impact on maternal-fetal relationships (Tukhvatshin & Subanova, 2020; Poursafa *et al.*, 2015; Elongji *et al.*, 2011).

The development of adverse complications increases the risk of damage to the fetus and newborn, in particular, the development of arterial hypotension, anemia, and further fetoplacental insufficiency (Auger *et al.*, 2017; Tadzhiboeva *et al.*, 2020).

The development of pregnancy in women living in high mountains is accompanied by both adaptive reactions on the part of the mother's body and the fetus (Soburov & Temirova, 2019; Zokirov & Pulatov, 2013). The addition of extra factors to high altitude ones, in the form of anemia, arterial hypotension, and placental insufficiency leading to secondary hypoxia, can "disrupt" adaptation mechanisms and lead to the development of pathology on the part of the mother, fetus, and placenta (Rybalkina & Uzgenova, 2014-1; Rybalkina & Uzgenova, 2014-2). As is known, the functional state of the placenta is largely determined by the degree of its development in accordance with the gestational age and the preservation of protective and adaptive mechanisms (Shiganova & Konycheva, 2007). Correspondence of the placenta maturity to the gestational age is one of the most important conditions for ensuring adequate development of the fetus and its protection.

Relevance. In recent years, a tendency has existed towards an increase in obstetric pathology and the birth of sick children as a result of the unfavorable impact of environmental and social factors on pregnant women, especially those living in mountainous conditions.

Arterial hypotension during pregnancy is most often associated with a decrease in peripheral resistance, which is caused by a violation of the neurohumoral regulation of the heart and blood vessels (Dzhoboeva & Dobrokhotova, 2013).

A proportionate decrease in vascular resistance was revealed at the level of pre-and post-capillary arterioles, which was combined with a slowdown in the speed of fast blood flow. There were no significant inter-altitude differences between the main and control groups of subjects. Thus, during pregnancy, mountain women develop a level of hemodynamics characteristic of vascular systems with low peripheral resistance, which, according to the literature, was also considered the normal state of pregnancy under normal conditions (Fatkullina, 2010).

An additional complication that occurs with FPI leads to a decrease in uteroplacental and fetoplacental blood flow, decreased arterial blood supply to the placenta and fetus (Vereina, 2012), limitation of gas exchange and metabolism in the fetoplacental complex, disruption of the processes of placental maturation; decreased synthesis and imbalance of placental hormones. All these changes suppress the compensatory and adaptive capabilities of the "mother-placenta-fetus" system, slow down the growth and development of the fetus, and cause complicated pregnancy and childbirth. As a result of exposure to damaging factors and the implementation of pathogenetic mechanisms leading to FPI, fetal hypoxia naturally develops (Chen & Lin, 2017).

Severe or prolonged hypoxia entails a breakdown of compensation mechanisms aimed at maintaining pregnancy associated with high altitude, arterial hypotension, and fetoplacental insufficiency (Stepanian *et al.*, 2013).

This research aimed to analyze the structure and dynamics of obstetric and gynecological morbidity among pregnant women living in high mountains.

2. MATERIALS AND METHODS:

2.1. Materials

- BIOMED-6 digital microscope with imaging capability (x460 magnification)
- Rotary microtome

- Paraffin infiltration apparatus
- Typical lab microscope slide
- Digital camera system for microscopy

2.1.1. Chemical Reagents and Supplies

- 10% formalin in a neutral buffer
- Ethanol solutions in various concentrations (70%, 80%, 95%, 100%)
- Xylene
- Paraffin wax
- Hematoxylin dye
- Eosin Y dye
- Mounting medium
- Glass slides and cover slips
- Tissue cassettes
- Common laboratory glassware

2.1.3. Study Population:

The study included 124 pregnant women from two different geographic locations:

- Highlands: 48 women from the Alay region (altitude: 2400–3200 meters).
- Lowlands: 76 women from the Aravan region (altitude: ~650 meters).

