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# Sensorineural Hearing Loss in the Structure of Occupational Morbidity in Ukraine: the Problem of Disease Detection

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***Abstract.*** **The objective** of the research was to compare Ukrainian statistics in occupational morbidity with data of other countries, to analyze the trend of the occupational hearing loss formation in Ukraine over a six-year period (2011 – 2016), to consider a modern state of sensorineural hearing loss detection and prophylaxis.

**Materials and methods**. A comparative analysis of occupational morbidity in Ukraine and other counties within 2011-2016 years was based on the data obtained from the reports of the Social Insurance Fund of Ukraine, Statistical Collector, Eurostat, the International Labour Office, the Bureau of Labor Statistic, etc.

**Results.** The difference in Ukrainian and international statistics in occupational morbidity can be explained by the diversity in the surveillance systems. The sharp decline in occupational morbidity in Ukraine within 2014-2016 is connected neither with the improvement of prophylactic measures nor with creating better work conditions. Sensorineural hearing loss has been ranked fourth in occupational morbidity accounting for 2.5%-4% of professional pathology and is underestimated.

**Conclusions**. The underestimation of occupational hearing loss in Ukraine is determined by economic and organizational reasons, scarce diagnostics during medical examinations, peculiarities of the national surveillance system. A possible solution to this problem includes but is not limited to the reduction in countless pathologies caused by a high level of unreported employment, the establishment of unified sensorineural hearing loss classification, the increase in an accuracy of noise zone determination (noise-map construction), the performance of pure-tone audiometry in extended range (9 – 16 kHz).

***Keywords: sensorineural hearing loss; occupational morbidity; surveillance system; prophylaxis.***

## Problem statement and analysis of the recent research

The fact that Ukraine has become an Associate Member of the European Union since 2017 requires State Standards to be reconciled with the European ones. It concerns not only the improvement of hygienic standards but the development of risk assessment approaches and the detection of occupational diseases as well. Hearing loss, which is one of the most important medical and social problems nowadays, needs special attention [1]. Occupational hearing loss is considered by the National Institute for Occupational Safety and Health (NIOSH) as one of the priority research areas of the 21st century. According to the American Bureau of Labor Statistics, occupational hearing loss is the most commonly recorded occupational disease in manufacturing [2]. Nearly the same situation is observed in Europe where noise is considered to be one of the major occupational risks (20% of the occupational burden of diseases) [3]. Moreover, 29.8 % of European workers admitted loud noise as a risk factor at their workplaces in 2014 [4]. Noise-induced hearing loss is estimated to be an important problem in Canada [5], China [6], Korea [7] and other countries.

The problem of occupational hearing loss is quite important for Ukraine due to the prevalent role of mining and manufacturing industries in its economy. These industries are characterized by harmful work conditions and the highest risks of occupational diseases development, including sensorineural hearing loss (SNHL) [8, 9].

The estimation of occupational hearing loss in Ukraine is based on both international and national standards. Considering necessity to establish the relationship between noise exposure at the workplace and the disease development, it is quite important to determine all physical characteristics of noise. The legal basis concerning the noise exposure measurement includes Directive 2003/10/EC [10], several International Organization for Standardization (ISO) standards [11–13] and national sanitary norms [14, 15].

Another group of the regulative documents concerns the approaches to noise-hearing loss estimation [16]. It should be mentioned, that the criteria for occupational noise-induced hearing loss vary from country to country [17–19]. Nowadays, four degrees of SNHL are distinguished in Ukraine [20]; however, this classification is still being discussed [21]. The American Speech-Language-Hearing Association (ASHA) suggests seven degrees of hearing loss (from normal to profound) [22]. European classification of occupational diseases does not suggest any degrees of "hypoacusis or deafness caused by noise" [23].

The most fundamental summary of findings of etiology, pathogenesis, diagnostic methods and treatment of this disease was published by Ukrainian otolaryngologists Shydlovska TV, Zabolotnyi DI, Shydlovska TA [21] in the monography "Sensorineural hearing loss" in 2006. More than forty years of experience in this field resulted in the development of a complex approach to the treatment of patients with SNHL. Deep studying concerning the improvement of diagnostic and prophylaxis of occupational hearing loss was done by Gvozdetskyi VA, Basanets AV et al. [24, 25].

