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Dynamics of the frequency of HIV transmission from mother to child according to early PCR diagnostics in Ukraine and its regions in 2016–2024

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Transmission of human immunodeficiency virus (HIV) from mother to child remains an urgent public health problem, as it determines the formation of new cases of infection among children. Early diagnosis by polymerase chain reaction (PCR) is a key tool for detecting infection in newborns and assessing the effectiveness of preventive measures.

Aim – to analyze the dynamics of the frequency of HIV transmission from mother to child based on the results of early PCR diagnostics in Ukraine and its regions in 2016–2024.

Materials and methods. A retrospective analysis of statistical data of the Public Health Center of the Ministry of Health of Ukraine on the frequency of mother-to-child transmission of HIV expressed per 100,000 live births was conducted. Methods of descriptive epidemiology, analysis of dynamic series, and comparative regional analysis were used. The data were generated on the basis of official reporting and the HIV infection monitoring system in Ukraine.

Results. A decrease in the frequency of mother-to-child transmission of HIV in Ukraine was established from 14.4 per 100,000 live births in 2016 to 8.5 in 2020. In 2021, the indicator remained relatively stable (8.8); however, in 2022–2023, its growth was observed to be 10.7 and 10.0, respectively. In 2024, a sharp decrease in the indicator to 3.5 was noted. A significant interregional variability of indicators was revealed with the presence of both high values and numerous zero levels, which may be related to the effect of small numbers and uneven coverage of early diagnosis.

Conclusions. In Ukraine, there is a general tendency to decrease the frequency of HIV transmission from mother to child, but in 2022–2023, a destabilization of indicators was noted. Significant regional variability and the presence of zero values may indicate a limitation of access to early PCR diagnostics. The obtained results emphasize the need to strengthen the system of monitoring, early detection, and prevention of HIV transmission from mother to child.

No conflict of interests was declared by the authors.

Keywords: human immunodeficiency virus (HIV), women, early diagnosis, polymerase chain reaction (PCR), children.

Динаміка частоти передачі ВІЛ від матері до дитини за даними ранньої ПЛР-діагностики в Україні та її регіонах у 2016–2024 роках

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Передача вірусу імунодефіциту людини (ВІЛ) від матері до дитини залишається актуальною проблемою громадського здоров'я, оскільки визначає формування нових випадків інфікування серед дитячого населення. Рання діагностика методом полімеразної ланцюгової реакції (ПЛР) є ключовим інструментом виявлення інфекції у новонароджених та оцінки ефективності профілактичних заходів.

Мета – проаналізувати динаміку частоти передачі ВІЛ від матері до дитини за результатами ранньої ПЛР-діагностики в Україні та її регіонах у 2016–2024 роках.

Матеріали та методи. Проведено ретроспективний аналіз статистичних даних Центром громадського здоров'я МОЗ України щодо частоти передачі ВІЛ від матері до дитини, вираженої на 100 000 живонароджених. Використано методи описової епідеміології, аналізу динамічних рядів та порівняльного регіонального аналізу. Дані сформовано на основі офіційної звітності та системи моніторингу ВІЛ-інфекції в Україні.

Результати. Встановлено зниження частоти передачі ВІЛ від матері до дитини в Україні з 14,4 на 100 000 живонароджених у 2016 році до 8,5 у 2020 році. У 2021 році показник залишався відносно стабільним (8,8), однак у 2022–2023 роках спостерігалось його зростання до 10,7 та 10,0 відповідно. У 2024 році спостерігалось різке зниження показника до 3,5. Виявлено значну міжрегіональну варіабельність показників із наявністю як високих значень, так і численних нульових рівнів, що може бути пов'язано з ефектом малих чисел та нерівномірним охопленням ранньою діагностикою.

Висновки. В Україні спостерігається загальна тенденція до зниження частоти передачі ВІЛ від матері до дитини, однак у 2022–2023 роках простежено дестабілізацію показників. Значна регіональна варіабельність та наявність нульових значень можуть свідчити про обмеження доступу до ранньої ПЛР-діагностики. Отримані результати наголошують на необхідності посилення системи моніторингу, раннього виявлення та профілактики передачі ВІЛ від матері до дитини.