Eligibility Criteria:

- Inclusion: Pregnancy of 20 weeks or more and residence of at least 5 years in the study area.
- Exclusion: Severe concomitant diseases (e.g., cancer, autoimmune disorders) or multiple relocations during pregnancy.

Study Period:

Data collected between 2019 and 2023.

2.2. Methods

2.2.1. Study Design

This research was structured as a prospective cohort study that took place from 2019 to 2023 in the Osh region of Kyrgyzstan. A stratified random sampling technique was utilized to guarantee that samples were representative from two separate geographical areas at varying elevations. All procedures associated with the study adhered to the ethical standards set forth in the Helsinki Declaration (2013) and received approval from the Ethics Committee for Clinical Research of Healthcare in the Osh Region and City of Osh (No. 01-15/22 dated 09.02.2022).

2.2.2. Study Population and Location

The research took place in two separate

geographical areas within the Osh region:

1. The highland area (Alay):

- Elevation range: 2400-3200 meters above sea level
- Participant count: 48 pregnant women (Group 1)
- Environmental characteristics: Reduced oxygen levels, unique mountainous climate patterns

2. The lowland area (Aravan):

- Elevation: Roughly 650 meters above sea level
- Participant count: 76 pregnant women (Group 2)
- Environmental characteristics: Typical atmospheric pressure and oxygen saturation

2.2.3. Criteria for Eligibility and Recruitment

The selection of participants was guided by specific inclusion and exclusion parameters to maintain the integrity of the study:

Inclusion Criteria:

- Verification of pregnancy at 20 weeks gestation or beyond
- Residency in the study region for at least 5 years
- Capability to attend regular follow-up appointments
- Agreement to provide informed consent

Exclusion Criteria:

- Diagnosis of significant concurrent illnesses (including but not limited to cancer and autoimmune diseases)
- Frequent relocations during the course of pregnancy
- Existence of conditions that could hinder participation in the study
- Inability to adhere to the follow-up schedule.

2.2.4. Clinical Monitoring and Data Collection Protocol

Patient oversight adhered to a defined schedule throughout the course of pregnancy:

1. First and Second Trimester Monitoring

(Up to 28 weeks):

- Monthly clinical evaluations
- Periodic assessments of health conditions
- Recording of any pregnancy-related issues
- Tracking of vital statistics and indicators of pregnancy development

2. Third Trimester Monitoring (28 weeks to delivery):

- Increased frequency of check-ups to biweekly
- Enhanced monitoring of maternal and fetal health
- Evaluation of pregnancy-related complications
- Planning and preparation for childbirth

2.2.5. Data Collection Tools:

Standardized forms were utilized to collect data on:

- Demographic information
- Medical history including chronic illnesses
- Current pregnancy specifics
- Living conditions and environmental influences
- Clinical observations and results from tests.

2.2.5. Placental Morphological Examination:

1. Sample Collection: Placental tissue samples were collected immediately after delivery, with sections taken from the central and peripheral regions.

2. Fixation: Samples were immersed in 10% neutral buffered formalin for 24–48 hours at room temperature to preserve tissue integrity.

3. Tissue Processing & Sectioning: After dehydration, samples were embedded in paraffin wax, and 4 μm thick sections were prepared using a rotary microtome.

4. Staining Protocol: Sections were deparaffinized, rehydrated, and stained with hematoxylin for 5 minutes and eosin for 2 minutes, followed by dehydration and mounting.

5. Microscopic Examination: Slides were analyzed under a BIOMED-6 digital microscope (x460 magnification).

Morphological changes such as sclerosis, vascularization, and hemorrhages were evaluated using standardized histopathological criteria.

6. Data Interpretation: Observations were recorded by two independent pathologists, and images were analyzed using image processing software (if applicable) to quantify structural alterations.

2.2.6. Statistical Analysis Methodology

The analysis of data was performed employing a thorough statistical framework:

2.2.7. Data Processing:

- Primary software: Microsoft Excel utilized for preliminary organization of data
- Advanced statistical evaluation: IBM SPSS Statistics version 13.0
- Assessment of data normality prior to the selection of statistical tests.