Nevertheless, scientific researches concerning dynamics of occupational hearing loss formation in Ukraine are scarce or devoted to particular problems of SNHL in some occupations.

**The objective of the research** was to compare Ukrainian statistics in occupational morbidity with data of other countries, to analyze the trend of the occupational hearing loss formation in Ukraine over a six-year period (2011 – 2016), to consider a modern state of SNHL detection and prophylaxis.

## Materials and methods

Dynamics of occupational morbidity in Ukraine within 2011-2016 was analyzed based on open access official reports of the Social Insurance Fund of Ukraine [26]. The rate of occupational diseases was calculated per 100,000 workers. The number of persons employed was gathered from reports of Statistic Service of Ukraine [27]. Ukrainian statistics in occupational morbidity were compared with official data in the Czech Republic, Belgium, Japan and the USA. The rate and number of occupational diseases, including occupational hearing loss, for representative countries were gathered from the official sources such as reports of the National Institute of Public Health (Czech Republic), the Federal Agency of Occupational risks (Belgium), the Japan Industrial Safety & Health Association (Japan), the Bureau of Labor Statistic (USA). Dynamics of the changes in occupational hearing loss cases in absolute amount and percentage was analyzed.

## Results

The population of Ukraine decreased from 45,778,500 in 2011 to 42,760,500 in 2016. Obviously, this process is reflected

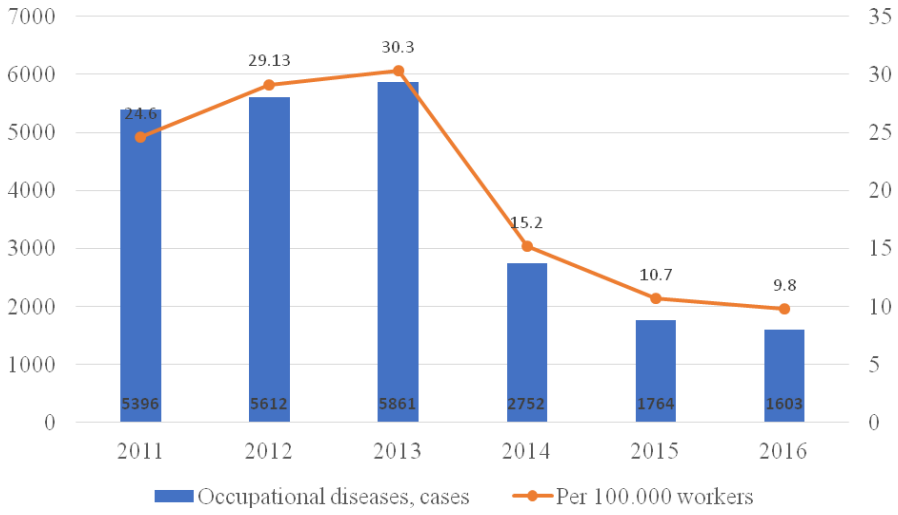


**Fig. 1. Rate of occupational morbidity in Ukraine during 2011 - 2016**

*Note:* * 2014-2016: data are given excluding the temporarily occupied territories of the Autonomous Republic of Crimea, the city of Sevastopol, and the part of the anti-terrorist operation zone

in employed population which declined from 20,324,200 to 162,769,00 within the same period [27]. Having gathered statistics about the indices of occupational diseases [26], the Social Insurance Fund of Ukraine declared an increasing trend in occupational morbidity during 2011–2013 against the backdrop of economic stagnation. Fig. 1 presents decreasing trend in occupational morbidity during the last three years (2014-2016).

