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EPIDEMIOLOGICAL CHARACTERISTICS OF CONGENITAL MALFORMATIONS IN THE TURKESTAN REGION OF KAZAKHSTAN: NOSOLOGICAL STRUCTURE AND RISK FACTORS

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Abstract

Congenital malformations are a significant public health problem that encompasses various disciplines, such as obstetrics, gynaecology, paediatrics, medical genetics, and others; the significant prevalence of the problem and the possibility of its prevention determine the study relevance of the prevalence and risk factors associated with the development of pathology. The study aims to investigate the epidemiological aspects of congenital malformations in the Turkestan region of the Republic of Kazakhstan, including Suzak, Otyrar and Sairam districts, as well as the cities of Kentau and Turkestan, and to consolidate the current literature on this problem. The study assessed the epidemiological evaluation of the nosological structure of congenital malformations in this region, covering the period from 2020 to 2022. The results showed that the most common malformations are musculoskeletal anomalies and cardiovascular disorders. In addition, the study identified key groups of risk factors that may influence the development of birth defects. Among such factors, genetic hereditary features, environmental conditions, lifestyle of expectant mothers and the presence of chronic diseases were found to be important. The period under review also observed a steady increase in the number of congenital malformations, especially in the category of cardiovascular pathologies. This emphasises the importance of developing and implementing preventive measures. One of the key findings of the study was the need to introduce pregravid training and lifestyle correction for expectant mothers. These steps can significantly reduce the incidence of congenital anomalies and improve pregnancy outcomes. In addition, new directions for future research aimed at studying risk factors and developing effective methods for the prevention of congenital malformations in this region were outlined. This study has broad practical relevance not only for medical staff, as it highlights the epidemiological aspect of the problem, but also for researchers, outlining the direction of further research, and the material can be applied by representatives of pressure groups to develop preventive interventions.

Keywords: *early diagnosis, pregravid preparation, paediatric population, new-borns, prenatal screening, neonatal mortality.*

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Резюме

ЭПИДЕМИОЛОГИЧЕСКАЯ ХАРАКТЕРИСТИКА ВРОЖДЕННЫХ ПОРОКОВ РАЗВИТИЯ В ТУРКЕСТАНСКОЙ ОБЛАСТИ КАЗАХСТАНА: НОЗОЛОГИЧЕСКАЯ СТРУКТУРА И ФАКТОРЫ РИСКА

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Врожденные пороки развития являются значимой проблемой общественного здравоохранения, охватывающей различные дисциплины, такие как акушерство, гинекология, педиатрия, медицинская генетика и другие; значительная распространенность проблемы и возможность ее профилактики определяют актуальность изучения распространенности и факторов риска, связанных с развитием патологии. Целью исследования является изучение эпидемиологических аспектов врожденных пороков развития в Туркестанской области Республики Казахстан, включая Сузакский, Отырарский и Сайрамский районы, а также города Кентау и Туркестан, и консолидация современной литературы по данной проблеме. В исследовании дана эпидемиологическая оценка нозологической структуры врожденных пороков развития в данном регионе, охватывающая период с 2020 по 2022 год. Результаты

показали, что наиболее распространенными пороками развития являются аномалии опорно-двигательного аппарата и сердечно-сосудистые заболевания. Кроме того, в ходе исследования были выявлены основные группы факторов риска, которые могут оказывать влияние на развитие врожденных пороков. Среди таких факторов значимыми оказались генетические наследственные особенности, экологические условия, образ жизни будущих матерей и наличие хронических заболеваний. В рассматриваемый период также наблюдался устойчивый рост числа врожденных пороков развития, особенно в категории сердечно-сосудистой патологии. Это подчеркивает важность разработки и внедрения профилактических мероприятий. Одним из основных выводов исследования стала необходимость внедрения прегравидарной подготовки и коррекции образа жизни будущих матерей. Эти шаги позволяют существенно снизить частоту врожденных аномалий и улучшить исходы беременности. Кроме того, были намечены новые направления будущих исследований, направленных на изучение факторов риска и разработку эффективных методов профилактики врожденных пороков развития в данном регионе. Данное исследование имеет широкую практическую значимость не только для медицинских работников, так как освещает эпидемиологический аспект проблемы, но и для исследователей, намечая направления дальнейших исследований, а материал может быть использован представителями влиятельных групп для разработки профилактических мероприятий.

