The dynamics of incidence of active tuberculosis in children in Bukovina, the impact of the COVID-19 pandemic

In the current conditions, tuberculosis remains one of the global health issues not only in Ukraine, but also worldwide [1, 13]. Ukraine remains one of the notorious leaders in the world ranking of tuberculosis (TB) incidence and mortality, according to WHO, ranking 5th in the world and 2nd in Europe according to these indicators.

**Objective** — to analyze the regional features of the epidemiology of tuberculosis among children in the Chernivtsi region.

**Materials and methods.** The medical records of all pediatric patients with newly diagnosed TB for the period from January 2020 to December 2022 in the Chernivtsi Regional Clinical TB Dispensary were analyzed. Statistical processing of the data obtained during the research was carried out using the IBM SPSS Statistics v. 26.0 program.

**Results and discussion.** An analysis of the dynamics by years, when Ukraine was in lockdown due to COVID-19, revealed an increase in the incidence of TB among children under the age of 14 — by 2.7 times compared to 2021 and almost 8 times compared to 2020. 2 cases (25 %) of extrapulmonary tuberculosis, one of which (meningoencephalitis) had an unfavorable prognosis and resulted in death. Indicators of the tuberculosis situation in the Chernivtsi Region in the age group of 15—17 years showed an increase in TB in the percentage ratio of almost 2 times, with an even gender distribution (50 % each) compared to 2020 and 2021.

**Conclusions.** In Bukovina, for the period from 2020 to 2022, increase in the incidence of tuberculosis among children (almost in 2 times) was registered. In 2022, in 100 % of cases, TB was detected during referral, and in children living in rural areas, the majority were girls (62.5 %). In 87.5 % of cases, the diagnosis was confirmed bacterioscopically, in 50 % of children the presence of contact with a tuberculosis source was determined, in 12.5 % there was no BCG vaccination, in 25 % of children MDR-TB was registered.

**Keywords**
Tuberculosis, children, morbidity, the COVID-19 pandemic.
The ongoing armed aggression of the Russian Federation for almost a year has led to a massive humanitarian crisis that has affected the entire population of Ukraine and is likely to increase the spread of TB in the future, along with the impact of the COVID-19 pandemic. Historical experience of military conflicts around the world confirms this. Access to medical care remains difficult throughout the country, including in regions that have not been directly affected by the aggression [7, 12].

Diagnosis of tuberculosis in children remains a difficult problem, especially in children under 5 years of age. Tuberculosis in children is often paucibacillary, and young children are usually unable to produce a sputum sample, so induced sputum or gastric aspiration can be used to obtain a sample for microbiological diagnosis, but these methods can cause discomfort, stress, and pain in children [2]. Additionally, after sample collection, a long incubation period (3—4 weeks) is often required to isolate Mycobacterium tuberculosis (MTB) in culture, which limits timely diagnosis and leads to delays in starting treatment. Diagnosis of TB in children under 5 years old, who are at the highest risk of developing severe forms such as tuberculous meningitis and miliary tuberculosis, presents particular difficulties. Most children are treated for tuberculosis infection based on clinical symptoms, which can result in both inadequate diagnosis and excessive treatment of childhood tuberculosis, especially in young children [3, 8].

Poor treatment outcomes and inadequate contact tracing practices lead to significant tuberculosis infection in children. Laboratory confirmation of tuberculosis in children remains insufficient. Improving the diagnosis of TB in children is essential for effective treatment of those with a bacteriologically confirmed diagnosis. Since 2021, the WHO recommends testing stool as a new type of sample along with sputum (expectorated or induced), nasopharyngeal aspirate, or gastric aspirate for Xpert Ultra testing as an initial diagnostic test for TB and for determining rifampicin resistance in children with signs and symptoms of tuberculosis infection. Stool samples can be easily obtained and contain Mycobacterium tuberculosis from swallowed sputum [1, 13].

The Public Health Center, with the support of a grant from the Global Fund to Fight AIDS, Tuberculosis, and Malaria, has implemented a series of systemic measures to introduce this innovative method [3, 12].