This significant decline can be explained by the impossibility to obtain data from the temporarily occupied territories of Crimea and parts of the Donetsk and Luhansk regions. The last ones are two biggest industrial regions of Ukraine with the prevalence of manufacturing, machine-building and coal-mine industry. It allows concluding that sharp decrease in occupational morbidity in Ukraine within 2014-2016 is connected neither with the improvement of prophylactic measures nor with creating better work conditions.

The comparison of Ukrainian statistics in occupational morbidity with data in the Czech Republic [28], Belgium, [29], Japan [30] and the USA [31] (Table 1) showed the significant difference in the absolute number of occupational diseases and cases per 100,000 workers as well. Such difference between Ukrainian statistics and data of other countries could be explained not only by the diversity of occupational surveillance systems but by various approaches to their detection as well.

Unfortunately, it is quite difficult to obtain general statistics in occupational morbidity in the European Union, since it does not have an entire source which "can provide a complete and adequate description of occupational safety and health" [32].

**Table 1. Comparison of occupational morbidity in Ukraine, the Czech Republic, Belgium, Japan and the USA in 2015**

| Country | Occupational diseases, cases | Per 100,000 workers |
|---|---|---|
| Japan | 7,368 | 10 |
| Ukraine | 1,764* | 10.7* |
| Czech Republic | 1,902 | 24.2 |
| Belgium | 3,175 | 82.6 |
| USA | 2,905,900 | 3,000 |

*Note:* *data are given excluding the temporarily occupied territories of the Autonomous Republic of Crimea, the city of Sevastopol, and the part of the anti-terrorist operation zone

Moreover, European statistics in occupational morbidity have not been collected since 2009 [33] due to a huge difference between health surveillance systems in each country of the EU. Ukrainian statistics include the diagnoses proved only by the Occupational Pathology Commission and documented assessment of work conditions, while in some countries, self-reported work-related health problems can be included in national statistics reports. Moreover, some countries do not have an approved list of occupational diseases, therefore, some illnesses, which are not considered as occupational ones in Ukraine (neurasthenia, an initial phase of hypertension, some functional disorders) are included in national statistics there [34].

According to the data of the State Statistics Service of Ukraine [36], in 2015, 26% of employees worked in hazardous work conditions and 12.6% of them worked at the industrial noise background which exceeded permissible levels. This situation is reflected in the structure of occupational morbidity in Ukraine. The average percentage of occupational morbidity within 2011-2016 is presented in Fig. 2. Respiratory diseases were ranked first (60.8 %), musculoskeletal disorders such as radiculopathy, osteochondrosis, arthritis, arthrosis etc. were ranked second (25.3%), vibration disease was ranked third (5.32 %) and SNHL was ranked fourth (3.2 %). All other types of professional pathology were ranked fifth (5.38 %).

It should be highlighted that SNHL contributes significantly to the structure of occupational morbidity in other countries. For instance, it was ranked second accounting for 12% of work-related health problems in the USA [32]. Having similar surveillance system with the Ukrainian one, the Russian Federation reported SNHL to be the third most common disease in the structure of occupational morbidity (9-12% of occupational pathology) [36]. Unfortunately, many countries across the EU have difficulties with gathering data about occupational hearing loss in their nations.

The percentage of workers suffering from SNHL in Ukraine fluctuated in the range between 2.5% in 2014 and 4% in 2013 during the last six years (Fig. 3).

According to some scientific researches, most cases of occupational hearing loss in Ukraine originated in coal-mine industry. Individuals exposed to high sound levels in manufacturing, constructing, airline maintenance, military, farming etc. present occupational groups with considerable risk of SNHL development [8].

It should be mentioned that occupational hearing loss develops gradually and the risk of developing the disease increases with the term of service. A lot of research conducted in the field of this problem revealed that frequency of SNHL doubles after 10-14 years of service [37].