Ключевые слова: *ранняя диагностика, прегравидарная подготовка, детская популяция, новорожденные, пренатальный скрининг, неонатальная смертность*

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Түйіндеме

ҚАЗАҚСТАННЫҢ ТҮРКІСТАН ОБЛЫСЫНДАҒЫ ТУА БІТКЕН ДАМУ АҚАУЛАРЫНЫҢ ЭПИДЕМИОЛОГИЯЛЫҚ СИПАТТАМАСЫ: НОЗОЛОГИЯЛЫҚ ҚҰРЫЛЫМЫ МЕН ҚАУІП ФАКТОРЛАРЫ

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Туа біткен даму ақаулары – бұл акушерлік, гинекология, педиатрия, медициналық генетика және басқа да салаларды қамтитын маңызды қоғамдық денсаулық сақтау мәселесі. Бұл мәселенің кең таралуы мен оның алдын алуға болатындығы патологияның таралуын және қауіп факторларын зерттеудің өзектілігін айқындайды. Зерттеудің мақсаты – Қазақстан Республикасының Түркістан облысындағы, соның ішінде Сузак, Отырар және Сайрам аудандары мен Кентау және Түркістан қалаларындағы туа біткен даму ақауларының эпидемиологиялық аспектілерін зерттеу және осы мәселе бойынша қазіргі ғылыми әдебиеттерді сараптау. Зерттеу 2020–2022 жылдар аралығындағы кезеңде аймақтағы туа біткен ақаулардың нозологиялық құрылымына эпидемиологиялық баға беруді қамтыды. Нәтижелер көрсеткендей, ең жиі кездесетін ақаулар – бұл тірек-қимыл аппаратының ақаулары мен жүрек-қан тамыр жүйесінің бұзылыстары. Сонымен қатар, зерттеу барысында туа біткен ақаулардың дамуына әсер етуі мүмкін негізгі қауіп факторлары анықталды. Олардың қатарына: тұқым қуалаушылық, қоршаған орта жағдайлары, болашақ аналардың өмір салты және созылмалы аурулардың болуы жатады.Қарастырылған кезеңде, әсіресе жүрек-қан тамыр жүйесіне қатысты ақаулар санында тұрақты өсу байқалды. Бұл жағдайдың алдын алуға бағытталған шараларды әзірлеу мен енгізудің маңыздылығын көрсетеді. Зерттеудің негізгі тұжырымдарының бірі – болашақ аналарға арналған прегравидарлық дайындық пен өмір салтын түзетудің қажеттілігі болды. Бұл қадамдар туа біткен ақаулардың жиілігін айтарлықтай азайтып, жүктілік нәтижелерін жақсарта алады. Сонымен қатар, осы аймақта туа біткен даму ақауларының алдын алудың тиімді әдістерін әзірлеуге және қауіп факторларын тереңірек зерттеуге бағытталған болашақ зерттеулердің жаңа бағыттары айқындалды. Бұл зерттеу тек медицина қызметкерлері үшін ғана емес, сонымен қатар зерттеушілер мен профилактикалық шараларды әзірлеуге қатысатын мүдделі топтар үшін де практикалық маңызға ие.

Түйінді сөздер: ерте диагностика, прегравидарлық дайындық, педиатриялық популяция, жаңа туғандар, пренаталдық скрининг, неонаталдық өлім-жітім.

Дәйексөз үшін: *Аязбеков А., Ошибаева А., Таубекова М., Танышева Г.* Қазақстанның Түркістан облысындағы туа біткен даму ақауларының эпидемиологиялық сипаттамасы: нозологиялық құрылымы мен қауіп факторлары // Ғылым және Денсаулық сақтау. 2025. Vol.27 (2), Б. 78-86. *doi 10.34689/SH.2025.27.2.010*

