Review paper

Farmers' occupational diseases of allergenic and zoonotic origin

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Abstract

Farmers are exposed to a number of biological, physical and chemical factors harmful to the health, resulting from the specific nature of their work environment. As is clear from epidemiological studies about occupational diseases, pneumoconioses and infectious and parasitic diseases are recorded most commonly. Due to the character of farmer's work, the greatest risk to his health is biological hazards in the form of numerous microorganisms and their metabolites, and particles of plants and animals contained in the organic dust and pathogens transmitted by vectors such as ticks. The health status of farmers is often worse than of other professional groups as a result of limited access to health care and lower health literacy. Therefore, farmers should be subject to a system of diagnosing occupational diseases, and many preventive and educational programs concerning health risks associated with their work. The aim of this paper is to characterize occupational diseases of farmers including allergic diseases, tick-borne diseases and zoonoses.

Key words: farmers, occupational diseases, prevention.

Introduction

The population employed in agriculture in Poland is about 25% of total employment [1]. Occupational diseases of farmers are to a large extent caused by biological factors [2]. Biological hazards are micro-organisms and macro-organisms, toxins and allergenic substances produced by them that have harmful effects on human health [3]. Biological occupational risk factors can be divided into several groups, such as viruses, bacteria, fungi, plant factors and animal factors. In terms of the type of harm to the human body, biological occupational risk factors can be divided into pathogens (bacteria, fungi, viruses), allergens (bacteria, fungi, particles of plants and animals), biological toxins (endotoxins, mycotoxins, plant toxins, animal venoms), carcinogens (aflatoxin, wood dust) and biological vectors carrying infectious diseases (ticks, mosquitoes) [4].

In accordance with Directive 2000/54/EC of the European Parliament and of the Council, biological risk factors are classified into four groups according to the degree of danger. Factors from the first group do not carry a real threat. Pathogens classified in the second group are not spreading, and there are effective methods of their prevention and treatment. Factors in the third group can also be effectively controlled but can cause serious disease to spread. The last group (fourth) consists of factors that cause serious disease with high mortality, rapidly spreading, for which there are no effective methods of prevention and therapy [5, 6]. The source of biological agents in the workplace usually is animal and vegetable products, dust, animal and human excreta, sewage and wastes. These factors are transmitted through airborne dust, airborne droplets, skin and mucous membranes, bite of vectors such as ticks, rarely by ingestion [7].

Bioaerosols, especially from organic dusts are the most common, allergic hazard in the farmer work environment [4]. They can cause asthma, allergic alveolitis, allergic rhinitis, irritation of mucous membranes, infectious diseases and cancer. The most harmful biological agents present in the dust are bacteria and fungi, and substances produced by them with allergenic and immunotoxic properties [7].

Farmers' occupational diseases of allergic origin

Current epidemiological data indicate a disturbing trend characterized by an increased incidence of all forms of aller-

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gies, which persists in many countries. Currently allergy is described as an epidemic of the twenty-first century. Respiratory diseases such as asthma, allergic alveolitis, airway hyperresponsiveness, chronic bronchitis, allergic rhinitis and allergic skin diseases are a particular problem of public health. Currently, more than 300 million people suffer from allergic symptoms or asthma. These problems affect the socio-economic quality of life [8].

Due to the special environment of farmers' work, they are exposed to a number of biological, physical and chemical factors harmful to the health. They include noise, vibration, high physical and mechanical load associated with the work, dust, both inorganic and organic toxins. Organic dust is extremely harmful due to the huge variety of components including ingredients of plants, animal proteins, bacteria, molds and their metabolites as mycotoxins [1]. Farmers in the workplace are in contact with many molds belonging to the group called "field molds" (mainly of the genera *Alternaria* and *Cladosporium*) that grow on plants and can cause allergic diseases among farmers working in the field, and the "storage molds" developing on food, such as molds in feed (*Aspergillus* and *Penicillium*) [9]. It is estimated that 5% to 80% of allergic patients with inhaled hypersensitivity are sensitive to molds [10].