Occupational hearing loss can lead to permanent deafness and psychosocial complications if preventive measures are not taken. In the light of this statement, the priority should be given to preventive measures and the improvement of early detection

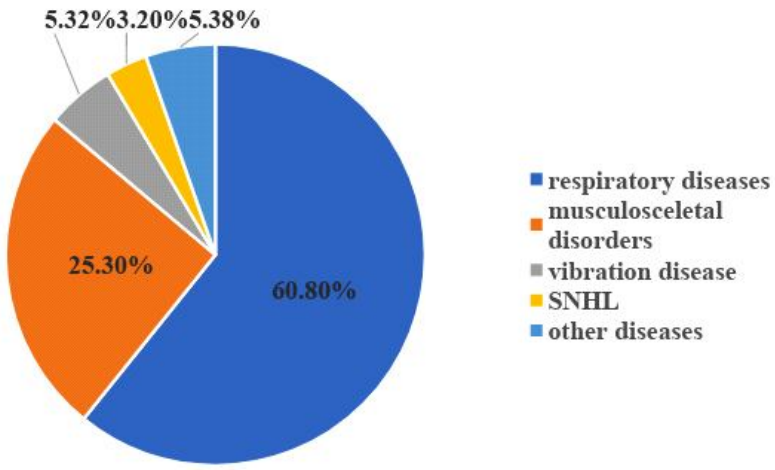


**Fig. 2. Structure of occupational morbidity in Ukraine (on average over 2011-2016)**

of this disease.

**Discussion**

According to the EUROGIP conclusions, the high reporting levels of the occupational diseases heavily depend on the efficiency of the system as a whole [38]. At the same time, Ukrainian occupational therapists report about the low level of SNHL detection [24, 25]. Among the possible reasons, the authors underline the following ones: organizational reason (necessity in the improvement of occupational hearing loss classification), the lack of diagnostic procedures (pure-tone audiometry is scarcely ever conducted during periodical medical examination of workers) and modern diagnostic equipment (occupational therapists in medical and social assessment boards have difficulties with assessment of central and peripheral parts of hearing analyzer), etc.

Among others, the following reasons can be mentioned. In fact, the Sanitary and Epidemiological Service (SES) in Ukraine which is responsible for the control of the working conditions and proper prophylaxis has been liquidated, most of the research institutions in the field of occupational health have been closed or have financial problems (in Donetsk, Kharkiv, etc.) and, finally, enterprises have no interest in increasing hygienic standards in the conditions of lack of government regulation in this field. Such situation led to the development of so-called countless pathology, especially in the private sector of the economy. Ukrainian statistics on occupational morbidity nationwide and SNHL in particular, do not include unreported employment which continues to be at relatively prominent level. For instance, in 2015, the number of such people was 4,303,300 and in 2016, it was 2,069,300 [35].

In order to more accurately establish the connection between the noise exposure and SNHL development, Ukrainian hygienists suggested using the construction of so-called noise maps [39]. This method deals with the measurement of sound levels and sound pressure in octave bands with geometric mean frequencies of 31,5 – 8000 Hz, the analysis of spectral characteristics of noise and the determination of the noise load zones. The main method used for developing a noise map is a geostatistical "Gridding Method". The proposed procedure improves the State Sanitary Standard of Ukraine 2867-94 since it helps increasing an accuracy of the noise zone determination. The comparison of the results obtained with the risks of hearing loss according to the ISO 1999:2013 [16] will allow substantiating effective prophylaxis methods of collective and individual protection.

The problem of hearing impairment underestimation is discussed not only in Ukraine. Considering the fact that the ISO 1999:2013 "does not specify frequencies, frequency combinations, or weighted combinations to be used for the evaluation of hearing disability; nor does it specify a hearing threshold level (fence) which it is necessary to exceed for hearing disability to exist" [16], some researchers asserted that sound level of 85 dB which is considered as safe is not enough substantiated. Even less intensive sound pressure (55 dB) was demonstrated to cause shifting of hearing thresholds after several years of exposure [40]. All mentioned above makes the process of comparison of occupational morbidity in different countries more difficult and underlines the necessity of generalized approach establishing.