Introduction

Within the framework of the state health programme of Kazakhstan, the priority is to protect the health of mothers and children. This is driven not only by humanitarian but also by strategic considerations, as maternal and child health has a direct impact on fertility rates, population growth and the overall health of the nation. In this context, congenital malformations (CMs), which are structural errors and chromosomal abnormalities that occur during foetal development, receive special attention. CMs are of high medical and social significance because they are often associated with increased mortality and morbidity during new-born and childhood. They can also cause disability in both the short and long term. Moreover, CM is associated with an increased risk of miscarriage and stillbirth, making its study and control critical public health challenges. Research on CM epidemiology, including data on its prevalence, risk factors and trends, is an integral part of efforts to prevent and manage these malformations. This enables the development of more effective prevention, diagnosis, and treatment strategies, as well as the optimisation of healthcare resources. In Kazakhstan, as in other countries, research into the epidemiology of congenital malformations is essential to ensure the health of future generations and the sustainable development of the nation.

This issue has been repeatedly considered by representatives of the scientific community, however, due to the universal nature of the problem, the issues of epidemiology and comprehensive analysis of risk factors have not been given due attention, including in Kazakhstan. Several researchers considered the CM issue not only separately, but also as part of the global problem of hereditary diseases, in particular. This is determined by a significant part of CM with a genetic predisposition, a similar approach was shared by S. Best et al. [3]. The researchers analysed genomic sequencing data from the 100,000 Genomes Project cohort to estimate the frequency of molecular diagnoses in congenital malformations caused by ciliopathies. The study found that a molecular diagnosis was made in 51.9% of cases, with mutations in the CEP290, CC2D2A, NPHP1 and IFT172 genes being the most common. The authors concluded that genomic sequencing is an important tool to identify genetic causes of CM. M. Manotas et al. investigated the prevalence and risk factors for the development of CM on the example of pathologies of the neurosensory system [17].

The analysis of cases and controls revealed that low maternal (1.34) and paternal (1.42) education, maternal occupation involving manual labour (1.31), family history of congenital anomalies (1.55), multiple pregnancies (1.47) and acute respiratory infection during pregnancy (2.41) were significant risk factors for the occurrence of both neurosensory system birth defects and CM in general. Along with studying risk factors and prevalence, other researchers, such as E.A. Ronner et al, addressed the quality of life of children with CM [20]. This group of scientists focused on studying the quality of life of patients and minimising the negative impact of birth defects. In particular, they paid special attention to psychosocial adaptation and correction of possible consequences after medical interventions. D.S. Kudratova et al. in the course of their study confirmed the importance of the problem of cardiovascular CM and their epidemiological analysis, especially in the current pandemic [13]. The authors made a recommendation to adopt the positive experience of countries with low mortality from this group of CM, emphasising the need for early detection, effective treatment, and systemic prevention of risk factors. It was specified that such measures can contribute to the reduction of morbidity and increase the effectiveness of control of these pathologies.

The tendency from the general to the particular in the consideration of this problem can also be seen in the study of risk factors, especially in isolation from purely epidemiological studies. The study conducted by U. Kozhakhmetova et al. analysed the change in the CM incidence among children living in the Republic of Kazakhstan for six years, from 2012 to 2017 [12]. This paper analysed the cases of children born with detected congenital anomalies. In addition, the researchers searched for specific causes and conditions that may influence the CM occurrence, both at the general population and individual levels. Y. Wang et al. considered the problem of congenital infections caused by TORCH pathogens (toxoplasmosis, rubella, cytomegalovirus, herpes) as a risk factor for CM development, focusing on the need to expand programmes for prevention, early diagnosis, and treatment of these infections [27].

As such, given the importance of further research, the study aims to conduct an epidemiological analysis, which includes determining the CM structure specific to this area, as well as a comprehensive review of the current literature on the prevalence of these pathologies and the risk factors that may contribute to their development. These districts are Suzak, Otyrar, and Sairam, as well as the cities of Kentau and Turkestan, are particularly noteworthy as study sites.

Materials and Methods

The study covers the following territories: Suzak, Otyrar and Sairam districts, as well as the cities of Kentau and Turkestan in Turkestan region of the Republic of Kazakhstan, based on the need to analyse epidemiological data on the CM nosological structure in the region. These territories and settlements were chosen for scientific work since similar studies have not been previously conducted in them, and they are representative of the whole country, which was used to obtain data on the CM nosological structure in Kazakhstan as a whole. The following materials were used to analyse the CM epidemiology: Baseline data were obtained from medical records, including medical records of new-borns, case histories, results of medical examinations and diagnostic reports. Statistical data on the number of born children with CM were obtained from the reports of medical institutions and health authorities of the Turkestan region. Thus, a statistical sample was formed, which includes 263 children with CM born in the period 2020-2022.

