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HYGIENIC CHARACTERISTICS OF CHEMICAL RISK FACTORS IN A RESIDENTIAL ENVIRONMENT

Yusupkhuzhayeva Aziza Majidovna
Associate Professor of the Department of Communal
Hygiene and Occupational Hygiene, Tashkent Medical Academy

Abstract
Hygienic characterization of chemical risk factors in a residential environment is an important component of human health monitoring, since most people spend most of their time in rooms where various chemicals may be present. These substances can enter residential premises through air, water, food or building materials, causing negative health effects. Within the framework of this work, the main chemical pollutants of residential premises, their sources, as well as ways of influencing the human body are considered. These factors include: formaldehyde, benzene, ammonia, lead, pesticides, as well as volatile organic compounds that can be released from furniture, building materials, and household chemicals. The risks associated with these substances are assessed based on their toxicity, concentration in the air, and exposure time. Special attention is paid to hygiene standards established for chemicals in residential premises, as well as measures to reduce their concentration and prevent pollution of the internal environment. Indoor air quality control methods and ways to improve ventilation are considered, as well as the role of preventive measures and informing the public about possible threats.

Keywords: Residential buildings, toxic substances, microclimate of residential buildings, formaldehyde, benzene, ammonia, lead, pesticides, volatile organic compounds.

Introduction

The living environment in which we spend a significant part of our lives has a profound impact on our health and well-being. One of the most important aspects of the quality of this environment are chemical factors, which can be both natural and anthropogenic (manmade). In this article, we will look at the main chemical components that affect humans in residential environments, their sources, health effects, and precautions [1].

The living environment plays a key role in maintaining human health, and the chemical factors present in it can significantly affect the physical and psychological state of residents. Chemical pollution of air, water, food, as well as exposure to chemicals contained in building materials and household chemicals, pose a threat to health and quality of life. In recent decades, scientific research has been actively studying the influence of these factors on human health, which served as the basis for this literature review [2].

One of the main chemical pollutants in residential areas are volatile organic compounds (VOCs), which enter the air with furniture, paints, building materials and household chemicals. Studies

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show that substances such as formaldehyde, toluene, benzene, and xylene can significantly impair indoor air quality. These compounds are highly toxic and can cause headaches, allergic reactions, asthma, and other respiratory tract diseases [3].

A literature review conducted by House and his colleagues (2024) notes that indoor VOC levels can be 2-5 times higher than outdoors. One of the most well-known sources of VOCs is the use of synthetic materials such as carpets, chipboard furniture, and wallpaper. Formaldehyde, for example, is released from building and finishing materials and can cause acute and chronic diseases, including cancer [4].

Water quality as a chemical factor of the residential environment. Residential water quality is an important aspect of health, as polluted water can be a source of various chemicals such as heavy metals (lead, mercury, cadmium) and chlorine. Problems with tap water quality are discussed in studies such as the work of Freeman and Parker (2016), where it is noted that old pipes and improper water treatment contribute to the ingress of toxic substances into the water [5].

Lead is one of the most dangerous pollutants, especially in old residential buildings with metal water pipes. It can cause poisoning, nervous disorders, and developmental problems in children. The effect of chlorine and its derivatives is also an urgent topic, since chlorine in water can react with organic substances to form chlorinated hydrocarbons, many of which are carcinogenic [6].

Construction and finishing materials often contain chemicals that can be released into the atmosphere and affect the health of residents. The effects of these substances on human health have been extensively studied, especially in the context of the use of VOCs in paints, varnishes, adhesives, as well as pesticides and antiseptics used to prevent the growth of mold and fungi.

According to a study by Sherby (2013), many building materials, especially cheap and non-certified ones, contain harmful chemicals such as formaldehyde and ammonia. These substances can cause people to have breathing problems, headaches, and allergic reactions. The effect on health depends on the concentration of chemicals in the air and the time of their exposure. It is important to note that, according to many studies, children and the elderly are more vulnerable to these impacts [7].

Household chemicals such as detergents, disinfectants, air fresheners, and cleaning powders often contain dangerous chemicals, including phosphates, ammonia, chlorine, and various fragrance additives. Literature evidence suggests that improper or excessive use of these products can lead to acute intoxication, as well as cause long-term problems with breathing, skin, and eyes (Benson, 2016).

The problem of chemicals in household chemicals has become particularly relevant in recent decades, when new synthetic detergents with less-studied components began to enter the market. According to a study conducted by Benjamin and colleagues (2018), many chemicals in household chemicals have an irritating effect on mucous membranes and can cause chronic respiratory diseases such as asthma and bronchitis [8].