The risk of hearing impairment rises significantly when noise exposure is combined with other occupational hazards (vibration, chemical substances, work hardness or work intensity, unfavorable microclimate, etc.) [41]. Occupational hearing impairment can develop even in conditions when noise levels do not exceed permissible ones. Usually, it happens when a combination of high work intensity with the necessity to select speech/non-language

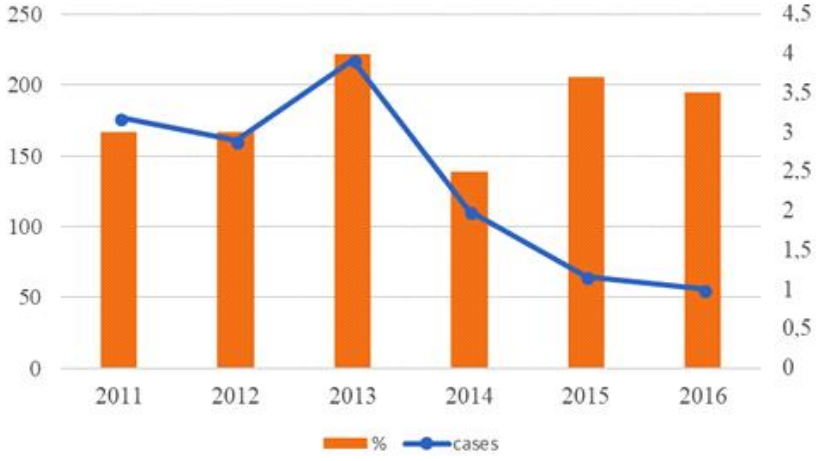


**Fig. 3. Dynamics of registration of SNHL cases during 2011-2016**

*Note:* * 2014-2016: data are given excluding the temporarily occupied territories of the Autonomous Republic of Crimea, the city of Sevastopol, and the part of the anti-terrorist operation zone

signals takes place, which was confirmed by the results of our study [42]. Obviously, researches in this field should be continued.

Low detection of SNHL in Ukraine could also relate to scarce diagnostics of early signs of hearing loss. The development of this disease is initially symptomless. It gradually progresses to a stage where people are unable to recognize speech, have problems with audibility, etc. Proper determination of initial changes in hearing analyzer when people do not have any subjective hearing complaints will allow detecting the risk groups among people working in the noise background and promptly implement prophylactic measures. With this purpose, it is necessary to conduct pre-employment and periodic medical examination using pure-tone audiometry. Our experience in this field confirms the point of view that pure-tone audiometry should be conducted not only in the conventional range (0.25 – 8 kHz) but in the extended range (9 – 16 kHz) as well [25].

As it was mentioned above, Ukrainian workers can be diagnosed with SNHL (or any other occupational disease) after an evidence base about occupational hazards at the workplace was assembled. The presence of clinical signs of disease is not considered as an ample proof without a special document "Sanitary and Hygienic Record of Work Conditions" signed by a hygienist. On the one hand, it complicates and delays the process of disease recognition as an occupational one; however, obviously, it seems to be essential.

**Conclusions**

1. The rate of occupational morbidity in Ukraine during 2011-2016 fluctuated in the range from 5,861 to 1,603 cases. The sharp decline in this index during the last two years is explained by military activity in two biggest industrial regions (Donetsk, Luhansk regions) and does not link with the implementation of prophylactic measures. The difference between Ukrainian statistics in occupational morbidity and data of other countries can be explained by the diversity of surveillance systems.

2. Occupational hearing loss is ranked fourth in the structure of occupational morbidity in Ukraine. It fluctuated in the range between 2.5% and 4% during 2011-2016 which is significantly less in comparison with other countries.

3. The underestimation of SNHL, highlighted by Ukrainian occupational pathologists, is determined by economic and organizational reasons, scarce diagnostics during medical examinations, peculiarities of the national surveillance system, prominent level of "countless pathology" due to a significant rate of unreported employment in the country.

4. A possible solution to this problem includes but is not limited to the reduction in countless pathologies, the establishment of unified SNHL classification, the increase in an accuracy of noise zone determination (noise-map construction), the improvement of medical examination procedures (detecting early signs of SNHL, performing pure-tone audiometry in extended range (9 – 16 kHz).

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