Several methods were employed to process the above-described materials. Descriptive statistics was used to outline the main characteristics of the data, including mean values, medians, standard deviations, and minimum and maximum values. An overview of the distribution of congenital malformations over the study period was acquired using this method. Frequency analysis was

employed to identify the number of cases of each type of congenital malformation in each of the three years and express them as a percentage of the total number of patients. Comparative analysis was used to determine changes in the prevalence of malformations over the three years. This involved comparing data between years to identify statistically significant differences. Time series analysis was used if the data were in the form of a time series to analyse the trends in the CM prevalence over time. Cluster analysis was used to identify similar patient groups or regions with similar patterns of CM. To consolidate knowledge regarding the CM epidemiology and the factors that influence this problem, both general theoretical methods of knowledge and the following methods were used: bibliographic, analytical and method of systematisation and categorisation of data.

An extensive literature search was conducted in reputable scientific sources, including CINAHL, Web of Science, Cochrane Library, Science Direct, PubMed, Psychology Database, JSTOR, Ovid and EMBASE. Queries covered various combinations of keywords and phrases related to the CM epidemiology and risk factors, including "birth defects", "epidemiology", "risk factors", "developmental abnormalities", "new-borns", "incidence", and others. Articles from 2018 to 2023 were covered in the search, including both basic research and current scientific publications, to gain a better understanding of the current methodological basis of the topic. The data systematisation and categorisation method were used to organise and classify the information obtained. A systematic data structure was developed, which was used to analyse and interpret information on CM and risk factors more effectively. This method also contributed to the identification of general trends and patterns in the prevalence of malformations, which is an important element of this study.

Results

As part of the epidemiological analysis of the above-presented material, the data presented in Table 1 was obtained and analysed, which is also visually represented in Figures 1-4.

Table 1.

Nosological structure of congenital malformations in new-borns in Turkestan region for 2020-2022.

CM	2020		2021		2022		Average value	Σ
Cardiovascular system	15	26.8%	33	37.9%	41	34.2%	32.96%	2.13%
Musculoskeletal system	18	32.1%	18	20.7%	32	26.7%	26.5%	1.84%
Digestive system	7	12.5%	11	12.6%	14	11.7%	12.26%	1.36%
Nervous system	7	12.5%	13	14.9%	10	8.3%	11.9%	1.36%
Syndromes associated with chromosomal aberrations	8	14.3%	10	11.5%	14	11.7%	12.5%	1.51%
Urinary system	1	1.8%	2	2.3%	5	4.2%	2.76%	0.89%
Respiratory system	0	0%	0	0%	3	2.5%	0.83%	-

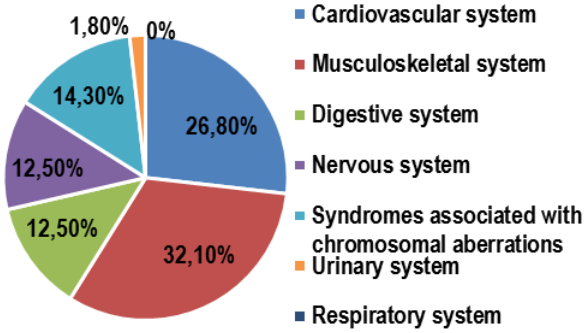

Figure 1. Nosological structure of congenital malformations in new-burns in Turkestan region in 2020.

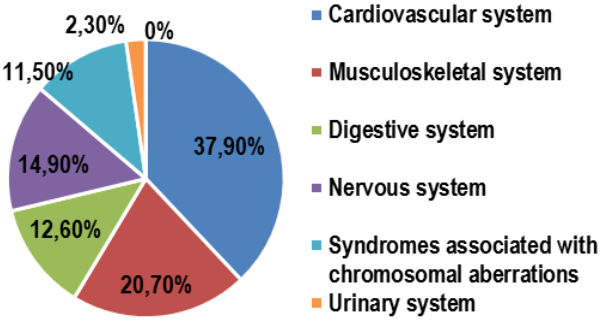

Figure 2. Nosological structure of congenital malformations in new-borns in Turkestan region in 2021.