Objective — to analyze the regional epidemiological characteristics of tuberculosis among children in the Chernivtsi Region.

Materials and methods
Medical records of all newly diagnosed cases of childhood tuberculosis registered at the Chernivtsi Regional Clinical Anti-Tuberculosis Dispensary from January 2020 to December 2022 (TB MANAGER electronic register) were analyzed. Statistical analysis of the collected data was performed using IBM SPSS Statistics v. 26.0 software.

Results and discussion
The increase in tuberculosis among adults is closely correlated with the increase in TB among children, which likely doubled according to the 2022 data in the Chernivtsi Region. The lockdown situation caused by the COVID-19 pandemic has had its negative impact.

Thus, in 2022, 8 children with active tuberculosis were detected in Bukovyna (1 child in Vyzhnytsia, Zastavnytsia, Storozynets, Kitsman, and Putyla districts, and 3 children in Novoselytsia). Accordingly, in 2021 there were 3 cases, and in 2020 only 1 case was registered. The characteristics of the first diagnosed cases of TB in children under 14 years of age in Chernivtsi Region during the lockdown period are presented in Table 1.

As the analysis of the data presented in Table 1 for 2022 shows, TB was detected in 100 % of cases at the time of seeking medical attention, and the majority of affected children lived in rural areas and were girls (62.5 %). In 87.5 % of cases, the diagnosis was confirmed bacteriologically, 50 % of children had contact with a TB source, and 12.5 % were not vaccinated with BCG.

The registration of disseminated tuberculosis in children, which accounted for 25 % of cases, is a cause for concern. In 2022, two cases (25 %) of extrapulmonary tuberculosis were registered, one of which (meningoencephalitis) had an unfavorable prognosis and ended in death. It should be noted separately that the child was not vaccinated.

The analysis of the dynamics by years when Ukrainian citizens were under lockdown conditions due to COVID-19 showed an increase in tuberculosis incidence among children under 14 years old — 2.7 times compared to 2021 and almost 8 times compared to 2020. All of the above indicates a sharply negative trend in controlling tuberculosis in children under 14 years old in Bukovyna (Fig. 1).

As demonstrated in Fig. 2, the COVID-19 pandemic had a negative impact on the prevalence of TB in children under 14 years old in Chernivtsi Region, with a statistically significant increase of almost 2.6 times compared to 2021. It should be noted that this indicator remained likely lower than the nationwide average for 2020—2021, almost 3 times lower.
The indicators regarding the tuberculosis situation in the 15—17 age group in Chernivtsi Oblast, presented in Table 2, demonstrated an increase in TB by almost 2 times in percentage terms, with an even gender distribution (50 % each) compared to 2020 and 2021. It should be noted that 50 % of cases were internally displaced persons from a region with a higher incidence rate (almost 2 times higher). The positive aspect is that in all cases, TB was detected upon seeking medical attention, and in 100 % of patients, it was confirmed bacteriologically (with 50 % having disseminated clinical form). In total,
during the COVID-19 pandemic period of 3 years, 4 cases of active tuberculosis were detected in this age subgroup (2 in Chernivtsi Region and 2 in internally displaced persons).

The analysis of tuberculosis (TB) incidence rates among children aged 15—17 years (Fig. 3) showed that in 2022, this indicator likely doubled compared to previous years. However, as shown in Fig. 4, the incidence of TB in children remains lower than in the pre-pandemic period, by almost 1.6 times, which may indicate insufficient work of primary care in timely diagnosing active TB.

The prevalence of tuberculosis in children aged 15—17 in Chernivtsi Region followed a similar trend to incidence. The likelihood of this indicator was almost 4 times lower than the national average during the COVID-19 pandemic period, by almost 1.6 times, which may indicate insufficient work of primary care in timely diagnosing active TB.

The prevalence of tuberculosis in children aged 15—17 in Chernivtsi Region followed a similar trend to incidence. The likelihood of this indicator was almost 4 times lower than the national average during the COVID-19 pandemic period, by almost 1.6 times, which may indicate insufficient work of primary care in timely diagnosing active TB.