Автори заявляють про відсутність конфлікту інтересів.

Ключові слова: вірус імунодефіциту людини (ВІЛ), жінки, рання діагностика, полімеразна ланцюгова реакція (ПЛР), діти.

Introduction

Infection caused by human immunodeficiency virus (HIV) remains one of the leading public health problems in the world and in Ukraine, particularly in the context of affecting women of reproductive age and the risk of infection of children [1]. The transmission of HIV from mother to child is a key way of forming new cases of infection in the child population, which determines the need for constant epidemiological monitoring and improvement of preventive measures [2].

Thanks to the implementation of modern approaches to prevention, in particular, antiretroviral therapy in pregnant women and newborns, the level of HIV transmission from mother to child has decreased significantly. At the same time, the effectiveness of these measures largely depends on the timely detection of infection in children. In this sense, early diagnosis using the polymerase chain reaction method is particularly important, as it enables the virus the detection of the virus during the first few months of a child's life, regardless of the presence of maternal antibodies [3].

In Ukraine, the system of epidemiological surveillance of HIV infection involves the regular collection and analysis of data on the transmission of HIV from mother to child, which is carried out by the Public Health Center of the Ministry of Health of Ukraine. The assessment of the dynamics of such indicators, expressed as a frequency per 100,000 live births, allows for determining the effectiveness of prevention programs, as well as identifying regional features and problem areas [4].

However, the interpretation of these indicators requires caution, as they may depend on the complete coverage of early diagnosis, the availability of medical services, and socio-economic factors [5]. The study of changes in these indicators in the context of modern challenges affecting the health care system and the population's access to medical care is especially relevant. In particular, disruptions in the logistics of medical services, migration processes, and changes in the structure of care provision can affect the timeliness of testing and case registration [6].

Analysis of the dynamics of the frequency of HIV transmission from mother to child based on the results of early polymerase chain reaction (PCR) diagnostics is an important tool for evaluating the effectiveness of measures to combat HIV infection and justifying further management decisions in the field of public health. The obtained results can be used to

optimize preventive programs, increase the availability of diagnostics, and improve the quality of medical care for mothers and children.

Aim – to analyze the dynamics of the frequency of HIV transmission from mother to child based on the results of early PCR diagnostics in Ukraine and its regions in 2016–2024.

Materials and methods of the study

The study has a retrospective descriptive nature and is based on the analysis of official statistical data on HIV in Ukraine. The source of information was the summarized data of the Public Health Center of the Ministry of Health of Ukraine, obtained as part of routine epidemiological surveillance.

The object of the study was the frequency of HIV transmission from mother to child based on the results of early diagnosis by PCR, expressed per 100,000 live births. The analysis includes data for 2016–2024 for Ukraine as a whole and by administrative-territorial units.

The work uses methods of descriptive epidemiology, in particular, analysis of dynamic series to assess changes in indicators over time. Absolute and relative frequency changes were calculated, general trends (increase, decrease, stabilization) were determined, and interregional variability was assessed. The comparative analysis was carried out by comparing the indicators between individual regions and the average value for Ukraine. Special attention is paid to the interpretation of indicator fluctuations, taking into account the possible influence of the effect of small numbers, which is characteristic of intensive indicators with a small number of events. We also took into account the potential influence of incomplete coverage of early diagnosis by the PCR method on the formation of indicators in different regions.

Statistical data processing was carried out using standard approaches to the analysis of medical and statistical information without the use of complex mathematical models. The results are presented in the form of generalized indicators, tables and their analytical description, which made it possible to assess the dynamics and regional features of the studied phenomenon.