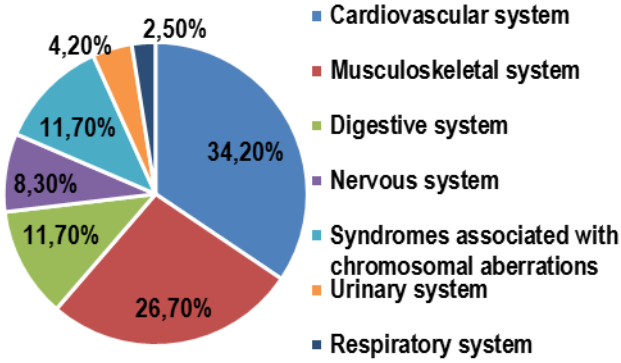

Figure 3. Nosological structure of congenital malformations in new-borns in Turkestan region in 2022.

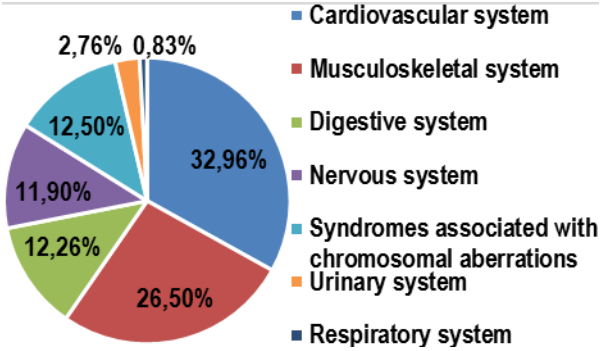

Figure 4. Nosological structure of congenital malformations in new-borns in Turkestan region in the period 2020-2022 (average values).

Based on the data presented, it is possible to conclude that the most common CMs in the Turkestan region are musculoskeletal system pathologies (26.7% of cases), cardiovascular system (32.96%) and syndromes associated with chromosomal aberrations, mainly Down syndrome (12.5%). There was an increase in CM occurrence over the three years, especially for pathologies of the cardiovascular, musculoskeletal, and urinary system. This increase can be attributed to several factors, including the deterioration of the environmental situation and changes in the lifestyle of the population. The identified structure of morbidity does not differ significantly from that in other countries, such as Norway 18], Egypt [1], and France [4].

Among CMs, congenital heart defects are the most common, as also confirmed by this study, with anomalies occurring in new-borns in the range of 4 to 10 cases per 1,000 live births [10]. Among the most typical among them are transposition of the main vessels, open ductus arteriosus, interventricular septal defect, Fallot's tetrad and atrial septal defects. No specific risk factors for the development of this group of pathologies have been identified, but the use of molecular research methods is now opening new perspectives in the study of cardiac developmental defects, reducing the gap in understanding between morphological, exogenous, and genetic aspects [6]. There is a suggestion that genetic factors play a significant role in CM development [9].

Musculoskeletal congenital malformations are the second most common group of congenital malformations for this work, after congenital heart disease. According to studies, they occur at a rate of 2 to 3 cases per 1,000 live births [21]. This group includes developmental anomalies of limbs, bone, and muscle structures of the skull, including cleft palate, which is most common in Turkestan region. Given the polymorphism of this group, there is currently no established concept regarding the factors that contribute to CM development. A significant role in this case is known to be attributed to molecular genetic changes and the use of drugs such as fluconazole [5], opioid analgesics [28], and macrolide antibiotics [16]. The somatic condition of the mother, including widespread endometriosis [15] and hypothyroidism [26], also plays a role. Environmental factors, such as agrochemical pollution, also play a role [7].

