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ENGLISH VERSION: RETROSPECTIVE ANALYSIS OF INFLUENZA AND PNEUMONIA MORBIDITY AND THEIR SYNERGISM IN SOME REGIONS OF UKRAINE*

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Influenza is one of the most topical public health problems worldwide, and the increased morbidity of pneumonia during influenza epidemics is often observed. The aim of this study was to analyze the incidence of influenza and pneumonia in Ukraine for 1998-2011 years by means of retrospective analysis, and to find possible correlation between these conditions. Organization and methods. The data from official statistical sources, issued by National academy of medical sciences, National institute of phthisiology and pulmonology and Influenza control center were analyzed. Using data for Vinnitska, Dnipropetrovska, Ivano-Frankivska and Kyivska oblasts corresponding linear regression models were built. The results of the modeling were compared with morbidity indices for current regions of Ukraine. Results. A strong correlation was revealed between intensive index of influenza morbidity in each region and an angle of regression model for pneumonia (Pearson's correlation coefficient was 0,91). Conclusion. It was established that pneumonia held the leading place in the structure of low respiratory tract diseases in Ukraine. A clear correlation was revealed between influenza and pneumonia morbidity, which is worth to consider while making prevention programs for both diseases.

Key words: influenza, pneumonia, correlation.

Actuality.

Influenza is the most prevalent and massive infectious disease in the whole world. According to WHO, about 100 million of people suffer from influenza annually. This number increases during pandemic years by 4-5 times. It is well known, that each third taken subject has at least one episode of influenza or common cold a year [1]. In Ukraine influenza and other viral respiratory infections are the dominating infectious pathologies. According to the data, published by MOH of Ukraine influenza control center, the peak level of morbidity for the last years is within the range from 17 to 45 cases per 100 000 of adult population (Fig. 1).

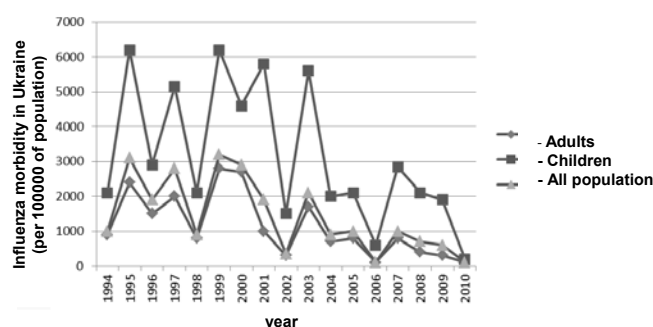


Fig. 1. Intensive influenza morbidity index (2011-2013 years)

These data make influenza a strategically important medical problem, requiring introduction of an effective anti-epidemic measures and their strict coordination in order to minimize morbidity and economic burden. In the structure of mortality and complication influenza also

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holds the first place among all infectious diseases. The mortality is higher in elderly, accounting for 80–90% of cases for 65 and older age group. In the age group 45–64 years the influenza mortality is 2 cases per 100 000 inhabitants [2]. The most common complications of influenza are community-acquired bacterial infections of respiratory tract, mainly pneumonia (Fig.1) [3]. Influenza pandemics in 1918, 1957 and 1968 revealed the shift of *S. pneumonia* (pneumonia pathogen) from a synantropic microorganism to potentially lethal pathogen [5]. Most of lethal outcomes during those pandemics were caused rather by pneumococcal infection than viral infection. An 96 autopsies findings during 1918 pandemic revealed co-infection with *S. pneumoniae* (23,2%), *S. haemolyticus* (18,0%), *S. aureus* (7,7%) and *H. influenzae* (4,7%) [10]. Same was true for California H1N1 influenza pandemic in 2009. In USA from autopsy lung specimens *S. pneumoniae* was isolated in 13% of cases. In clinical studies, conducted in Argentina and Japan, it was estimated that about 50% of severe cases of influenza had been associated with pneumococci [11-13].

Based on statistical data, pneumonia is a leading cause of death among all infectious disease, and the fourth – among death causes for the people aged 65 years and older. Pneumonia incidence varies in the world from 3,5 to 15 cases per 1000 inhabitants with mortality rate from 3 to 25%. About 4 million people in USA suffer from pneumonia annually, 25% of them require hospitalization [14, 15].