2.2.8. Statistical Tests:

- Mann-Whitney test for non-parametric comparisons across groups
- Student's t-test for analysis of parametric data
- Calculation of means (M) and standard deviations (σ)
- Statistical significance benchmark set at $p < 0.05$.

2.2.9. Quality Control:

- Double entry of data to reduce inaccuracies
- Routine validation checks of data
- Consultation with statisticians for complex analyses.

2.2.10. Study Documentation and Quality Assurance

All procedural activities of the study were accurately recorded in compliance with good clinical practice standards:

- Keeping thorough study logs
- Frequent quality assessments of gathered data
- Secure storage of study materials and data
- Regular meetings with the team to ensure

adherence to the protocol.

2.2.11. Study Design:

- Each participant was monitored from registration at the antenatal clinic until the end of pregnancy.
- Stratified random sampling was used to ensure representativeness by geographic region.

Monitoring and Data Collection: Medical examinations:

- First and second trimesters: Monthly check-ups and tests.
- Third trimester: Biweekly check-ups.
- Patient surveys covered general health, chronic diseases, pregnancy history, and living conditions, with data recorded in a standardized form.

3. RESULTS AND DISCUSSION:

3.1. Results

During the analyzed period, an increase was noted in pregnant women living in high mountains for five nosologies of morbidity. In the second Group of women, a decrease in eclampsia, edema, proteinuria, and hypertension is observed. In 2019, the intensive indicator (InIn) of circulatory system disease in pregnant women of the first Group was 314.2 women per 100 thousand pregnant women. Over the same period, the InIn in the second Group was 32.0, that is, several times less compared to the InIn of the first Group, Table 1.

Starting from 2020 to 2021, InIn diseases of the circulatory system Group I decreased by 47%, but these indicators were 26% higher than those of Group InIn groups. In 2022, the InIn in the first Group increased by 13.3%, and in the indicators of the second Group, there was a decrease in diseases of the circulatory system by 41%. An increase in this pathology among pregnant women in the highlands was noted in 2023, where the InIn is 293.4 per 100 thousand births. In pregnant women in low mountains, there is also an increase in InIn from 64.2 to 86.2, which is an increase of 25%.

Anemia among pregnant women accounts for almost 50% of all pathologies in pregnant

women and is the most common nosology in Kyrgyzstan. Over the five years of analysis, the rates of anemia among highlanders admitted under medical supervision in an institution providing primary health care (PHC) did not differ significantly. But they exhibited periodic fluctuations, since from 2019 to 2021, there was a 49% decrease in InIn, which by 2023 increased to 38631.4 per 100 thousand or compared to the previous year, the growth is 36%.

Among pregnant women of Group II examined, an increase was also noted starting in 2019, where the InIn was equal to 15743.1. The maximum indicator of 27294.5 per 100 thousand pregnant women was recorded in 2020, with a further decline to 4012.5 by 2022. In 2023, there will be an increase in the number of pregnant women with anemia to InIn 22364.4.

In general, when comparing intensive indicators, the anemia of groups I and II in pregnant women in high mountains was much higher.

The highest rate of entotic complications during pregnancy among residents of high mountains (Group I) was registered in 2023 (1836.4 per 100 thousand pregnant women). This figure for highlanders over five years showed an increase of 59%. But this pathology shows cyclical variations in prevalence. Since registered pregnant women with venous complications in 2019, there were 768.2 intensive indicators per 100 thousand births. Which by 2020 increased by 41%, and by 2021, a decrease of 60% was noted. Starting from 2022, InIn with this pathology in pregnant women of Group I has increased by 28% (Figure 1).

The second Group also showed a slight increase in venous complications during pregnancy. Intensive indicators per 100 thousand pregnant women in 2020, 2021, 2022 were not significantly different. When compared with the values of 2019, an increase of 35% was noted.

