**Ukrainian Scientific Medical Youth Journal**
Issue 2 (154), 2025

ISSN 2786-6661
eISSN 2786-667X

**UDC: 614.47:004.6:351.774.7](477)**
**https://doi.org/10.32345/USMYJ.2(154).2025.198-208**

Received: April 29, 2025
Accepted: June 01, 2025

# Can vaccination data in electronic systems be trusted? A comparative analysis of the aggregated immunization coverage database and records from electronic health system with consideration of settlement type

**Yevgenii Grechukha[1], Denys Deineha[2], Yaroslava Chaikivska[2], Alla Volokha[1]**

[1] Shupyk National Healthcare University of Ukraine, Dorohozhytska St, 9, Kyiv, Ukraine, 04112.

[2] WHO Country Office in Ukraine, Mykhaila Hrushevskoho St, 9B, Kyiv, Ukraine, 01021.

**Corresponding Author:**

Yevgenii Grechukha

kcphc.grechukha@gmail.com

***Abstract:*** *reliable, high-quality vaccination data is vital to monitor immunization coverage and identify programmatic gaps. In Ukraine, two independent systems operate in parallel for capturing immunization data: the aggregated, with duplication by paper, database UkrVak system and the electronic health system (eHealth), which accumulates individual-level vaccination records. While eHealth offers real-time data and improved traceability, questions remain about its completeness and usability, especially in light of operational challenges, infrastructure gaps, and lack of dose-level tracking functionality. Objective: to compare routine childhood immunization data captured in UkrVak and eHealth across healthcare facilities serving rural, semi-urban, and urban populations in Lviv and Rivne oblasts, and assess the consistency and reliability of both systems as tools for immunization monitoring. A cross-sectional, descriptive and analytical study was conducted using data from six healthcare facilities, including primary healthcare centers (PHCs) and clinical hospital outpatient departments (CHs). Facilities were stratified by type of settlement served. Four vaccine indicators were analyzed: DTP-3, Polio-3, MMR-1, and MMR-2. UkrVak data (aggregated, as of 9–10 months of 2024) were obtained via official requests from regional disease prevention centers. eHealth data (individual-level, as of October 2024) were extracted from national dashboards. The number of children receiving full vaccine courses in eHealth was estimated by dividing raw entries by 3 (or 2 for MMR-2). For each vaccine and facility, the following were calculated: absolute difference, absolute error, relative error. Pearson correlation coefficient (r) and linear regression were used to assess the statistical relationship between the systems. Results. A strong positive correlation was observed between UkrVak and eHealth data correspondence. ($r = 0.987$, $p < 0.0001$). The linear regression model showed that 97.3% of the variation in UkrVak data could be explained by eHealth entries ($R^2 = 0.973$, $F = 800.4$, $p < 0.0001$). However, systematic discrepancies were identified across vaccine types and facility characteristics. MMR-2 and Polio-3 exhibited the highest mean relative errors (45.52% and 25.7%, respectively), likely due to dose tracking limitations and delays in documentation. A particularly large discrepancy (117 children) was found for MMR-2 in a rural facility, highlighting risks of underreporting in eHealth. When stratified by settlement type, rural facilities had the largest discrepancies (mean relative error: 20.13%) compared to urban (4.56%) and semi-urban (10.00%)*

*settings. Conclusions: While eHealth and UkrVak systems are statistically aligned, they are not functionally interchangeable. Discrepancies vary by vaccine, region, and settlement type, reflecting structural and operational constraints. Transitioning toward a unified electronic immunization registry with standardized data fields, rural infrastructure support, and real-time validation is critical to improve the accuracy and reliability of immunization coverage monitoring in Ukraine.*

**Keywords:** Database; Data Accuracy; Demographic Factors; Health Information Systems; Immunization; Vaccination; Vaccination Coverage.

## Introduction

Immunization plays a fundamental role in reducing the burden of vaccine-preventable diseases in the 21st century [1]. Achieving high vaccination coverage is a critical factor in maintaining herd immunity, preventing outbreaks, and eliminating diseases that pose a threat to public health. The World Health Organization (WHO) sets the target coverage level for most routine vaccinations at no less than 95%. The same goal is set in the National Immunization Strategy until 2030 [2].

In Ukraine, despite significant progress in recent years, vaccination coverage remains unstable and varies by region, age group, and specific vaccines. In 2023, according to the Ukrainian Public Health Center data, the coverage of the primary immunization series for diphtheria, tetanus, and pertussis (DTP-3) among children under one year was approximately 85%; coverage with three doses of the polio vaccine (Pol-3) reached 86%, and the first dose of the measles, mumps, and rubella (MMR) vaccine was at 84% – all below the internationally recommended level [3]. The situation is further complicated by the full-scale war, internal population displacement, disrupted access to healthcare services, and the spread of vaccine misinformation.