Results of the study and discussion

Analysis of the frequency of mother-to-child transmission of HIV based on the results of early PCR diagnostics in Ukraine in 2016–2024 demonstrated

Table
Frequency of HIV transmission from mother to child based on the results of early PCR diagnostics in Ukraine and its regions in 2016-2024 (per 100,000 live births)

Ukraine	14.4	12.9	11.9	10.5	8.5	8.8	10.7	10.0	3.5
Chernihiv region	0	13.1	14.7	33.0	0	0	0	0	0
Chernivtsi region	9.7	0	0	0	0	0	0	0	0
Cherkasy region	28.4	10.5	11.7	0	0	0	30.7	17.7	0
Khmelnyskyi region	0	0	9.3	0	0	0	0	0	0
Kherson region	46.4	0	12.3	27.0	28.2	28.1	54.2	0	0
Kharkiv region	4.2	4.7	10.5	5.7	0	12.9	0	27.3	26.1
Ternopil region	0	10.8	0	0	13.0	0	0	0	0
Sumy region	11.3	0	0	15.5	0	0	24.2	0	0
Rivne region	0	0	0	0	0	0	0	0	0
Poltava region	0	26.9	19.6	0	0	0	0	0	0
Odesa region	41.6	24.4	30.8	14.2	0	25.9	27.3	14.8	7.8
Mykolayiv region	37.1	40.5	22.3	38.2	0	14.2	24.0	0	0
Kyiv	16.4	3.2	0	7.0	14.1	6.8	11.4	10	0
Lviv region	7.4	8.1	0	4.6	4.8	5.1	-	12.3	0
Luhansk region	15.4	24.8	55.7	0	66.1	29.8	0	-	-
Kirovohrad region	11.3	26.2	14.6	16.3	51.5	18.1	0	47.1	25.4
Kyiv region	15.8	13.2	23.1	8.5	9.7	7.9	0	0	0
Ivano-Frankivsk region	0	0	0	0	16.9	0	0	12.0	0
Zaporizhzhia region	19.2	21.7	0	0	0	0	47.9	0	0
Zakarpattia region	0	0	0	0	0	0	0	0	0
Zhytomyr region	0	0	0	0	0	0	29.5	14.6	0
Donetsk region	15.5	23.6	34.4	28.0	10.4	9.9	37.2	0	0
Dnipropetrovs region	29.0	40.9	44.9	45.2	23.8	30.8	31.3	28.4	14.0
Volyn region	15.3	0	0	0	0	10.2	0	0	0
Vinnitsia region	6.5	21.4	0	8.4	17.5	0	0	12.4	6.5
Years	2016	2017	2018	2019	2020	2021	2022	2023	2024

clearly expressed dynamics of indicator changes and significant interregional variability. At the national level, a gradual decrease in frequency has been established in 2016–2020: from 14.4 to 8.5 per 100,000 live births. The absolute decrease was 5.9, which corresponds to a relative decrease of 41.0%. The most pronounced decrease was observed in the period of 2016–2017 (-1.5; -10.4%) and 2019–2020 (-2.0; -19.0%). In 2021, the indicator remained stable (8.8), which is only 3.5% more compared to 2020.

In 2022, the frequency increased to 10.7 (+1.9; +21.6% compared to 2021), and in 2023 the indicator slightly decreased to 10.0 (-0.7; -6.5%). In 2024, a sharp decrease to 3.5 was noted, which is 65.0% less compared to 2023 and is the lowest value for the entire period (Table).

The regional analysis showed a significant amplitude of fluctuations of the indicator. In 2016, the range of variation was from 0 to 46.4 per 100,000 live births (Kherson region), while the indicator was 41.6 in Odesa region, and 29.0 in Dnipropetrovsk region. In 2017, the maximum values were recorded in Dnipropetrovsk (40.9) and Mykolaiv (40.5) regions.

In 2018, an increase in indicators was observed in a number of regions, in particular in the Luhansk region – up to 55.7, which became one of the highest values for the entire period. In 2019, the maximum values were recorded in Dnipropetrovsk (45.2) and Mykolaiv (38.2) regions.

Particularly pronounced peak values were observed in 2020: in the Luhansk region – 66.1 (the highest value for the entire study period), in the Kirovohrad region – 51.5, and in the Kherson region – 28.2. In 2021, the maximum values were lower, but remained significant: Dnipropetrovsk – 30.8, Luhansk – 29.8, Odesa – 25.9.