During the entire observation period, the indicators of venous complications in the second Group of pregnant women were at a low level compared to the first one. Edema, proteinuria and hypertension in pregnant women of Group II did not differ significantly during the study period (2019-2023). When compared with the indicators of Group I, they were several times lower. In pregnant women living in high mountains, from 2019 to 2022, there was an increase in registered

pregnant women with this pathology. In 2023, there is a slight decrease of 15%, that is, the intensive rate per 100,000 pregnant women was 2234.6 (Table 2).

Eclampsia in pregnant women in both groups for 2019-2020 did not differ significantly, remaining within the range of 31-37 intensive indicators per 100 thousand pregnant women. In 2021, no eclampsia was observed among pregnant women in low mountains, while in Group I there was a significant increase from 37.1 to 521.8 per 100 thousand pregnancies by 2022, these values were reduced to 143.5 with a subsequent decrease to 38.2 Inln. From this we draw conclusions: eclampsia in pregnant women living in high mountains has an irregular pattern, which is characterized as pregnancy progresses.

3.1.1. Morphological study of the placenta

The placenta of women giving birth in high mountains and low mountains had the same smooth surface. However, among postpartum women living in low mountains, a relatively larger area was noted (by 18.6 %, $p < 0.05$). The chorionic plate is covered by the amnion (Figure 2), with fibrous structures of connective tissue.

The wall of the blood vessels is of normal thickness; a moderate amount of blood is observed in the lumen.

In the placenta I groups, large villi are found, and there are also small ones, whose outlines are pronounced, and there are narrowings and expansions (Figure 3). Observed in pronounced sclerosis and vascularization. Stromal cells contain fibroblasts. Uneven blood supply. The stem vessels are anemic. Their walls are sclerotic.

3.1.2. Statistical results

Based on the provided data, several statistically significant trends and differences emerge. The most prominent observation is the significantly higher prevalence of circulatory system diseases, anemia, and venous complications during pregnancy among women residing in high-altitude regions (Group I) compared to those in lower altitudes (Group II). The differences in Intensive Indicators (Inln) between the two groups are often several-fold, indicating a substantial disparity in maternal health outcomes.

Furthermore, while some morbidity rates exhibit a relatively stable pattern in Group II,

Group I experiences more pronounced fluctuations, described as cyclical variation or irregular pattern. This variability suggests a greater sensitivity to external factors or unmeasured variables affecting the health of pregnant women in high-altitude environments. The increase in anemia in group I, from 2021 to 2023, is an alarming statistic that requires further research.

The morphological analysis of the placenta reveals structural differences between the two groups, particularly regarding villi size, vascularization, and sclerosis. The observed uneven blood supply and anemic stem vessels in Group I placentas may contribute to adverse pregnancy outcomes in high-altitude pregnancies. Also, it was noted that postpartum women in low mountains had a relatively larger placental area.

In summary, the statistical results highlight the distinct challenges faced by pregnant women in high-altitude regions, underscoring the need for targeted interventions and healthcare strategies to address the elevated morbidity rates and improve maternal health outcomes in these populations. Future research should focus on identifying the specific factors contributing to these disparities and evaluating the effectiveness of potential interventions.

3.2. Discussion

According to foreign researchers, the highlands is physiologically and clinically a significant problem at altitudes greater than or equal to 2500 m above sea level. Pregnancy initiates dynamically physiological reactions to compensate for the metabolic needs associated with pregnancy. Main problem is that in high-rise hypoxia conditions it is necessary to support the development of the fetus by sufficiently oxygenated blood. Several authors have concluded that pregnant women from high mountain districts are at risk for the frequency of development of PE, delay intrauterine development of the fetus and, as a result, increases the risk of maternal and perinatal mortality (Liu *et al.*, 2017; Bailey *et al.*, 2020). Based on this, the highlands are an invaluable model for studying physiological and pathological mechanisms that occur in time pregnancy.