High-quality data is essential for effective monitoring of immunization programs. In Ukraine, at least two systems for recording vaccination data currently function in parallel. Since 2008, the UkrVak reporting form has been used by healthcare facilities as an official depersonalized database, often duplicated in paper format and based on aggregated facility-level reporting [4]. The introduction of the electronic health system (eHealth) began in 2016 and now enables the accumulation of individual physician records on patient visits, including administered vaccinations [5]. In the context of digitalization and the rapid development of information technologies, the question arises whether eHealth can fully replace UkrVak as the primary data source for analyzing vaccination coverage. There are currently differing assessments regarding the reliability of each system. On the one hand, eHealth provides real-time, individualized data. On the other hand, due to limited standardization, the absence of mandatory fields for vaccine dosage, issues with synchronization and data completeness, and a lack of historical data, eHealth may have significant gaps. UkrVak, although more traditional, is considered the official source for national reporting, but it often lacks the capacity for real-time monitoring and proper immunization program planning.

Particular attention in this analysis should be paid to the regions and communities, including hard to reach population [6]. In this regard and within current primary healthcare system in Ukraine – took into account type of settlement served by healthcare facilities. Digital infrastructure, internet access, staffing, and reporting capacity may differ significantly between rural, semi-urban, and urban areas. Including healthcare facilities from various contexts—from rural villages to urban centers – provides a more comprehensive understanding of the potential sources of variation between the two systems.

## Aim

The aim of this study is to conduct a comparative analysis of the number of vaccinations recorded in the UkrVak immunization database and the electronic health system (eHealth) in a sample of healthcare facilities in Lviv and Rivne oblasts that serve populations in different types of settlements – rural, semi-urban, and urban

**Materials and methods**

The study is descriptive and analytical in nature and aims to compare quantitative data on routine immunization coverage recorded in two independent systems. The analysis was conducted using comparative statistical approaches and regression modeling methods.

The study included six healthcare facilities (primary healthcare facilities (PHC) and outpatient departments of clinical hospitals (CH)) serving different types of settlements. Specifically: PHC_Lviv_Davydiv and PHC_Rivne_Hoshcha primarily serve rural populations; CH_Lviv_Rydky and CH_Rivne_Oleksandriya serve mixed populations living on the border between urban and rural areas; CH_Lviv_Velykomostivska and PHC_Rivne_city primarily serve urban populations. For each facility, the number of vaccinations recorded in the UkrVak reports (as of 9–10 months of 2024) was analyzed following official requests from respective regional Center for Diseases prevention and Controls and compared to the corresponding entries in the eHealth system from open source dashboards by the National Health Service of Ukraine (as of October 2024) [7].

Four key indicators of routine childhood immunization were considered:

- DTP-3 – three doses of the diphtheria, pertussis, and tetanus vaccine by the age of 1 year.
- Polio-3 – three doses of the polio vaccine by the age of 1 year.
- MMR-1 – the first dose of the measles, mumps, and rubella vaccine at 12 months of age.
- MMR-2 – the second dose of the measles, mumps, and rubella vaccine at 6 years of age.

To assess the strength and direction of the relationship between data recorded in UkrVak and eHealth systems, the Pearson correlation coefficient (r) was calculated. The analysis was based on the estimated number of children who received a full vaccination course according to eHealth (i.e., total records divided by 3 for three-dose vaccines like Polio-3 and DTP-3), compared to values from UkrVak.

Formula for Pearson correlation coefficient ($r$):

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2} \cdot \sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

where,

$x_i$ – data from eHealth
$y_i$ – corresponding data from UkrVak
$\bar{x}, \bar{y}$ – sample mean
$n$ – number of observations

Meaning of "r" can ranges from –1 to +1, where: (1) r ≈ +1 – strong positive relationship; (2) r ≈ –1 – strong negative relationship; (3) r ≈ 0 – no linear relationship. A p-value was also computed to determine the statistical significance of the correlation.

To model the dependency between eHealth and UkrVak vaccination data, a simple linear regression (Ordinary Least Squares) was used. The dependent variable was the number of vaccinated children reported in UkrVak, and the independent variable was the corresponding eHealth estimate.

Formula for linear regression:

$$\text{UkrVak} = \beta_0 + \beta_1 \cdot \text{eHealth} + \epsilon$$

we computed:

- the coefficient of determination ($R^2$) to assess model fit;
- regression coefficients $\beta_0$ (intercept) and $\beta_1$ (slope);
- p-values for each coefficient;
- the overall F-statistic to test the significance of the model.

Since the analytical dashboards of the eHealth system do not capture the number of doses administered for each child, the total number of vaccination records was divided (by three DTP-3, Polio-3; by 2 from MMR-2) to estimate the number of children who received a full immunization course.

For each healthcare facility and each type of vaccination absolute error relative error (RE, %).

Formula for absolute error (|Δ|):

$$\Delta = \text{UkrVak - eHealth.}$$

Formula for relative error (RE, %):

$$\text{RE} = |\Delta| / \text{UkrVak} \times 100.$$

ISSN 2786-6661
eISSN 2786-667X

Statistical analysis was performed using the Statistical Package for Social Science (SPSS version 12.0).

**Results**

A consolidated data table with collected data is presented in Annexes 1-3.

*Correlation between UkrVak and eHealth data*

We start our analysis to assess the strength and direction of the relationship between data recorded in UkrVak and eHealth systems. Pearson Correlation Coefficient was 0.987, that indicates a very strong positive correlation (p-value: < 0.0001, which means that this correlation is statistically significant).