Based on the data presented in Table 3, the situation with the epidemiology of active TB incidence and prevalence in children in the Chernivtsi Region has significantly worsened in the pre-pandemic and pandemic period of 2022, not only in Bukovyna but also throughout Ukraine, which is in line with previous forecasts. Epidemiological indicators of childhood TB in Bukovyna were likely lower than nationwide, but in our opinion, this does not indicate a well-functioning system or create a platform for optimism, but may be a result of underdiagnosis of children at the primary healthcare level. For example, insufficient control of risk groups with systematic screening.

Due to the onset of the COVID-19 pandemic caused by SARS-CoV-2 in 2020, the number of newly detected cases of tuberculosis decreased, which potentially could have led to the accumulation of undiagnosed and latent cases of TB that were detected at later stages and in more severe forms, demon-

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### Table 2. Analysis of newly diagnosed cases of tuberculosis in children under 15—17 years of age in Chernivtsi Region

<table>
<thead>
<tr>
<th>Index</th>
<th>2022 year</th>
<th>2021 year</th>
<th>2020 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discovered upon application</td>
<td>2 (100 %)</td>
<td>1 (100 %)</td>
<td>1 (100 %)</td>
</tr>
<tr>
<td>Preventive medical examination</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>According to the forms of the TB process:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>infiltrative</td>
<td>50 % (Chernivtsi)</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>disseminated</td>
<td>50 % (Chernivtsi)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Destr.+</td>
<td>50 % (Chernivtsi)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>MBT+</td>
<td>100 %</td>
<td>100 %</td>
<td>—</td>
</tr>
<tr>
<td>Complicated course</td>
<td>50 % (Chernivtsi)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Contact with TB patients</td>
<td>—</td>
<td>—</td>
<td>100 %</td>
</tr>
<tr>
<td>There is no sign of BCG</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Complicated course</td>
<td>50,0 %</td>
<td>100 %</td>
<td>—</td>
</tr>
<tr>
<td>Rural</td>
<td>—</td>
<td>100 %</td>
<td>—</td>
</tr>
<tr>
<td>Municipal</td>
<td>100 %</td>
<td>—</td>
<td>100 %</td>
</tr>
<tr>
<td>Boys</td>
<td>50 %</td>
<td>100 %</td>
<td>—</td>
</tr>
<tr>
<td>Girls</td>
<td>50 %</td>
<td>—</td>
<td>100 %</td>
</tr>
</tbody>
</table>

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Fig. 3. Incidence of tuberculosis in children aged 15—17 in Chernivtsi Region and Ukraine for 2019—2022 (per 100,000 population)

Fig. 4. Prevalence of tuberculosis in children aged 15—17 in Chernivtsi Region and Ukraine for 2019—2022 (per 100,000 population)
strating a potentially significant increase in the number of active cases (almost three times) in 2022. In our opinion, the expansion of the use of molecular express diagnostics for the detection of TB in the early stages will significantly help to detect the disease in time, which is the key to overcoming the incidence of active tuberculosis in children in Bukovina under the influence of the COVID-19 pandemic [4, 9].

The above-mentioned problem becomes especially relevant in the conditions of massive displacement of people due to the state of war and the constant influence of negative stressors, when the weakening of the resistance of the immune system leads to the progression of various diseases, including tuberculosis. The question of the impact of martial law conditions on the potential of tuberculosis epidemiology, including that of children, requires a separate analysis.