Analysis of morbidity in pregnant women showed that eclampsia, edema, proteinuria and

hypertension are higher in high mountains.

Various biochemical mechanisms can cause anemia in pregnant women at high and low altitudes:

Hypoxia: Hypoxia, a condition where the blood lacks sufficient oxygen, is common at high altitudes due to the significantly lower oxygen content in the air. This can cause an increase in erythropoietin production but can also lead to disturbances in the process of erythropoiesis (red blood cell formation).

Hormonal influence: Erythropoietin levels and function can be altered by hormones during pregnancy. At high altitudes, these changes can be more pronounced because of stress factors such as hypoxia and changes in blood pressure.

Iron metabolism: Iron is a key element for the synthesis of red blood cells. At high altitudes, iron metabolism can be disrupted because of changes in oxygen levels and hormonal factors, which can lead to iron deficiency and the development of anemia.

Adaptation to altitude: Through increased red blood cells and hemoglobin, people residing at high altitudes can acclimate to the reduced oxygen levels. However, in pregnant women, this adaptation may be less effective, which can lead to the development of anemia.

Diet and nutrition: At high altitudes, the availability and quality of food may be lower, which can lead to a deficiency of vitamins and minerals needed for the normal functioning of the hematopoietic system.

Rates of anemia in pregnant women at high mountains were much higher compared to those at low altitudes, suggesting that hypoxia directly affects the hemoglobin content in the blood during pregnancy.

Pregnant women at high altitudes might face greater exposure to chemicals, potentially increasing their risk of circulatory problems.

Low oxygen levels (hypoxia): At high altitudes, the oxygen content in the air is significantly lower, which can lead to hypoxia, which can worsen cardiovascular problems.

Changes in hormonal levels: High altitude can cause stress reactions, which affect hormonal

levels and can lead to hypertension and other cardiovascular diseases.

Changes in metabolism: In conditions of low oxygen, the body can change its metabolic processes, which can negatively affect the cardiovascular system.

Increased blood pressure: High altitude can cause an increase in blood pressure, which is also a risk factor for cardiovascular diseases.

Pregnant women, particularly those with pre-existing cardiovascular issues, may experience a worsening of their condition because of these factors.

Based on the data obtained, we can conclude that residents of high mountains have a high probability of developing venous complications during pregnancy.

At morphological research placentas, more pronounced morpho-functional pathological changes were revealed, such as hemorrhages in the intervillous space, with pronounced sclerosis and vascularization.

Methods employed to monitor oxygen levels in studies examining high-altitude placental physiology are diverse and often involve a combination of direct and indirect approaches. Direct measurement typically relies on specialized sensors and probes placed within the uterine environment or even directly within placental tissue. These devices, often electrochemical in nature, provide real-time assessment of partial pressure of oxygen (PO₂) at specific locations. More sophisticated techniques, such as microdialysis coupled with oxygen sensors, allow for continuous monitoring of interstitial fluid oxygen concentrations within the placenta, offering a dynamic picture of oxygen availability at the cellular level. These direct measurements, however, are inherently invasive and require careful consideration of potential impacts on placental function.

Indirect methods offer a less invasive alternative for assessing oxygen status. Arterial blood gas analysis in the mother provides valuable information about maternal oxygenation and overall respiratory function, which indirectly reflects oxygen delivery to the uterus. Doppler ultrasound, widely used in obstetric care, can assess blood flow velocity and resistance in the uterine and umbilical arteries. Reduced blood flow, especially with increased resistance, may indicate

compromised oxygen delivery to the placenta. Additionally, non-invasive techniques like near-infrared spectroscopy (NIRS) can be used to estimate tissue oxygenation by measuring the absorption and scattering of near-infrared light in placental tissue. NIRS provides a measure of oxygen saturation in hemoglobin and myoglobin, offering an indication of oxygen utilization within the placenta.