Exposure to various components of organic dusts may lead to a hypersensitivity reaction to specific ingredients, as well as development of a number of allergic diseases such as allergica alveolitis, bronchial asthma, allergic rhinitis or allergic conjunctivitis and dermatitis. Components of dust can also cause the development of diseases with immunotoxic background such as "sick building syndrome" [9]. Clinical signs of EAA (extrinsic allergic alveolitis, farmer's lung disease) affecting farmers working with moldy hay were described by Campbell in 1932 [11]. Alveolitis allergica is an interstitial inflammatory lung disease, which is a result of a hypersensitivity reaction to inhaled antigens. The most common etiologic agents of allergic alveolitis are antigens present in rotten hay (spores of thermophilic actinomycetes) and the proteins contained in the feces of birds and fur of animals. The two most common forms of allergic alveolitis are a farmer's lung and bird breeder's lung [12]. Initially, the disease is asymptomatic, leading to irreversible damage to the lung tissue. Patients complain of cough and dyspnea [9].

Another disease that occurs when organic dust is inhaled is the organic dust toxic syndrome (ODTS). The ODTS is common in swine workers or people exposed to grain dust. The ODTS is a disease process covering both the airways and alveoli. The clinical presentation is nonspecific and includes flu-like symptoms, cough, and sometimes shortness of breath. The treatment is only symptomatic and disease does not leave any permanent sequelae [9, 12].

Another disease caused by biological activity of harmful factors is known as bronchial asthma. It is a chronic inflammatory disease of the respiratory tract, which is based on airway hyperresponsiveness and leads to recurrent attacks of dyspnea. Asthma can occur in a variety of environments as a result of exposure to organic dust, in both the agricultural and forestry sectors but also in food production. The most common allergens that can cause asthma are house dust mites, animal dander, pet bird feathers, pollen of grasses, trees, fungal spores and other components of organic dusts. The main symptoms of asthma are coughing, shortness of breath attacks or wheezing. Because of its insidious onset, asthma is often mistakenly diagnosed as chronic bronchitis, and therefore is not treated or inadequately treated [9]. Studies of patients with respiratory allergy showed that 19.1% were sensitized to at least one of the fungi allergens and 73.7% to pollen [13]. Molds are among the factors that can initiate the disease process in patients predisposed to allergies and can cause exacerbation and persistence of clinical symptoms in people who are allergic. The biggest threat is molds of the genus *Penicillium*, *Aspergillus*, and *Alternaria*, which can cause occupational asthma among farmers [14].

Agriculture is a sector of the economy with the highest risk of occupational skin disease [15]. Allergic contact dermatitis is the most common occupational dermatitis in farmers which was diagnosed in 86% of all cases. Eczema causes are dominated by plant and animal allergens, and pesticides [16]. The relatively distinctive character of occupational dermatoses in agriculture is air-borne dermatitis, in which plant dusts are the main cause. Plants may also cause allergic skin reactions by contact [17].

Another significant threat present in the work environment of the farmer is mycotoxins secondary metabolites of molds. Diseases caused by mycotoxins are called mycotoxicoses and have been known for years. Toxic effects of mycotoxins after eating them with food are well known [18], but the scientific literature also mentions their harmful effect through the respiratory system. Inhalation of aflatoxins is carcinogenic and exposure to ochratoxins can cause kidney damage [19]. Mycotoxins present in the dust grain are a potential occupational hazard for farmers. In the case of the dust grain, the effect of several mycotoxins may accumulate and cause symptoms in the form of "acute episodes of lung toxicity" and other symptoms such as burning eyes, shortness of breath, chest pain, fever, dry cough and malaise [19, 20].