**Conclusions**

Chernivtsi Region during the period from 2020 to 2022, there has been a probable increase in the incidence of tuberculosis among children (almost twice). Due to the onset of the COVID-19 pandemic caused by SARS-Cov-2, the number of newly diagnosed tuberculosis cases decreased in 2020, which potentially could have led to an accumulation of undiagnosed and latent TB cases, which were detected at later stages and in more severe forms and demonstrated a potentially likely increase in the number of active cases (almost three times) in 2022. Among them, cases of family tuberculosis accounted for 28.6 %. In 2022, in 100 % of cases, TB was detected during referral, and in children living in rural areas, the majority were girls (62.5 %). In 87.5 % of cases, the diagnosis was confirmed bacterioscopically, in 50 % of children the presence of contact with a tuberculosis source was determined, in 12.5 % there was no BCG vaccination, in 25 % of children MDR-TB was registered. Two cases of extrapulmonary tuberculosis (clinical form of tubmeningoencephalitis) were detected in children who were not vaccinated, one of them was fatal.

Table 3. Dynamics of incidence and prevalence of tuberculosis in children in Chernivtsi Region per 100,000 child population for 2019—2022

<table>
<thead>
<tr>
<th>Index</th>
<th>Region</th>
<th>Years</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Up to 14 years</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidence per 100,000 children</td>
<td>Chernivtsi Region</td>
<td>13.3</td>
<td>0.6</td>
<td>2.0</td>
<td>5.2</td>
<td></td>
</tr>
<tr>
<td>Ukraine</td>
<td>9.0</td>
<td>5.9</td>
<td>7.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevalence per 100,000 children</td>
<td>Chernivtsi Region</td>
<td>1.3</td>
<td>0.6</td>
<td>2.0</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td>Ukraine</td>
<td>7.8</td>
<td>5.2</td>
<td>6.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>15—17 years old</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidence per 100,000 children</td>
<td>Chernivtsi Region</td>
<td>11.2</td>
<td>3.6</td>
<td>3.5</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>Ukraine</td>
<td>20.0</td>
<td>14.2</td>
<td>12.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevalence per 100,000 children</td>
<td>Chernivtsi Region</td>
<td>11.2</td>
<td>3.6</td>
<td>3.5</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>Ukraine</td>
<td>18.1</td>
<td>14.6</td>
<td>10.7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There is no conflict of interest.

**Reference**

Динаміка захворюваності дітей на активний туберкульоз на Буковині, вплив пандемії COVID-19

За даними ВООЗ, Україна посідає п’яте місце у світі за захворюваністю та смертністю від туберкульозу (ТБ) і друге — в Європі.

Мета роботи — проаналізувати регіональні особливості епідеміології туберкульозу серед дітей у Чернівецькій області.

Матеріали та методи. Проаналізовано медичні картки всіх пацієнтів дитячого віку з вперше діагностованим ТБ за період із січня 2020 р. до грудня 2022 р. у Чернівецькому обласному протитуберкульозному диспансері. Статистичну обробку отриманих даних проведено за допомогою програми IBM SPSS Statistics v. 26.0.

Результати та обговорення. Аналіз динаміки по роках, коли Україна перебувала в умовах локдауну через COVID-19, виявив приріст захворюваності на ТБ серед дітей віком до 14 років (у 2,7 разу порівняно з 2021 р. і майже у 8 разів порівняно з 2020 р.). Зареєстровано 2 (25 %) випадки позалегеневого ТБ, один з них (менінгоенцефаліт) мав несприятливий прогноз і призвів до летального наслідку. Показники щодо ситуації з туберкульозу в Чернівецькій області у віковій категорії 15—17 років продемонстрували приріст ТБ практично вдвічі з однаковим розподілом за статтю (по 50 %) порівняно з 2020 та 2021 р.

Висновки. На Буковині за період з 2020 до 2022 р. зареєстровано статистично значущий приріст захворюваності на ТБ серед дітей. У 2022 р. у 100 % випадків ТБ був виявлений при звертанні і у дітей, що проживали у сільській місцевості, переважали дівчатка (62,5 %). У 87,5 % випадків діагноз був підтверджений бактеріоскопічно, у 50 % дітей визначена наявність контакту з туберкульозним джерелом, у 12,5 % була відсутня вакцинація БЦЖ, у 25 % дітей був зареєстрований МЛС-ТБ.

Ключові слова: туберкульоз, діти, захворюваність, пандемія COVID-19.