*Differences by vaccine type and facilities*

Mean absolute and relative errors between UkrVak and eHealth were calculated for each vaccine type. This allows us to identify which specific vaccines are associated with the greatest discrepancies in the data.

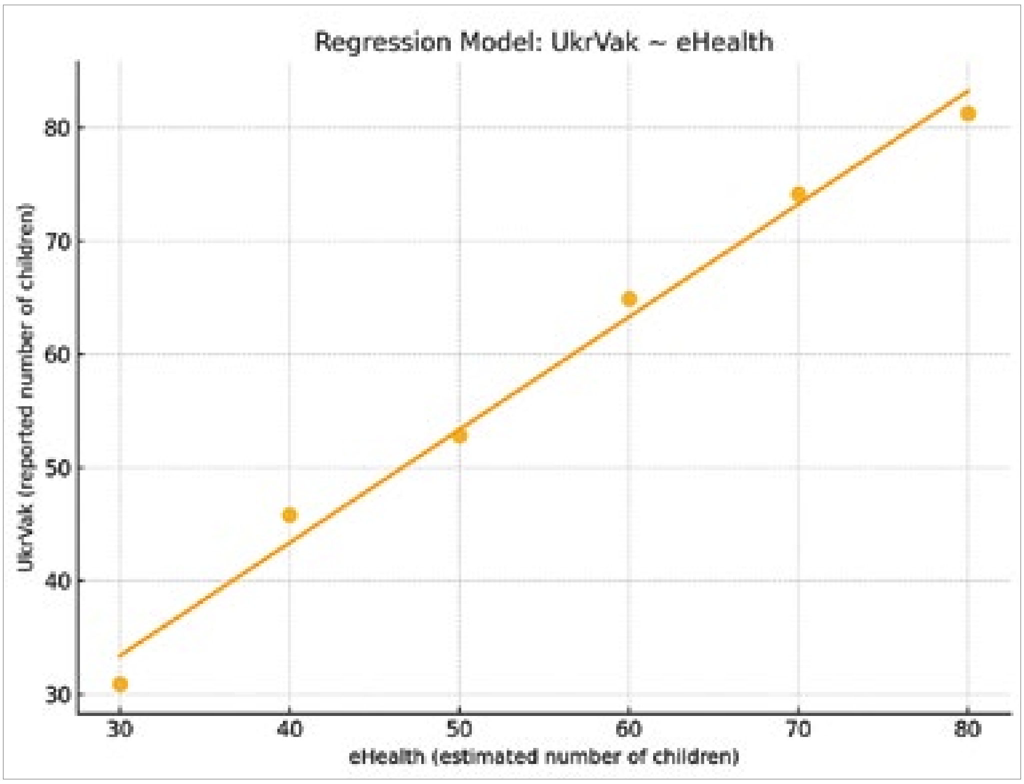
In Rivne oblast, the mean absolute error was 20.50 (±6.36), and the relative error was 23.86% (±5.10%). In Lviv oblast, the mean absolute error was 51.75 (±31.37), and the relative error was 35.86% (±26.53%).

The largest difference was observed for MMR2 in a rural facility. Moreover, as a result of the outlier detection), one case with an exceptionally large error was identified: for MMR2, where the discrepancy between UkrVak and eHealth amounted to 117 children. This difference significantly exceeds the average

**Table 1.** The mean absolute and relative errors between UkrVak and eHealth for each type of vaccine

| № | Vaccine | Abs. Error | Rel. Error (%) |
|---|---|---|---|
| 1 | DTP-3 | 32.5 | 21.45 |
| 2 | MMR-1 | 31.0 | 35.13 |
| 3 | MMR-2 | 53.5 | 45.52 |
| 4 | Polio-3 | 57.0 | 25.7 |

*The highest errors were observed for MMR2 and Polio3, which may reflect data entry challenges or limitations in documentation.*




**Picture 1.** To model the dependency between eHealth and UkrVak vaccination data, a simple linear regression (Ordinary Least Squares) was used. $R^2 = 0.973$ (i.e., 97.3% of the variation in UkrVak is explained by eHealth). F-statistic = 800.4, $p < 0.0001$. Number of observations: 24. This indicates that 97.3% of the variation in UkrVak values is explained by eHealth inputs.