Different world surveys report influenza as an important factor, facilitating high rates of bacterial pneumonia morbidity. At the same time a grade of correlation between influenza and pneumonia varies from low to moderate [16]. The pikes of pneumonia and influenza morbidity overlay, especially in winter season [17-20]. Nevertheless, for Ukraine there are no such data, which could clearly demonstrate such correlation. Hence, the aim of this study was to analyze the incidence of influenza and pneumonia in Ukraine for 1998-2011 years by means of retrospective analysis, and to find possible correlation between these conditions.

Organization and methods.

The data from official statistical sources, issued by National academy of medical sciences, National institute of phthiisology and pulmonology and Influenza control center were analyzed [3, 21, 22].

The analysis of influenza morbidity (per 100 000 inhabitants) clearly demonstrated a decrease of this index both in children and in adults (Fig. 2).

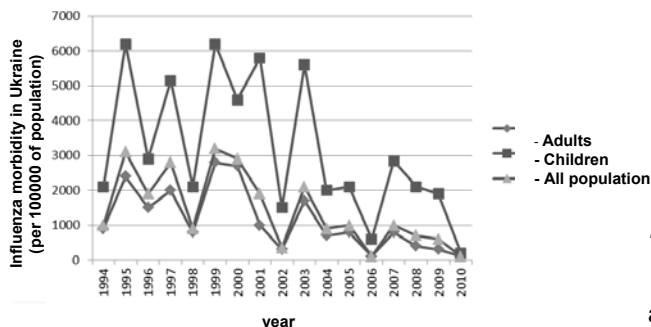


Fig. 2. Incidence of influenza in Ukraine per 100 000 inhabitants (1994-2010 years.)

The highest levels of morbidity for the period 1998-2010 were registered in Lviv oblast (2662,5 cases per

100 000 inhabitants), which was 493 times higher than in Crimea Republic (Fig. 3).

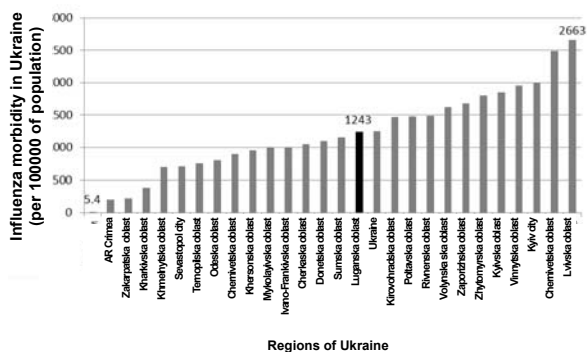


Fig. 3. Mean incidence of influenza by oblasts in Ukraine (1998-2010 years)

The influenza incidence between epidemics is literally not observed. A seasonal growth is observed in December, reaching the maximum in February, almost disappearing in April (Fig. 4).

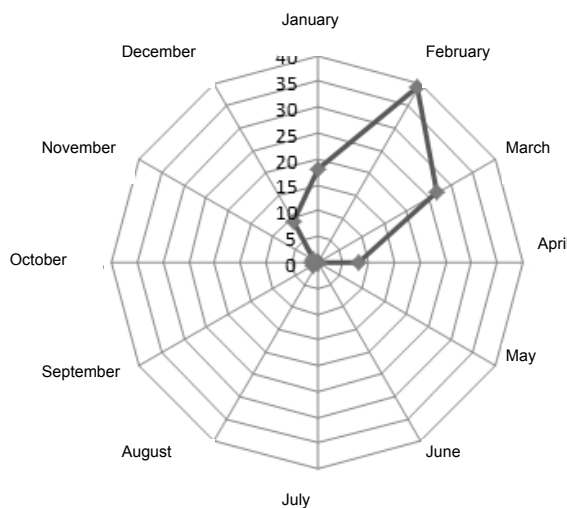


Fig. 4. Mean index of seasonal incidence of influenza

Until 2009 the mortality due to influenza was low – 0,05 cases per 100 000 inhabitants. A prominent (30-fold) increase of this index was registered in epidemic season in 2009-2010 (Fig. 5).