A significant part of the problem is central nervous system abnormalities, a group of anomalies that occur in 2 cases per 1,000 new-borns. Given the particular severity of these abnormalities, the high proportion of planned terminations of pregnancy for medical reasons and the proportion of spontaneous abortions, especially in the early stages of pregnancy, when the mother may not have information about the fact of pregnancy, the prevalence may be even higher [8]. Given the long developmental time and the peculiarities of the structures of the central nervous system, a wide range of factors, from maternal metabolic disorders and the lack of certain nutrients to the toxic effects of drugs, can lead to disorders of their formation. In modern studies concerning the problem of central nervous system malformations, the issue of heavy metals' influence on the formation of cerebral structures occupies a special place. These substances can accumulate in the cerebrospinal fluid due to their ability to pass through the blood-brain barrier. Heavy metals can affect not only the morphogenesis of central nervous system structures but also affect brain metabolism at deeper levels, including the activity of enzyme systems associated with ATP, which is critical for such metabolically active tissues as the nervous system [19]. Lead is particularly active across the haemtoencephalic barrier, it also increases the overall permeability of the barrier, leading to brain oedema, development of hydrocephalus, herniation, haemorrhage, and others [30]. Manganese and aluminium may be associated with neurodegenerative disorders and other adverse effects, in particular, the latter causes memory impairment and leads to the development of chronic fatigue, irritability and depression, which is possibly related to the influence on neurotransmission mediated through the cholinergic system [29]. Numerous studies revealed a correlation between metal exposure and congenital malformations of the central nervous system [14].

Particular attention should be devoted to Spina Bifida, based not only on its high prevalence but also on the presence of several modifiable factors. Neural tube defects are serious congenital anomalies that manifest themselves when the neural plate, the embryonic structure from which the brain and spinal cord are formed, fails to close properly around the third to fourth week of gestation [22]. The malformation, depending on the severity, may present with several symptoms ranging from minor neurological abnormalities to foetal death. This pathology has a wide range of risk factors: female sex of the foetus, belonging to the Hispanic ethnic group, especially if the mother is Hispanic, the presence of cases of children born with neural tube defects in the family history; endocrine-metabolic disorders in the mother, such as obesity, gestational and pregestational diabetes mellitus, some role is also played by the mother's excessive use of saunas and whirlpools, especially in early pregnancy [24]. The most notable risk factor is folic acid deficiency in the maternal diet. The inclusion of folic acid intake in the maternal diet and the use of folic acid preparations are mandatory components of pregravid preparation. Thus, studies conducted in several countries such as Canada, Costa Rica, USA, South Africa, and Brazil proved that the integration of this practice helped to reduce the number of neural tube defects by 19-50%, which illustrates the prospects of modifying risk factors not only for Spina Bifida but also for other malformations [25].

Urinary tract malformations are common and there is a wide variation in the prevalence of these malformations, which is well demonstrated by several

studies carried out in different countries. Thus, the prevalence ranges from 4 per 10,000 new-borns in Taiwan to a much higher number of 4 cases per 1,000 new-borns in some European countries [2, 23]. This group covers a wide range of abnormalities that can manifest themselves as purely functional or structural abnormalities that affect the urinary system from the kidneys, ureters, urine collection system and bladder. Urinary tract abnormalities are associated with a high risk of adverse birth outcomes, and the most severe forms may be accompanied by spontaneous abortion [11]. Subsequently, these anomalies are closely associated with impaired renal function, irrespective of the level at which the urinary system is affected. In Japan, 39.8% of cases of terminal renal failure in persons under 20 years of age are associated with urinary tract malformations. Risk factors, in this case, include the male sex of the foetus, which increases the risk of pathology by 1.83 times, maternal age over 35 years, metabolic and endocrine diseases of the mother in the form of gestational obesity and pregestational diabetes, genetic and environmental factors, in particular, the pathology is more often detected in large urban agglomerations.

These abnormalities have a significant impact on the health of the new-born and require highly competent and urgent intervention, which requires significant material resources. The prevalence of digestive system disorders varies greatly depending on the geography of the region and the time of the study, from 1.28-4.55 cases per 10,000 births in Europe to 1.97 cases per 1,000 new-borns in Japan. Lack of, erroneous or outdated understanding of the prevalence of this pathology may lead to an underestimation of the resources needed to treat it effectively. Differences in statistics may affect the specificity of care, which emphasises the importance of updating information in this area. Consensus has not been reached regarding risk factors for the development of digestive system disorders, although it is well known that maternal age over 35 years, certain infections, medications, and drugs can influence the likelihood of developing the pathology.