ISSN 2786-6661
eISSN 2786-667X

**Table 2.** The mean absolute and relative errors between UkrVak and eHealth by each type of vaccine per facilities

| Region | Facility | Vaccine | UkrVak (#vaccinated children) | eHealth (vaccinated children) | Difference | Relative Error (%) |
|---|---|---|---|---|---|---|
| Rivne | PHC_Rivne_city | DTP-3 | 489 | 458 | 31.0 | 6.34 |
| | | Polio-3 | 539 | 459 | 80.0 | 14.84 |
| | | MMR-1 | 445 | 433 | 12.0 | 2.7 |
| | | MMR-2 | 688 | 713 | -25.0 | 3.63 |
| | CH_Rivne _ Oleksandriya | DTP-3 | 31 | 26 | 5.0 | 16.12 |
| | | Polio-3 | 31 | 25 | 6.0 | 19.35 |
| | | MMR-1 | 24 | 26 | -2.0 | 8.3 |
| | | MMR-2 | 61 | 14 | 47.0 | 77.05 |
| | PHC_Rivne_Hoshcha | DTP-3 | 93 | 59 | 34.0 | 36.56 |
| | | Polio-3 | 93 | 59 | 34.0 | 36.56 |
| | | MMR-1 | 92 | 46 | 46.0 | 50.0 |
| | | MMR-2 | 189 | 72 | 117.0 | 61.9 |
| Lviv | PHC_Lviv_Davydiv | DTP-3 | 36 | 37 | -1.0 | 2.7 |
| | | Polio-3 | 37 | 37 | 0 | 0 |
| | | MMR-1 | 64 | 49 | 15.0 | 23.43 |
| | | MMR-2 | 91 | 66 | 25.0 | 27.47 |
| | CH_Lviv_ Velykomostivska | DTP-3 | 60 | 58 | 2.0 | 3.33 |
| | | Polio-3 | 39 | 54 | -15.0 | 38.46 |
| | | MMR-1 | 66 | 53 | 13.0 | 19.69 |
| | | MMR-2 | 117 | 110 | 7.0 | 5.98 |
| | CH_Lviv_Rydky | DTP-3 | 69 | 66 | 3.0 | 4.34 |
| | | Polio-3 | 64 | 63 | -1.0 | 1.56 |
| | | MMR-1 | 79 | 63 | 16.0 | 20.25 |
| | | MMR-2 | 65 | 49 | 15.0 | 23.07 |

*The table presents the ten cases with the highest absolute discrepancies between vaccination data recorded in UkrVak and eHealth.*

value and may indicate a serious issue in data entry or synchronization between the systems.

If we'll narrow our analysis to the type of settlement, the results show that the largest discrepancies between systems occur in rural areas.

This analysis considered that the reporting periods in UkrVak and eHealth may not fully coincide. However, large discrepancies indicate structural limitations, not only temporal lags.

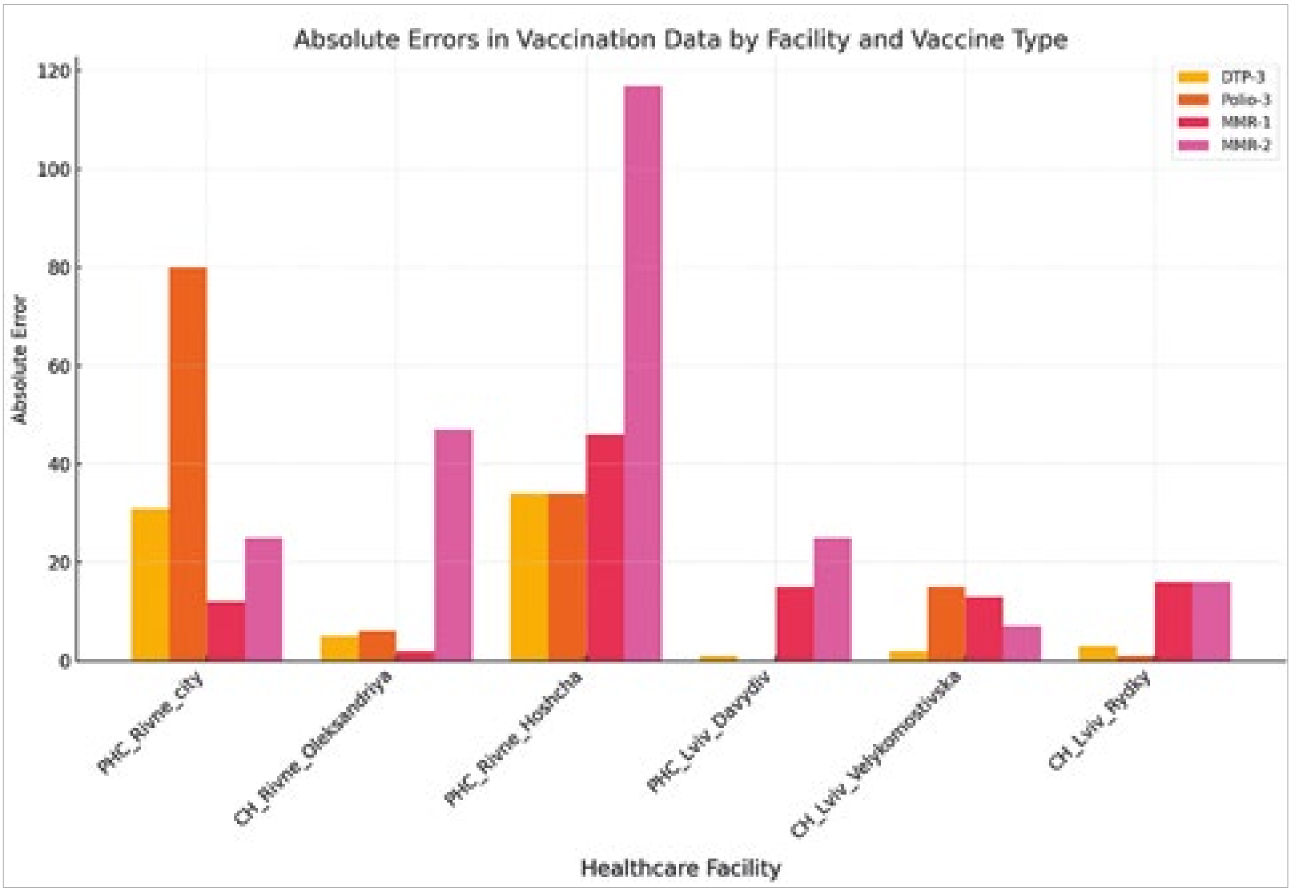
**Discussion**

This study aimed to assess the reliability and usability of Ukraine's two parallel vaccination data sources for monitoring routine immunization coverage in Ukraine. While both systems are functioning nationwide, their structural differences and the absence of direct