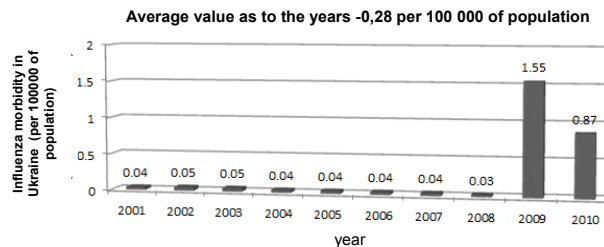


Fig. 5. Mean mortality due to influenza and other viral respiratory infections in Ukraine (2001-2010 years)

Official statistics, unfortunately, doesn't fully describe a real epidemiology situation in Ukraine and its regions. The matter is that statistical reports do not differentiate between community-acquired and hospital pneumonia. But, despite this fact, these reports help to reveal certain trends (Fig. 6).

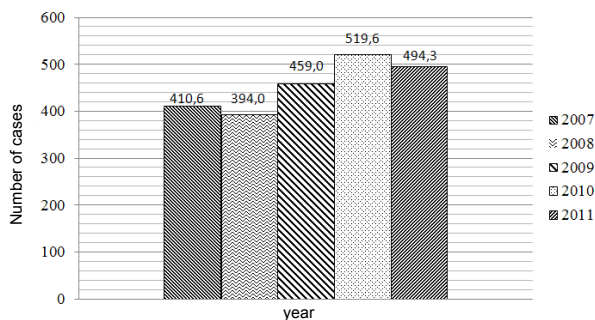


Fig. 6. Pneumonia morbidity in Ukraine in adults 2007-2011 years (per 100 000 inhabitants).

The highest numbers of morbidity were registered in 2009-2010. In 2010 it exceeded corresponding value of 2008 by 24,2%, in 2011 – by 5%. An analysis of morbidity was conducted in four oblasts of Ukraine: Ivano-Frankivska, Vinnytska, Kyivska and Dnipropetrovska (Fig. 7). This index was significantly higher than mean Ukrainian in such oblasts as Vinnytska, Ivano-Frankivska and Kyivska. In Dnipropetrovska oblast this index was below the average value. The data presented convincingly demonstrate that maximums of morbidity in current oblasts were noted in 2009-2010 years. In Ivano-Frankivsk oblast the incidence of pneumonia in 2009 was 11,7% higher than in 2008, and in 2010 – by 6% higher than in 2011. Correspondingly, in Kyivska oblast the morbidity index increased in comparison with 2008 by 1,2 times, in 2010 by 5% in comparison with 2011.

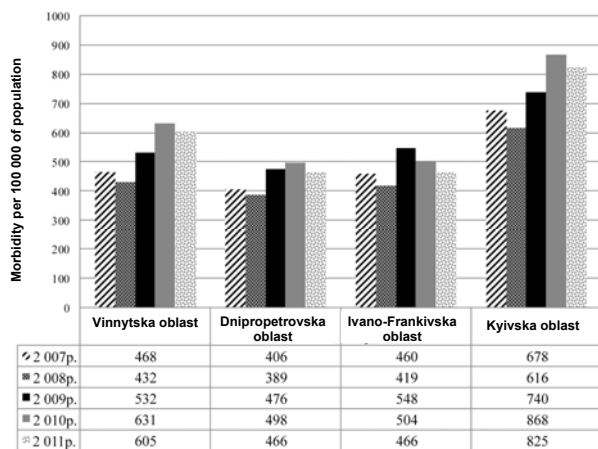
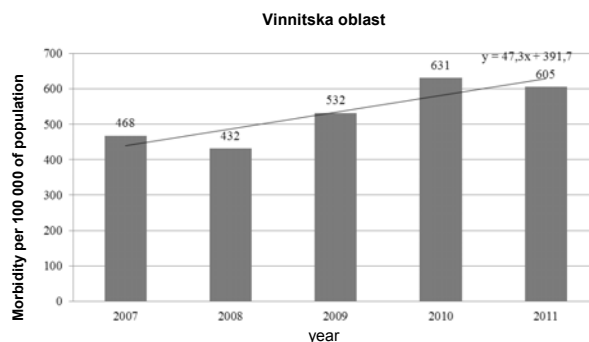


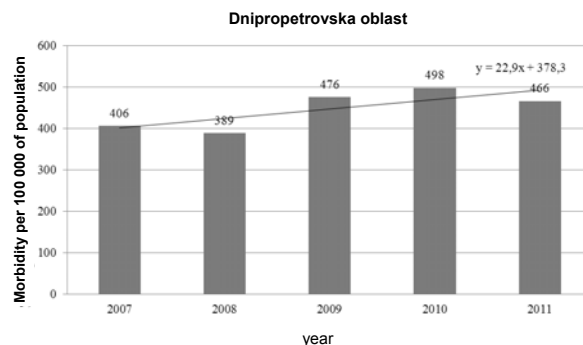
Fig. 7. Pneumonia morbidity in some oblasts of Ukraine per 100 000 inhabitants in 2007-2011 years.