Mortality from CM occurs mainly in the first 170 hours after birth, in 37.5% of cases. This high rate of postneonatal mortality was attributed to decompensation of the functions of pathologically altered organs, which can be qualified as the presence of malformations incompatible with life. An uneven distribution of deaths between inhabitants of rural and urban areas was also revealed, with a preponderance of mortality in favour of the inhabitants of villages. Gender inequality was also found to be significantly higher in all study periods, with boys dying more often than girls and this upward trend steadily continuing. It was found that the vast majority of deaths from CM occur in infancy (82.6%). The study highlights the high level of infant mortality due to birth defects and the differences in mortality between boys and girls, as well as the influence of place of residence on mortality statistics.

As such, by analysing the structure of congenital malformations in the Turkestan region and establishing the prevalence of the most significant anomalies, as well as highlighting the influence of various risk factors, both modifiable and non-modifiable, on the structure of morbidity, several important aspects should be emphasized. Modern scientific research methods allow us to view this problem in a new light, and the division of factors into modifiable and non-modifiable provides a clear basis for further interventions. Many of these factors are amenable to correction, including biological and social aspects, providing a wide range of possible interventions. These interventions may encompass pregravid practices as well as the introduction of national programmes aimed at reducing tobacco, alcohol, and drug use. Despite the persistence of significant social gaps between different segments of the population, this fact leaves a wide scope for potential action and the development of targeted interventions. Health interventions can help to reduce this gap and improve public health in general. In addition, risk factors that may not currently appear to be amenable to targeted interventions are increasingly being identified thanks to modern advances in molecular genetics. These discoveries have the potential to improve the diagnosis and prognosis of birth defects and, in the long term, may serve as a basis for the development of preventive interventions against CM.

Discussion

Thus, during the epidemiological analysis of CMs in Turkestan in 2020-2022, the most common CMs in the region were found to be musculoskeletal anomalies, cardiovascular malformations, and chromosomal anomalies. An increase in the number of cases of CM development was also observed over the period, with a special emphasis on the increase in the frequency of pathologies related to the cardiovascular system. In general, the nosological structure of CM in the region was similar to that of other countries, although further comparison may require further clarification. A comprehensive analysis of modern sources on risk factors for the development of CM was also conducted, which allows us to find points for further practical application of this study as a basis for the development of programmes to address these factors. In addition, further research on prenatal diagnosis and pregravid preparation, which play an important role in reducing the incidence and negative outcomes of CM, deserves special attention

The nosological structure was also dominated by cardiovascular and musculoskeletal CMs (31.77% and 25.14%, respectively), which is similar to the results obtained in this study. However, a significant proportion of genitourinary anomalies (17.5%) was also detected in Ukraine, which is strikingly different from the indicators in Kazakhstan. The presented material also highlights

the stable prevalence of chromosomal anomalies, which does not correspond to the results obtained in this study, where this indicator fluctuated.

The study showed a steady increase in CM incidence, with a particular focus on the formation of oropharyngeal clefts, thus confirming the findings of this paper regarding the increasing CM prevalence, including musculoskeletal disorders. Thus, the results are at variance with the materials of this study, as only single cases of respiratory system CM were identified in the Turkestan region.

A high proportion of stillbirths occurred in children with chromosomal abnormalities, Spina bifida and Potter syndrome, the latter of which was not observed in the Turkestan region.

Prenatal diagnosis allows the detection of potential CM early in pregnancy. This process provides an opportunity for parents and healthcare providers to take appropriate measures to treat or terminate the pregnancy. Given the importance of prenatal diagnosis and the presence of risk factors such as maternal age, place of residence, and unhealthy habits, ensuring access to this diagnosis for all expectant parents is an integral part of a strategy to reduce infant mortality from CM. The introduction of effective prenatal diagnosis has the potential to significantly improve the prospects of children born with CM and reduce their mortality.