Furthermore, biochemical markers in maternal and fetal blood can provide indirect insights into oxygen-related stress. For instance, measuring levels of erythropoietin (EPO), a hormone stimulated by hypoxia, can indicate the extent to which the fetus is experiencing low oxygen conditions. Similarly, analyzing concentrations of oxidative stress markers, such as reactive oxygen species (ROS) and antioxidant enzymes, can reveal the degree of cellular damage resulting from oxygen deprivation. These biochemical analyses, when combined with other oxygen monitoring techniques, paint a more comprehensive picture of the placental response to high-altitude hypoxia.

Despite all the existing research on the disease during pregnancy in high altitude conditions, up to the present, the features remain insufficiently studied obstetric and gynecological pathologies given categories of female patients.

This study was conducted to evaluate the incidence rates of pregnant women living in high mountains. Submitted data suggests that women mountaineers are more likely to develop diseases of the circulatory system.

4. CONCLUSION

The incidence of anemia during pregnancy among residents of high mountain regions is higher than in the lowlands. Increased circulatory system disease among pregnant women in the highlands was noted in 2023, where the $I_n I_n$ is 293.4 per 100 thousand births. Residents of high mountains are more likely to develop venous complications during pregnancy compared to residents of low mountains. In the histological picture, the placentas of women giving birth in high-mountain and low-mountain areas have identical smooth surfaces.

Under the influence of mountain hypoxia, more pronounced morpho-functional pathological changes are observed in the placenta of parturient women, such as hemorrhages in the intervillous

space, with pronounced sclerosis and vascularization.

5. DECLARATIONS

5.1. Limitations of the study

Data related to the number of pregnant women in the study areas was limited.

The impact of air pollution and healthcare access, among other environmental and social factors, was insufficiently addressed.

Equipment: the use of only one type of microscope may have limited the completeness of pathology detection.

Elimination of limitations in future studies

Expand the sample by including pregnant women from other high-mountain areas.

The impact of various environmental and social factors should be assessed through multivariate analysis.

More modern diagnostic methods, such as immunohistochemistry and mass spectrometry, are used for placental tissue analysis.

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5.4. Competing interests

The authors declare no conflict of interest.

5.5. Authors' contribution to the study

K. Kasieva - data collection.

T.M. Topchubaeva - data collection.

S. Azhibaeva - clinical data collection.
 B.M. Atakulova - study of personnel provision.
 Dzh.A. Umetova - analysis of morbidity.
 R.R. Tukhvatshin - technical support.
 A.I. Subanova - statistical processing, generalization and writing of the article.

6. HUMAN AND ANIMAL-RELATED STUDIES

6.1. Ethical Approval

The study was conducted with the approval of the Ethics Committee for Clinical Research of Healthcare of the Osh Region and the City of Osh (No. 01-15/22 dated 09.02.2022). The study compliance with the ethical principles of the Helsinki Declaration (2013) and current regulatory requirements.

6.2. Informed Consent

All patients were accepted as volunteers for this study, and were informed about the purpose of the study.