**Table 3.** The mean absolute and relative errors between UkrVak and eHealth by settlement type

| Settlement Type | Abs. Error | Rel. Error (%) |
|---|---|---|
| Urban area | 16.33 | 4.56 |
| Semi-urban | 3.83 | 10.00 |
| Rural area | 17.67 | 20.13 |

ISSN 2786-6661
eISSN 2786-667X




**Picture 2.** The graph illustrates absolute discrepancies between UkrVak and eHealth vaccination data across different healthcare facilities in Rivne and Lviv regions, categorized by vaccine type (DTP-3, Polio-3, MMR-1, MMR-2). The most significant discrepancies are noted for the MMR-2 vaccine, particularly in the rural facility (PHC_Rivne_Hoshcha).

integration raise important questions about data consistency and programmatic reliability. The results reveal a strong between the two systems but also highlight systematic discrepancies that vary by vaccine type, facility, region, and type of settlement. This discussion interprets these findings in the context of broader health information system strengthening, digital transformation, and equitable immunization program delivery.

During this study we confirm a robust statistical association between eHealth and UkrVak reports. This finding suggest that trends in one system are reliably mirrored in the other, supporting the view that eHealth has substantial potential as a real-time alternative to aggregate reporting. However, this correlation should not be misinterpreted as equivalence. Correlation measures the consistency of direction and magnitude of changes, not their absolute values. A system can be highly correlated with another yet differ systematically in scale, bias, or completeness [8,9].

Moreover, the assumption of complete dose recording in eHealth (dividing total entries by 3 for DTP-3 and Polio-3 or by 2 for MMR-2) may artificially inflate alignment, as real-world series completion rates can vary, especially in conflict-affected settings [10,11]. Without explicit dose tracking functionality or a centralized immunization registry or separate but dedicated module, dose-based precision in eHealth remains limited as of now [12].

Among the vaccines assessed, MMR-2 and Polio-3 showed the highest absolute and relative discrepancies. This pattern aligns with well-documented global challenges in tracking second doses and multi-visit schedules, especially in electronic systems that are not fully integrated with immunization workflows [13].

ISSN 2786-6661
eISSN 2786-667X

Notably, in Ukraine's current setting of armed conflict, continuity of digital services and secure data access is uneven, particularly in high-risk or temporarily occupied regions. In such environments, dependence on real-time digital systems must be balanced with backup methods or hybrid reporting formats.

One of the most policy-relevant findings of this study is that facilities in rural areas had significantly higher average absolute and relative data discrepancies compared to urban and semi-urban sites. This supports extensive global evidence that the digital divide – defined by infrastructure, human resources, and institutional digital literacy – directly impacts health data quality.

eHealth-based data entry requires not only consistent internet access but also well-trained personnel, system uptime, user-friendly interfaces, and sufficient time allocation in workflows. In rural Ukrainian PHCs, where staff are often overburdened, internet connectivity can be unreliable, and training opportunities limited, electronic data entry may be delayed, omitted, or deprioritized. These structural disadvantages mirror findings from digital health assessments in Georgia, Moldova, and Armenia, where rural health workers consistently reported lower eHealth usability and higher reporting errors [14].

As the findings show, UkrVak and eHealth serve different reporting logics: UkrVak is centralized, standardized, and historically complete but operates on aggregate inputs and lacks patient-level traceability. eHealth provides real-time, individual-level tracking but suffers from missing fields, lack of historical data, and inconsistent uptake. Operating these systems in parallel leads to redundant data entry, potential inconsistencies, and increased burden on healthcare workers [15]. Without integration, the co-existence of both systems may erode data trust and complicate efforts to streamline national immunization information.

All these factors must also be considered when evaluating the largest discrepancies and anomalies observed in this study. One of the most significant anomalies – a discrepancy of 117 children for MMR-2 vaccination – was identified in a rural facility (PHC_Rivne_Hoshcha). Such a substantial difference warrants deeper analysis, as it likely reflects multiple underlying issues rather than a single isolated factor. Firstly, the rural context of facility inherently involves infrastructural challenges, such as unreliable internet connectivity and limited access to technological support, potentially compromising the timeliness and accuracy of data entry into the eHealth system. Secondly, healthcare personnel in rural facilities typically face higher workloads combined with fewer opportunities for systematic training, which could lead to errors, omissions, or inconsistencies when managing electronic health records. Additionally, the technical limitations of the eHealth system itself – specifically the absence of detailed dose-level tracking capabilities – further exacerbate these discrepancies by restricting the precision and reliability of vaccination data. Lastly, the temporal mismatch between data entry into UkrVak and eHealth, even within the same reporting period, may amplify apparent discrepancies, as records in eHealth can often be delayed due to operational constraints, resource shortages, or systemic inefficiencies. Consequently, this significant anomaly highlights the urgent need for targeted interventions, including strengthening rural healthcare infrastructure, enhancing training programs for medical staff in digital documentation practices, and implementing substantial technical improvements within the eHealth system, with particular attention to the needs and operational realities of rural and underserved healthcare facilities.