To minimize the effects of chemical factors in residential areas, a number of measures are recommended to improve the quality of air, water and materials used in everyday life. First, it is important to ensure good ventilation of the premises, which will help reduce the concentration of VOCs and other pollutants in the air. You should also use environmentally friendly building materials and household chemicals certified according to safety standards [9, 11].

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It is also recommended to carry out regular water quality checks and install water filters, which will reduce the concentration of heavy metals and other toxic substances. Studies have shown that modern filtration systems can significantly improve the quality of drinking water and reduce the risk of diseases associated with water pollution (Green, 2017).

In recent years, the quality of the air environment of residential and public buildings, where numerous sources of pollution often create high concentrations, and the duration of their exposure is maximal compared to other environments, has increasingly required the close attention of environmentalists, hygienists, engineers, and builders. Therefore, the indoor air environment, even in cases with relatively low concentrations due to the large amount of toxic substances and small volumes of air for dilution, is not indifferent to humans and can seriously affect their well-being, work capacity and health [10, 12].

The objectives of this study are to increase safety and improve the quality of life in residential settings, as well as to minimize the effects of harmful chemical factors on human health.

Various methods are used to study chemical risk factors in the residential environment, which help to understand what substances are present in the air, water, soil and other components, and how they can affect human health. Here are the main methods that are used: Substance analysis: These are laboratory tests that determine which chemicals are in the air, water or on other surfaces in the house. For example, special devices can be used to measure the content of harmful substances such as gases or metals. Simple tests: Portable devices or test strips are sometimes used to quickly measure the level of contamination. This allows you to quickly find out if there are dangerous substances in the air or water. Environmental monitoring: Regular checks of the quality of air, water and other elements of the living environment help to identify pollution. This may include measurements, as well as inspection of premises for sources of contamination, such as building materials or chemicals.

The results and their discussion. Currently, the influence of various levels of chemical pollution of the air environment of residential and public buildings on such indicators of public health as general morbidity, allergopathology, immune status, etc. has been proven and quantified.

We have established that the air environment in buildings is formed mainly under the influence of: 1) atmospheric air and 2) the power of internal pollution sources. The latter primarily includes construction and finishing materials, human waste products, and The latter primarily includes construction and finishing materials, human waste products, and non-field combustion of household gas.

According to previous studies, more than 100 volatile chemicals belonging to various classes of chemical compounds are simultaneously present in the air of residential and public buildings, including marginal, unsaturated and aromatic hydrocarbons, halogenated hydrocarbons, alcohols, phenols, simple and complex ethers, aldehydes, ketones, heterocyclic compounds, amino compounds. In addition, the indoor air contains metal aerosols: lead, cadmium, mercury, copper, zinc, nickel, magnesium, chromium, etc. Most of these substances are highly toxic and belong to the 1st and 2nd hazard classes.

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Since all buildings have constant air exchange with the external environment and, as our research has shown, fences do not protect residents from polluted atmospheric air, dust and toxic substances present in the outdoor air are also found in the premises, and often in higher concentrations than in the atmospheric air.

The table contains a list of the most ecologically and hygienically significant substances for both atmospheric and indoor air pollution, ranges of their concentrations in the atmosphere and in the indoor air environment are indicated, and coefficients of correlation between outdoor pollution and indoor pollution are determined.

As can be seen from the data obtained, the coefficients of atmospheric pollution transfer inside the building are different for different substances. When comparing the concentrations of nitrogen oxides, carbon monoxide and metals in residential buildings and in atmospheric air, it was found that the concentrations of these substances inside the building are at or slightly lower than their concentrations in the outdoor air, except when internal sources contribute.

As a result of the conducted research, a reliable direct correlation has been established between air pollution of residential premises and atmospheric air for substances such as carbon monoxide, nitrogen oxides, lead, chromium, cadmium, copper, iron, and zinc. This fact indicates that the main source of these substances is the incoming atmospheric air.