In 2022, new peak values were recorded, in particular in the Kherson region – 54.2, Zaporizhzhia – 47.9, and Donetsk – 37.2. In 2023, the highest values were recorded in Kirovohrad region – 47.1 and Kharkiv region – 27.3. In 2024, the maximum values decreased significantly: Kharkiv – 26.1, Kirovohrad – 25.4.

An important feature is a significant proportion of zero values. On average, between 40% and 60% of regions had zero readings each year, and this trend continued throughout the study period. For example, in 2018, more than half of the regions had no registered cases, and in 2024, the majority of regions were also characterized by zero values. The coefficient of variation of the indicator between regions was high

in all years of observation, which indicates significant heterogeneity. The amplitude of fluctuations in different years exceeded 40–60 per 100,000 live births, which confirms the pronounced instability of regional indicators.

In general, the obtained results demonstrate that, despite the general decrease in the frequency of HIV transmission from mother to child in 2016–2020, the variability of the indicator increased, the appearance of sharp peak values in certain regions, and the preservation of a significant share of zero levels. This testifies to the complex nature of the dynamics of the studied indicator and the unevenness of its distribution in Ukraine.

The obtained results indicate the presence of positive dynamics in reducing the frequency of HIV transmission from mother to child in Ukraine in 2016–2020. The decrease in the rate by 41.0% during this period is probably related to the expansion of access to antiretroviral therapy among pregnant women, the improvement of the quality of antenatal care, and the implementation of modern approaches to the prevention of infection transmission. The obtained data are consistent with global trends in reducing mother-to-child transmission of HIV, which is in line with World Health Organization (WHO) goals [11].

However, the further dynamics of the indicator in 2021–2023 were characterized by instability and an increase in frequency, which may be due to the influence of external factors, in particular, a violation of access to medical services, a decrease in the coverage of preventive programs, and early diagnosis. The increase of the indicator in 2022 by 21.6% compared to the previous year indicates a possible deterioration of the effectiveness of the infection control system in the conditions of crisis changes [8].

An important result of the study is the identification of significant interregional variability of indicators. The presence of both high (more than 50 per 100,000 live births) and zero values in different regions indicates uneven access to medical services, differences in the organization of care, and possible peculiarities of case registration [9]. At the same time, it should be taken into account that the studied indicator is intensive, so its significant fluctuations may be due to the effect of small numbers, when even a small number of cases significantly affects the frequency level [7]. The high proportion of zero values, which was observed in a significant number of regions during the entire period of the study, requires special attention. Such results may reflect not only the ab-

sence of mother-to-child transmission of HIV, but also insufficient coverage of early PCR diagnosis or limited access to testing [10].

A sharp decrease in the indicator in 2024 to 3.5 per 100,000 live births requires careful interpretation, as it may be related to both a real improvement in the epidemiological situation and incomplete or delayed reporting of statistical data.

The results of the study emphasize the need for further improvement of the early diagnosis system, ensuring equal access to medical services in the regions, and improving the quality of epidemiological surveillance of mother-to-child transmission of HIV in Ukraine.

Conclusions

In the course of the study, it was established that in Ukraine in 2016–2020, there was a steady decrease in the frequency of HIV transmission from mother to child based on the results of early PCR diagnostics from 14.4 to 8.5 per 100,000 live births, which indicates an increase in the effectiveness of preventive

measures. In 2021, the indicator remained stable, but in 2022–2023, its growth was noted, which indicates the destabilization of the epidemiological situation.

Significant interregional variability of indicators was revealed, which was manifested by the presence of both high values and numerous zero levels. This may be due to differences in the availability and quality of medical services, as well as the influence of small numbers in the formation of intensive indicators.

A high proportion of zero values probably indicates not only the absence of cases of transmission, but also possible limitations in the coverage of early diagnosis by the PCR method. A sharp decrease in the indicator in 2024 requires further study, taking into account the completeness of statistical data.

The obtained results confirm the need to further improve the system of early diagnosis, increase the availability of medical care, and ensure effective epidemiological surveillance of HIV transmission from mother to child in Ukraine.

The authors declare no conflict of interest.

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