A national electronic immunization registry, either as a module within eHealth or a complementary system, would offer the benefit of longitudinal tracking, dose-level accuracy, and program analytics – provided it is co-developed with users, validated with data quality reviews, and phased in with full policy and technical alignment.

Moving from parallel systems to full integration requires:

- Policy clarity on the legal and operational status of eHealth records;
- Mandated, standardized data fields to reduce interpretation variability;

- Automated validation algorithms to flag extreme values;
- Rural prioritization in system support, internet access, and workforce development.

In current and a post-war context where digital health will play a central role in recovery and modernization, Ukraine has an opportunity to leapfrog from dual systems to a unified, resilient, and inclusive health information architecture.

*Study Limitations*

When reviewing the results of this study, it is important to consider that the research has several significant limitations. The first and most significant limitation is the lack of detailed breakdown on vaccine dose data in the eHealth system, which prevented an accurate count of fully vaccinated children. This issue arises from the current technical functionality of the system and the limitations of publicly available data on the dashboards provided by the National Health Service of Ukraine. This limitation was anticipated in the study design, and mathematical calculations were provided to address this issue.

The next limitation is the temporal discrepancy between reporting periods in the eHealth and UkrVak systems, which created potential data mismatches. Although the same time period was analyzed for both systems, it should be acknowledged that data entry into the eHealth system may indeed occur with delays.

The final limitation is that currently neither UkrVak nor eHealth provides data disaggregated by territorial affiliation; instead, the data originate from healthcare facilities that may serve markedly different populations. Given this, the study design was specifically developed to select facilities that approximately represent populations residing in different types of settlements. Consequently, significant discrepancies observed, especially in rural facilities, indicate potential operational and technical challenges that were not explored in depth.

**Conclusions**

This study confirms that eHealth and UkrVak systems are statistically aligned but not functionally equivalent. Discrepancies – especially by vaccine type, region, and settlement – highlight structural gaps in implementation and underscore the need for:

- Clear national policy on data use, verification, and accountability;
- Integration of immunization tracking into a centralized digital system;
- Real-time data validation mechanisms;
- Settlement-sensitive support for under-resourced facilities.

High-quality data is not simply a technical output; it is a strategic asset in safeguarding public health. Ensuring that eHealth can fulfill this role will require continued investment, collaboration, and attention to frontline realities.

**Anexes.**

**Annex 1. DTP-3**

| Region | Facility | DTP-3 (under 1 y.o.; UkrVak) | Overall records on DTP (under 1 y.o.; eHealth) | DTP-3 (under 1 y.o.; eHealth and math suggestion*) |
|---|---|---|---|---|
| Rivne | PHC_Rivne_Hoshcha | 93 | 177 | 59 |
| | CH_Rivne_Oleksandriya | 31 | 78 | 26 |
| | PHC_Rivne_city | 489 | 1374 | 458 |
| Lviv | PHC_Lviv_Davydiv | 36 | 112 | 37,3 |
| | CH_Lviv_Rydky | 69 | 199 | 66,3 |
| | CH_Lviv_Velykomostivska | 60 | 175 | 58,3 |

**However, from eHealth data, it is unclear how many children received 1 dose of vaccine, how many received 2 doses, and how many received 3 doses, since we have vaccination records but no information regarding the vaccine dose number. Using a mathematical approach, we can assume that all children were vaccinated with 3 doses and perform the mathematical calculations accordingly.*

ISSN 2786-6661
eISSN 2786-667X

### Annex 2. Polio-3

| Region | Facility | Polio-3 (under 1 y.o.; UkrVak) | Overall records on Polio (under 1 y.o.; eHealth) | Polio-3 (under 1 y.o.; eHealth and math suggestion*) |
|---|---|---|---|---|
| Rivne | PHC_Rivne_Hoshcha | 93 | 177 | 59 |
| | CH_Rivne_Oleksandriya | 31 | 75 | 25 |
| | PHC_Rivne_city | 539 | 1377 | 459 |
| Lviv | PHC_Lviv_Davydiv | 37 | 111 | 37 |
| | CH_Lviv_Rydky | 64 | 191 | 63,7 |
| | CH_Lviv_Velykomostivska | 39 | 163 | 54,3 |

### Annex 3. MMR-1 and 2

| Region | Facility | MMR-1 (1 y.o.; UkrVak) | MMR-1 (1 y.o.; eHealth) | MMR-2 (1 y.o.; UkrVak) | MMR-2 (1 y.o.; eHealth) |
|---|---|---|---|---|---|
| Rivne | PHC_Rivne_Hoshcha | 92 | 46 | 189 | 72 |
| | CH_Rivne_Oleksandriya | 24 | 26 | 61 | 14 |
| | PHC_Rivne_city | 445 | 433 | 688 | 713 |
| Lviv | PHC_Lviv_Davydiv | 64 | 49 | 91 | 66 |
| | CH_Lviv_Rydky | 79 | 63 | 65 | 49 |
| | CH_Lviv_Velykomostivska | 66 | 53 | 117 | 110 |

**Ethical aspects.** Ethical aspects and data confidentiality were carefully considered during the study. All analyzed data were aggregated, anonymized, and contained no personal identifiers, thereby ensuring compliance with ethical standards and confidentiality guidelines. The study did not involve direct interaction with patients or handling sensitive personal information.