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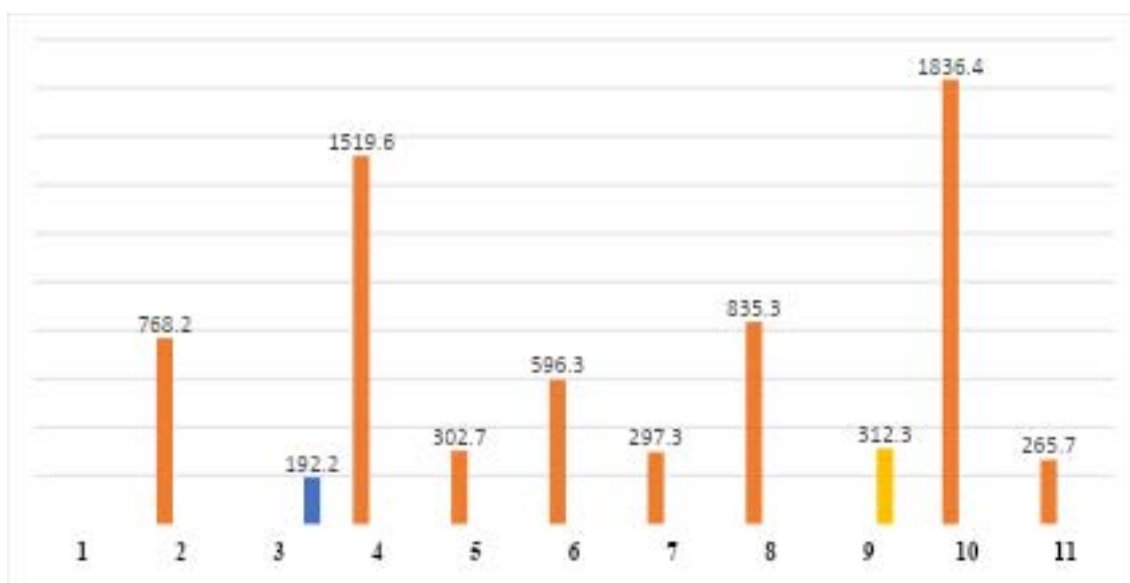


Fig. 1. Venous complications during pregnancy. Note: (rate per 100,000 pregnant women). I group, InIn group.

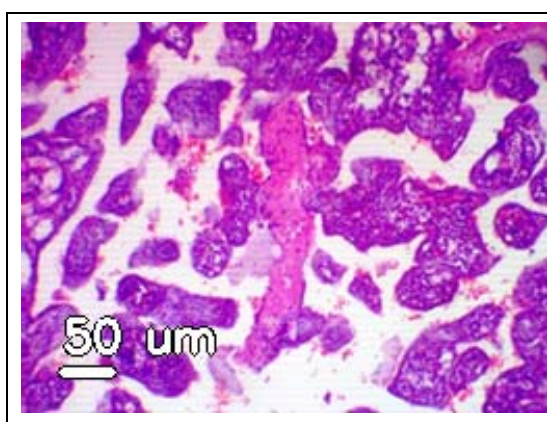


Fig. 2. Structure of placenta, InIn group.

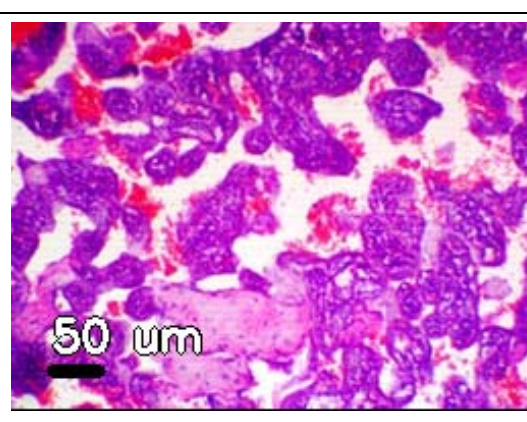


Fig. 3. Structure of placenta, I group.

Table 1. Morbidity rate in pregnant women (per 100,000 pregnant women)

Years	2019		2020		2021		2022		2023	
	Group I	Group InIn	Group I	Group InIn	Group I	Group InIn	Group I	Group InIn	Group I	Group InIn
Diseases of the circulatory system	314.2	32.0	259.5	0.0	149.1	110.2	172.4	64.2	293, 4	86.2
Anemia	37325.4	15743.1	36434.4	27294.5	18375.0	4752.9	24652.4	4012.5	38631.4	22364.4

Table 2. Morbidity rate in pregnant women (per 100,000 pregnant women)

Years	2019		2020		2021		2022		2023	
	Group I	Group InIn	Group I	Group InIn	Group I	Group InIn	Group I	Group InIn	Group I	Group InIn
Edema, proteinuria and hypertension	1187.2	160.2	2112.7	127.5	2571.7	152.4	2646.1	187.4	2234,6	157,3
Eclampsia	34.9	32.0	37.1	31.9	521.8	0.0	143.5	30.2	38,2	28,7