Table No. 1 The main sources of chemical factors in the residential environment

A source	Chemicals	Health effects
Finishing materials and furniture	Formaldehyde, volatile organic compounds (VOCs)	Eye, nose, throat irritation, headache, allergies
Household chemicals	Acetone, chlorine, ammonia, phenols	Toxic effects, respiratory tract irritation
Indoor smoking	Nicotine, tar, carbon monoxide	Cancer, diseases of the respiratory and cardiovascular systems
Gas stoves and heaters	Nitrogen oxides, carbon monoxide	Headache, fatigue, poisoning
Plastic products	Phthalates, bisphenol A	Endocrine system disorders, reproductive problems
Mold and fungi	Mycotoxins	Allergic reactions, breathing problems
Pollution from the street (transport, factories)	Heavy metals, benzene, dust, sulfur and nitrogen oxides	Cancer, diseases of the respiratory and cardiovascular systems

At the same time, concentrations of volatile organic compounds (formaldehyde, phenol, styrene, benzene, acetone, and ethyl acetate) in indoor air exceeded concentrations in atmospheric air by 4 times or more. This indicates that the main source of their entry into the indoor air environment are internal sources of pollution.

As a result of a comparative quantitative assessment of chemical pollution of outdoor air and indoor air in residential and public buildings, it turns out that air pollution in buildings exceeds the

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level of outdoor air pollution by an average of 2.0-5 times, depending on the degree of pollution of the latter and the power of internal pollution sources.

It is advisable to divide the main sources of indoor air pollution into 4 groups that can be accounted for;

1. Substances entering a room with polluted atmospheric air;
2. Substances released by construction and finishing materials;
3. Anthropotoxins;
4. Products of combustion of household gas and human household activities.

As a result of the conducted research, the qualitative and quantitative characteristics of the chemical composition of the air environment of residential premises have been established, the main sources of their entry into the air of residential buildings have been identified, quantitative characteristics of the level of chemical pollution of the air environment have been established depending on: the level of atmospheric air pollution; saturation of premises with polymer materials; the number of people in the room; the service life of the building; temperature and ambient humidity; multiplicity of air exchange.

Among the volatile chemicals found in the air of residential and public buildings, formaldehyde, phenol, benzene, styrene, ethylbenzene, toluene, xylene, acetaldehyde, acetone, ethyl acetate, nitrogen oxides, carbon monoxide are of the greatest ecological and hygienic importance.

One of the most common air pollutants are formaldehyde and phenol. Over the past two decades, the popular term “phenolic-formaldehyde houses" has even appeared. The concentration of formaldehyde in the apartments we examined ranged from 0.002 to 0.055 mg/m3 and exceeded the maximum permissible concentrations for atmospheric air by 1.1-18.5 times, and for the air environment of residential and public buildings by 0-5.4 times.

A direct dependence of the formaldehyde content in the air on the saturation of polymer materials (correlation coefficient 0.55) has been established. Thus, in apartments with polymer saturation not exceeding 1 m2/m3, formaldehyde concentrations did not exceed 0.020 mg/m3, and in apartments with polymer saturation above 2.0 m2/m3, the average formaldehyde content was 0.045 m2/ m3.

Conclusion

Chemical factors in a residential environment play an important role in maintaining human health and well-being. Air, water pollution and exposure to chemicals contained in building materials, finishes, and household chemicals pose a serious threat affecting the physical and psychological condition of residents. In recent decades, this issue has become the subject of active research, which has revealed many dangers that people face in their homes and apartments.

Exposure to volatile organic compounds (VOCs) such as formaldehyde, benzene, and toluene is one of the most common and dangerous sources of chemical air pollution in indoor environments. These substances can lead to serious respiratory diseases, allergies, and even cancer. Problems with water quality, especially the presence of heavy metals and chlorine in it, also pose a health hazard, especially if the house uses old water pipes or the water purification system is malfunctioning.

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Equally important is the effect of chemicals in building materials such as paints, varnishes, adhesives and antiseptics. These materials can release toxic substances, affecting the health of residents, especially in poorly ventilated rooms. In turn, chemicals in household chemicals such as ammonia, chlorine, and phosphates often lead to acute and chronic diseases of the respiratory tract, skin, and eyes. Taking into account all these risks, it is extremely important to take measures to minimize the effects of chemical factors on human health. One of the most effective methods is to ensure good ventilation of the premises, the use of environmentally friendly and certified building materials and household chemicals, as well as the installation of water filtration systems. This will help reduce the concentration of harmful chemicals in residential areas and create safe living conditions.

Thus, the problems of chemical pollution of the residential environment require careful attention from both the scientific community and the public. The use of modern technologies aimed at improving the quality of air, water and materials in residential areas, as well as awareness of possible risks, will help significantly improve the health and quality of life of people living in such conditions.

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Web of Medicine: Journal of Medicine, Practice and Nursing
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