**Financing**

This study did not receive any external funding.

**Conflict of interests**

The authors declare no conflict of interest in any form.

**Consent to publication**

The study did not involve any patient participation. The possibility of publishing the provided materials was discussed and approved with the participating healthcare facilities and rCDC.

**ORCID ID**
**and authors contribution**

0000-0001-7371-3798 (A, C, D) Yevgenii Grechukha

0009-0009-6519-9915 (A, B, C) Denys Deineha

0009-0009-6440-3419 (B, C) Yaroslava Chaikivksa

0000-0003-3092-2228 (E, F) Alla Volokha

A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of article.

## REFERENCES.

1. Shattock AJ, Johnson HC, Sim SY, Carter A, Lambach P, Hutubessy RCW, at all. Contribution of vaccination to improved survival and health: modelling 50 years of the Expanded Programme on Immunization. Lancet. 2024 May 25;403(10441):2307-2316. doi: 10.1016/S0140-6736(24)00850-X.

2. Cabinet of Ministers of Ukraine Order No. 562-r of June 1, 2023, “On the approval of the Strategy for the development of immunoprophylaxis and protection of the population from vaccine-preventable infectious diseases for

the period up to 2030, and the approval of the operational plan for its implementation in 2023–2025", available: https://zakon.rada.gov.ua/laws/show/562-2023-%D1%80#Text

3. General data on vaccination coverage in Ukraine, the Ukrainian Public Health Center, 2023. Available: https://phc.org.ua/kontrol-zakhvoryuvan/imunizaciya/okhoplennya-scheplennyami

4. Order of the Ministry of Health of Ukraine No. 413 dated July 25, 2008, "On the approval of reporting and registration forms for planning and implementing preventive vaccinations 'UkrVak 08'". Available: https://zakononline.com.ua/documents/show/51655___538042

5. Order of the Ministry of Health of Ukraine No. 587 dated February 28, 2020, "Certain issues regarding the maintenance of the Register of medical records, referrals, and prescriptions in the electronic health care system" https://zakon.rada.gov.ua/laws/show/z0236-20#Text

6. Ekezie W, Awwad S, Krauchenberg A, Karara N, Dembiński Ł, Grossman Z, at all. Access to Vaccination among Disadvantaged, Isolated and Difficult-to-Reach Communities in the WHO European Region: A Systematic Review. Vaccines (Basel). 2022 Jun 28;10(7):1038. doi: 10.3390/vaccines10071038. PMID: 35891201; PMCID: PMC9324407.

7. National Health Service of Ukraine, Analytical dashboards. Available: https://edata.e-health.gov.ua/e-data/dashboard

8. Arts DG, De Keizer NF, Scheffer GJ. Defining and improving data quality in medical registries: a literature review, case study, and generic framework. J Am Med Inform Assoc. 2002 Nov-Dec;9(6):600-11. doi: 10.1197/jamia.m1087. PMID: 12386111; PMCID: PMC349377.

9. Rahmadhan MAWP, Handayani PW. Challenges of vaccination information system implementation: A systematic literature review. Hum Vaccin Immunother. 2023 Aug;19(2):2257054. doi: 10.1080/21645515.2023.2257054. Epub 2023 Sep 25. PMID: 37747287; PMCID: PMC10619519.

10. Farid M, Ibrahim A, Mohammad H, Hassan Q, Omar MA, Ismael MA, at al. COVID-19 vaccination campaigns in fragile and conflict-affected settings, Somalia. Bull World Health Organ. 2024 Sep 1;102(9):674-680. doi: 10.2471/BLT.23.291105. Epub 2024 Jul 11. PMID: 39219761; PMCID: PMC11362698.

11. Nnadi C, Etsano A, Uba B, Ohuabunwo C, Melton M, Wa Nganda G, at al. Approaches to Vaccination Among Populations in Areas of Conflict. J Infect Dis. 2017 Jul 1;216(suppl_1):S368-S372. doi: 10.1093/infdis/jix175. PMID: 28838202; PMCID: PMC5754212.

12. Scharf LG, Coyle R, Adeniyi K, Fath J, Harris L, Myerburg S, at al. Current Challenges and Future Possibilities for Immunization Information Systems. Acad Pediatr. 2021 May-Jun;21(4S):S57-S64. doi: 10.1016/j.acap.2020.11.008. PMID: 33958094; PMCID: PMC8112731.