Health statistics show that most of occupational diseases of allergic origin reported in Polish farmers is caused by pathogens present in organic dusts. In Poland, lung diseases are more common in farmers than in the rest of the population, just as in other countries [9]. Aspects of occupational diseases in non-agricultural sectors of the economy are understood much better. This is due to the fact that the same or similar activities are carried out by more people under the control of health and safety services and labor inspection and the employees benefit from an organized preventive health care provided by the occupational health service. Individual farmers are at a disadvantage

because there is no permanent monitoring of the health (preventive examinations) of this professional group or monitoring of the health hazards in the work environment of a private farm. Other negative factors include low health awareness of farmers and primary care physicians working in the country and a low level of knowledge about the possible health risks encountered in agriculture [1].

Tick-borne diseases

Farmers are exposed to different types of diseases because of the nature of their work. Apart from allergic diseases, occupational hazards of farmers include tick-borne diseases, the main reservoir of which is wild and domestic animals, and the vector is ticks. Many years of research and observation indicate their endemic presence in Poland. These diseases are a serious epidemiological problem, especially in the working environment of farmers at the edge of forests, meadows, tall grass [21, 22].

The most well-known threat to professional farmers is Lyme disease, which is also the most common tick-borne disease in Poland. The reservoir of *Borrelia burgdorferi* – infectious agent of Lyme disease – is mainly rodents. Lyme disease is widespread throughout the country, and the incidence rate per 100 thousand of the Polish population steadily increased from 4.79 in 2000 to 22.86 in 2012 [23]. Extensive research on prevalence of ticks infected with *B. burgdorferi* spirochetes, covered over 20,000 ticks collected in 10 provinces in 1993-2001 showed that the prevalence ranged from 6% to 15% in the studied regions [24, 25]. Lyme disease is not always sufficiently quickly diagnosed and treated. In the phase of systemic infection it often requires hospitalization and long-term treatment, while the early initiation of the antibiotic relatively quickly leads to cure. Symptoms of influenza dominate among many symptoms of Lyme disease, but one of the first symptom is erythema migrans [26].

Another dangerous pathogen transmitted by ticks is tick-borne encephalitis virus (TBEV) [27]. The TBE is a viral disease of the central nervous system. The etiological agent of the disease is an RNA virus belonging to the genus *Flavivirus*. The reservoir of the virus is small rodents, and to a lesser extent, medium and large mammals. People are usually accidental hosts, which are subject to infections, mainly due to bites by infected ticks or consumption of unpasteurized milk. The disease proceeds in two stages. The first stage resembles a flu. Some patients recover, while in others the second phase of the disease can run mildly as viral meningitis or be more severe as meningoencephalitis or meningoencephalomyelitis. In the second case, the sequelae are frequent and in extreme cases the disease can lead to death [28]. Serological investigations in the region of Lublin in 1998 showed antibodies against TBE in 32% of farmers [29].

Intercurrent infections of other species of tick-borne microorganisms, which usually get into the human body simultaneously with *Borrelia burgdorferi* may be of utmost importance. They include rickettsiae *Anaplasma phagocytophilum* [30]. Occupational groups at risk of anaplasmosis are employees of agriculture and forestry. Rickettsiae *A. phagocytophilum* are obligate intracellular parasites, which attack granulocytes. Human granulocytic anaplasmosis is acute disease and the symptoms include high temperature, muscle pain, malaise, headache, and sometimes nausea, vomiting, cough, and chills [31]. Due to non-specific symptoms, anaplasmosis is correctly diagnosed only in about 22% of the cases [32]. According to various researchers, from 1.75% to 38.5% of the *I. ricinus* ticks from northern and eastern Poland are infected with *A. phagocytophilum* [33]. A high percentage of infection of ticks (14%) collected from plants were found in the northern part of Poland (around the center of the Tri-City) [34].

In addition to the spirochete Borrelia burgdorferi, and rickettsial *A. phagocytophilum* ticks can carry protozoa of the genus *Babesia*, bacteria of the genus *Bartonella*, rod-shaped bacteria of tularemia and Q fever germs [35].