A statistical analysis was performed using PC software. Pearson's correlation coefficient and correlation analysis were performed using MS EXCEL 2010. A construction of interpolation curves was done using Mathcad 15 software package.

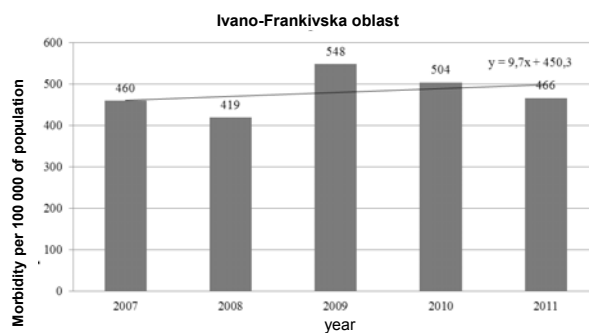
Using data for Vinnytska, Dnipropetrovska, Ivano-Frankivska and Kyivska oblasts corresponding linear regression models were built (Fig. 8). The results of the modeling were compared with morbidity indices for current regions of Ukraine.



a



b



c



d

Fig. 8a-d. Linear regression models of pneumonia morbidity for some oblasts of Ukraine

A strong correlation was revealed between intensive index of influenza morbidity in each region and an angle of regression model for pneumonia (Pearson's correlation coefficient was 0,91). The more intensive was the influenza morbidity, the more intensive was the incidence of pneumonia in current region (Tab. 1).

Table 1
A correlation between intensive index of influenza morbidity and pneumonia incidence in some oblasts of Ukraine

Oblast	Pneumonia incidence (2007–2011 years) (regression model)	Influenza incidence (1998–2010 years)	Pearson's correlation coefficient
Vinnitska	$y = 47,3x + 391,7$	1978,13	0,91
Dnipropetrovska	$y = 22,9x + 378,3$	1641,44	
Ivano-Frankivska	$y = 9,7x + 450,3$	985,56	
Kyivska	$y = 54,6x + 581,6$	1896,13	

Discussion.

In current study we revealed that pneumonia morbidity was closely correlated with circulation of influenza virus both during epidemic and pandemic in 2009 in Ukraine. The pneumonia incidence had a trend towards the growth, which was demonstrated on example of four oblasts, despite certain differences in terms and duration of influenza virus circulation.

Considering the tremendous significance of pneumonia nowadays, even a weak correlation between this disease and influenza is a real breakthrough, since a number of cases may be prevented by influenza immunization. Current statistical analysis is the first attempt in understanding of influenza virus circulation and its influence on pneumonia incidence in a country with mild climate.

This study has some limitations. First, it utilized the data from two unrelated sources of survey data, while a control of either influenza or pneumonia was crucial. Unfortunately, under current condition this is impossible to achieve. Moreover, since even mild influenza can lead to pneumonia, the influenza tests should be widely used among pneumonia patients. Retrospective of case-control studies is difficult to conduct, since at the moment of manifestation of pneumonia the commercially available tests for influenza detection both in children and adults would become not useful. Second, in current study we didn't consider other potential factors as low temperature, circulation of respiratory syncytial virus, which are also pre-dispositive for pneumonia [15, 16, 19].

Thus, we revealed that circulation of influenza virus was associated with increasing incidence of pneumonia both during seasonal epidemics and pandemic in Ukraine. In mild climate the influenza plays a role of a messenger in pathogenesis of secondary bacterial pneumonia. Assuming this statement, it becomes reasonable to pay more attention on vaccination programs in order to prevent pneumonia.

Conclusion.

It was established that pneumonia held the leading place in the structure of lower respiratory tract diseases in Ukraine. Its incidence was characterized by certain differences between regions of the country. The highest values of morbidity were registered in Vinnitska, Dnipropetrovska, Ivano-Frankivska and Kyivska oblasts. The results of the study demonstrated a clear correlation between influenza and pneumonia morbidity, which is worth to consider while making prevention programs for both diseases.

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