13. Mantel C, Hugo C, Federici C, Sano N, Camara S, Rodriguez E, at al. Impact of electronic immunization registries and electronic logistics management information systems in four low-and middle-income countries: Guinea, Honduras, Rwanda, and Tanzania. Vaccine. 2025 Apr 2;54:127066. doi: 10.1016/j.vaccine.2025.127066. Epub ahead of print. PMID: 40179523.

14. Tornero Costa R, Adib K, Salama N, Davia S, Martínez Millana A, Traver V, at al. Electronic health records and data exchange in the WHO European region: A subregional analysis of achievements, challenges, and prospects. Int J Med Inform. 2025 Feb;194:105687. doi: 10.1016/j.ijmedinf.2024.105687. Epub 2024 Nov 10. PMID: 39556969; PMCID: PMC11635092.

15. Budd J. Burnout Related to Electronic Health Record Use in Primary Care. J Prim Care Community Health. 2023 Jan-Dec;14:21501319231166921. doi: 10.1177/21501319231166921. PMID: 37073905; PMCID: PMC10134123.

# Чи можна довіряти даним про вакцинацію в електронних системах? Порівняльний аналіз агрегованої бази даних охоплення імунізацією та записів з електронної системи охорони здоров'я з урахуванням типу населеного пункту

**Євгеній Гречуха[1], Денис Дейнега[2], Ярослава Чайківська[2], Алла Волоха[1]**

[1] Національний університет охорони здоров'я України імені П. Л. Шупика, вул. Дорогожицька, 9, Київ, Україна, 04112.

[2] Бюро ВООЗ в Україні, вул. Михайла Грушевського, 9Б, Київ, Україна, 01021.

**Corresponding Author:**

Yevgenii Grechukha

kcphc.grechukha@gmail.com

***Анотація:*** *надійні та якісні дані про вакцинацію є критично важливими для моніторингу охоплення щепленнями та виявлення прогалин у програмах імунопрофілактики. В Україні паралельно функціонують дві незалежні системи збору даних про щеплення: агрегована, що має дублювання в паперовому форматі, база даних «УкрВак» та електронна система охорони здоров'я (eHealth), яка накопичує індивідуальні записи про щеплення. Незважаючи на переваги eHealth у забезпеченні оперативності та простежуваності даних, залишаються питання щодо її повноти та функціональності — зокрема, через обмеження у відображенні доз вакцинації, нестабільну інфраструктуру та операційні виклики. Мета. Порівняти дані про рутинну вакцинацію дітей, зафіксовані в УкрВак та eHealth, у закладах охорони здоров'я Львівської та Рівненської областей, які обслуговують сільські, напівміські та міські громади, та оцінити узгодженість і надійність кожної з систем як інструментів моніторингу охоплення щепленнями. Було проведено поперечне описове та аналітичне дослідження на основі даних із шести закладів охорони здоров'я, зокрема центрів первинної медико-санітарної допомоги (ЦПМСД) та поліклінічних відділень лікарень. Заклади були стратифіковані за типом населеного пункту, який вони обслуговують. Аналізовано чотири показники вакцинації: АКДП-3, Поліо-3, КПК-1, КПК-2. Дані УкрВак (агреговані, станом на 9–10 місяців 2024 року) отримано за офіційними запитами до регіональних центрів контролю хвороб. Дані eHealth (індивідуальні, станом на жовтень 2024 року) були витягнуті з національних дашбордів. Для оцінки повноти вакцинації в eHealth записи були умовно поділені на 3 (або на 2 для КПК-2). Для кожного типу вакцини й закладу розраховували абсолютну різницю, абсолютну та відносну похибки. Було проведено кореляційний аналіз (коефіцієнт Пірсона) та лінійну регресію. Результати: було встановлено сильний позитивний кореляційний зв'язок між даними УкрВак та eHealth ($r = 0.987$, $p < 0.0001$). Модель лінійної регресії показала, що 97.3% варіації в УкрВак пояснюється показниками eHealth ($R^2 = 0.973$, $F = 800.4$, $p < 0.0001$). Однак виявлено систематичні розбіжності між системами залежно від типу вакцини та характеристик закладу. Найбільші відносні похибки спостерігались для КПК-2 (45.52%) та Поліо-3 (25.7%), що, ймовірно, пов'язано з обмеженням щодо обліку доз та затримками в заповненні електронної документації. Найбільша розбіжність – 117 дітей – виявлена для КПК-2 у сільському закладі. При стратифікації за типом населеного пункту найбільші розбіжності були зафіксовані в сільській місцевості (середня відносна похибка: 20.13%) порівняно з міською (4.56%) та напівміською (10.00%). Висновки. Хоча дані з eHealth та УкрВак демонструють високу статистичну узгодженість, системи не є функціонально взаємозамінними. Виявлені розбіжності за видами вакцин, регіонами та типами населених пунктів свідчать про необхідність впровадження централізованого електронного реєстру щеплень, стандартизації полів введення, зміцнення інфраструктури в сільських районах та запровадження механізмів валідації даних у реальному часі.*

**Ключові слова:** база даних, точність даних, демографічні чинники, інформаційні системи охорони здоров'я, імунізація, вакцинація, охоплення вакцинацією.