Protozoa *Babesia microti* and *Babesia divergens* cause disease called babesiosis. The disease may be acute or mild, in some cases, asymptomatic. Invasions of these protozoa are characterized by flu-like symptoms (headache, fever, chills), which are accompanied by hemoglobinuria (dark urine) and, enlarged liver and spleen [36]. In Europe, *B. divergens* infections were mainly recorded, and *B. microti* was described first in the USA, but the study of ticks showed that *B. microti* is also a threat to people in Europe [37]. In Poland, protozoan infection rates of ticks with *B. microti* varied depending on the region. Studies conducted in the northern part of the country have infection rates of 2.3% [34].

The bacteria of the genus *Bartonella* can be transmitted by ticks, but this is not the only route of infection. Bartonellosis is a group of diseases that attacks the red blood cells and endothelial cells. Best-studied species are *B. henselae*, which causes the cat scratch disease, *B. bacilliformis* causing Carrion's disease and *B. quintana* transmitted by clothing lice that causes trench fever [38].

Another tick-borne illness, and at the same time a zoonotic threat to farmers is tularemia – acute infectious bacterial disease, whose etiological agent is a small, polymorphic coccobacillary *Francisella tularensis*. In Poland, the most common source of infection for humans is infected animals, especially rabbits, or infected ticks. Once it was thought that a small group of people – hunters and fur traders are exposed to tularemia. The man becomes infected through the bite of infected ticks and direct contact with the infected animals. Cases are most common during the summer months, what is related to the high activity of ticks [39]. Epidemiological reports of 1996–2009 issued by the National Institute of Public Health demonstrate about 4–6 cases per year, which is about 0.01–0.02 cases of the disease in thousand people [23]. Research data on occupational diseases from the Czech Republic in 1996–2000 show that 3.5% of occupationally exposed persons had tularemia antibodies [40].

Q fever is an infectious zoonotic disease occurring in domestic (sheep, goats, cattle) and wild animals (deer, wild), as well as in people working in farms, veterinary clinics and in forestry workers. It is caused by multiplying intracellularly bacterium *Coxiella burnetii*, producing spores – especially robust to the influence of physico-chemical properties. In Poland, as a disease of humans, it has been known since 1956, and the most common source of infection for humans is infected cattle and sheep and contaminated habitat of these animals, including dried feces of infected animals. Ticks are currently considered as a reservoir of *C. burnetii* and responsible for the spread of infection to wild and domestic animals [41]. Q fever is rarely diagnosed in humans, but is found throughout the country. Symptoms of Q fever are flu-like and include very high fever, headache, myalgia, cough, chills, but in 60% of cases the course is asymptomatic [42].

Diagnosis of occupational infections causes many problems in the medical practice. Similar symptoms of many diseases, including tick-borne and zoonotic, may limit the use of diagnostic methods [43]. The results of numerous serological tests indicate that farmers are a professional group, which may be much more likely to infect both TBEV and the spirochete *Borrelia burgdorferi* than people from urban environment [21].

Summary

The presence of harmful biological agents in the workplace and the resulting threat to the health of workers is an important, often overlooked problem of occupational medicine and public health.

In 2010, the most common occupational diseases were pneumoconioses (26.9% of all occupational diseases) and infectious and parasitic diseases (24.9%). The incidence of occupational diseases was 418.5 per 100 thousand workers among agricultural workers and foresters. Infectious and parasitic diseases prevailed among the most commonly recognized diseases (92.4%), and Lyme disease was the most common among them (96.7%) [44].

Epidemiological studies indicate that the health of the agricultural population of working age and older is worse than in other occupational groups. The access of the population to health care, especially specialists is difficult. At the same time most of the health awareness of the rural population is judged to be very low [1]. The fact is that farmers are not yet sufficiently covered by a system of detection, diagnosis and recognition of occupational diseases, so introduction of preventive and educational programs for farmers seems to be very important.

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