These techniques also depend on the expertise of the staff member performing the procedure, and their results may be difficult to obtain due to, for example, abnormal foetal position or maternal obesity. Invasive procedures such as chorionic villus biopsy and amniocentesis provide high accuracy in the CM diagnosis, especially hereditary forms, but are associated with risks to mother and child. However, new diagnostic methods based on the analysis of biomarkers in maternal body fluids provide a more elegant and earlier way to detect and predict fetal malformations. For example, the detection of circulating placental mRNA is possible as early as the 4th week of pregnancy, well before the embryo is fully developed. Such circulating biomarkers, including proteins, long noncoding RNAs, microRNAs, circular DNAs and RNAs, can be used for prenatal diagnosis at different stages of pregnancy, and they represent an important tool for predicting and assessing foetal development. The studies mentioned above comprehensively address the topic of prenatal diagnosis, omitting epidemiology and risk factors for the development of CM, in contrast to this paper, for which these aspects are the main focus. Nevertheless, the presented studies complement the work on the issues of early detection of CM.

Considering the range of modifiable risk factors, pregravid preparation – a set of measures that includes preparation and counselling of women planning a pregnancy or in the reproductive age – comes to the forefront in the fight against CM. This process aims to prepare future parents for a successful pregnancy, safe delivery, and care for the child's health after birth. Most importantly in the context of the problem, pregravid preparation includes correction of behavioural factors and somatic diseases that may be risk factors for CM. Preconception interventions, including pregnancy planning counselling, optimising glycaemic control before conception and the use of multimedia educational materials such as CD-ROMs or pamphlets, have been used to prevent pregnancy complications in women with type 1 and type 2 diabetes. In the case of epilepsy, interventions included structured counselling, interactive educational sessions and adjustment of antiepileptic medication use according to the woman's condition. The target population included women with epilepsy and those at risk of developing neural tube abnormalities. In cases of thyroid disease, pre-conception interventions included optimising thyroid status before pregnancy using medication or surgery. In women with phenylketonuria, the main pre-conception intervention was dietary modification and restriction of consumption of foods containing phenylalanine. Recommended vaccinations for women of childbearing age include HPV, hepatitis B, varicella, influenza, measles, mumps, rubella, diphtheria, tetanus, and pertussis. Screening of high-risk women for tuberculosis, hepatitis C, gonorrhoea and chlamydia is also recommended. In HIV, pre-conception counselling plays an important role. Antiretroviral therapy and caesarean section can significantly reduce the risk of vertical transmission of HIV from 25% to 1%.

The paper also emphasises the need for behavioural intervention in the case of drug, alcohol and tobacco use to withdraw. The authors took a comprehensive approach to the problem of risk factor modification through pregravid preparation, which is also important in the context of this study, as the material presented above can serve as a basis for the methodological development of early interventions to prevent the development of CM.

Conclusions

The data presented in the study indicate that CMs in the Turkestan region are represented by a wide range of pathologies of different body systems, with the most common being pathologies of the musculoskeletal and cardiovascular systems. This suggests the need to pay special attention to these categories of malformations in the development of prevention and treatment programmes at both regional and national levels. A study of long-term trends indicates a continuous increase in the number of CM cases, especially cardiovascular malformations, which should also be considered in the design of prevention programmes. The increase can be attributed both to increased awareness and diagnosis, making previously neglected cases available for study, and to an actual increase in the incidence of malformations.

The overall CM incidence pattern identified in this study is similar to data from other regions and countries.

This indicates that the problems associated with CM are global and require worldwide attention and joint efforts to overcome the problem. However, it is important to address regional peculiarities and territory-specific risk factors. It is also important to note that CM has a significant impact on neonatal mortality. This aspect requires additional research and attention from the medical community, as well as the development of measures to reduce mortality and improve the prognosis of children born with CM. The study identified several major risk factors including heredity, maternal age, sex of the child, ethnicity, exposure to environmental factors, lifestyle and maternal somatic diseases, especially gestational and pre-gestational diabetes. At times, non-obvious factors, such as the number of pregnancies, have an impact on the formation of CM. This highlights the importance of diverse and flexible approaches to the prevention of CM, including genetic counselling, maternal education, and environmental interventions.

The importance of timely prenatal diagnosis, including ultrasound and genetic testing, as well as regular screening in all pregnant women, should be emphasised. This will make it possible to detect possible CM early and take appropriate measures. To reduce the CM incidence, a set of measures is needed, including pregravid training for expectant mothers, lifestyle corrections and management of chronic diseases in pregnant women, as well as improving the environmental situation in the region. Given the growing knowledge of risk factors and effective methods of preventing the occurrence of CM, more research is needed in this area to develop more adaptive and targeted approaches to CM risk management.

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