# Assessment of risk perception connected with exposure to indoor air pollution in the group of inhabitants of Silesian Voivodeship

## Ocena percepcji zagrożeń związanych z narażeniem na zanieczyszczenie powietrza wnętrz w grupie mieszkańców województwa śląskiego

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[a)] *idea and hipotheses*
[b)] *research*
[c)] *statistics*
[d)] *text and references*
[e)] *the scientific care*

## Abstract

**Introduction**. Population increasingly draws attention to the issues concerning the environment degraded by the progress of civilization and the impact of this process on health. However, public awareness of the risk exposure to indoor contaminants is lagging a long way behind knowledge regarding outdoor environmental hazards. The aim of the study was to assess the risk perception related to exposure to indoor environmental factors in the population of Silesia.

**Materials and methods**. In this study the electronic version of a questionnaire survey – downloaded on the website www.moja-ankiety.pl. was used. During the 3-months duration of the project 552 subjects participated in the survey. In the study participated the Silesian Voivodeship inhabitants such as chat rooms users, newsgroups and online forum participants. Data analysis was performed by using statistical program – STATA Version 8 SE [9], where the Kruskall-Wallis test and $\chi^2$ test were applied. Statistical significance was assessed at p value $< 0.05$.

**Results**. Despite the low perception of environmental health hazards inside the dwellings, the majority of respondents were able to indentify health effects and ways to reduce exposure to indoor air pollution. Both gender, place of residence, education level and age significantly affected the level of perception of respondents on the risk connected with exposure to indoor air pollution.

**Conclusion**. It is necessary to continuously work on raising public awareness of environmental health hazards in confined spaces, the causes of their occurrence, types, effects and above all the ways to counter these threats.

**Key words:** indoor air pollution, health risk, risk perception

## Streszczenie

**Wstęp**. Populacja mieszkańców zwraca coraz większą uwagę na kwestie związane z degradacją środowiska w wyniku postępu cywilizacyjnego i skutku tego procesu na zdrowie. Jakkolwiek ich świadomość narażenia na zanieczyszczenia wnętrz jest znacznie mniej zaawansowana w stosunku do zagrożeń środowiskowych z zewnątrz. Celem tego badania była ocena ryzyka związanego z narażeniem na czynniki środowiskowe wnętrz u mieszkańców województwa śląskiego.

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**Materiały i metody.** W tym badaniu zastosowano ankietę w wersji elektronicznej umieszczonej na stronie internetowej www.moja-ankiety.pl. W czasie trzymiesięcznych badań udział wzięło 552 uczestników, mieszkańców województwa śląskiego takich jak: użytkownicy czatów, grup dyskusyjnych i forów internetowych. Analiza danych była przeprowadzona przy użyciu programu statystycznego STATA Version 8 SE [9], gdzie zastosowano testy Kruskall-Wallis i $\chi^2$. Istotność statystyczna była oceniona na poziomie wartości $p < 0,05$.

**Wyniki**. Pomimo niskiej percepcji odnośnie zdrowotnych zagrożeń środowiskowych wewnątrz pomieszczeń, większość respondentów była w stanie ocenić skutki zdrowotne i sposoby ograniczenia narażenia na zanieczyszczenia powietrza wnętrz. Zarówno płeć, miejsce zamieszkania, poziom wykształcenia jak i wiek wywierały znaczny wpływ na poziom percepcji respondentów co do ryzyka związanego z narażeniem na zanieczyszczenie powietrza wewnątrz.

Wnioski. Koniecznym jest stałe podnoszenie społecznej świadomości dotyczącej środowiskowych zagrożeń zdrowia w pomieszczeniach zamkniętych, przyczyn ich powstawania, rodzajów, skutków i przede wszystkim sposobów zwalczania tych zagrożeń.

**Słowa kluczowe:** zanieczyszczenie powietrza wnętrz, ryzyko zdrowotne, percepcja ryzyka.

## Introduction

Population increasingly draws attention to the issues concerning environment, degraded in progress of the civilization and the impact of this process on health. However, public awareness of the risks attributed to the exposure to indoor contaminants is insufficient when compared to knowledge regarding outdoor environmental hazards [1]. For many years justified social unrest aroused the high levels of environmental air pollution [2]. Results of the studies performed in the last several years indicate that concentrations of toxic substances in indoor's air often exceed these measured outdoors [3]. Bad indoor air quality is mainly related to the incidence of respiratory and allergic disorders and diseases. Chronic exposure to indoor air pollution could lead to so-called „sick building syndrome", which manifests itself by headaches, irritations of the eye and mucous membranes of the nose and throat, sleeping disorders, breathing difficulties, sluggishness and concentration disorders [4, 5]. The World Health Organization (WHO) has reviewed the nine major global contaminants of indoor air pollution and pointed to benzene, nitrogen dioxide, formaldehyde, naphthalene, radon, tetrachlorethylene, carbon monoxide, trichlorethylene, PAHs - polycyclic aromatic hydrocarbons as the most important, ascertaining their standard values on the levels not risky to human health [6].

Considering the large group of contaminants in indoor environment and the broad spectrum of health effects of exposure to indoor air pollution there is a need to increase public awareness. The success of preventive measures depends on the level of public awareness on indoor pollution.

The aim of the study was to assess the risk perception related to exposure to indoor environmental factors in the group of residents of Silesian Voivodeship.

## Materials and methods

The study was conducted in late January-March 2011. It was questionnaire based survey on indoor pollution impact on health including potential preventive measures taken. The questions related to respondent's knowledge on health effects of indoor air pollution and potential preventive measures taken. Information on the aim of the study was downloaded on website www.moje-ankiety.pl. The study participants completed the questionnaire containing the metrics and 7 questions. The main questions were closed with the possibility of giving multiple answers (Table I). During the period of 3-months of the study 552 subjects participated in the survey. Data was obtained from 450 ones. The database was created by an export of the questionnaire data from the website www.moje-ankiety.pl to the Microsoft Excel worksheets. The analysis of the data was performed by using the STATA 8 SE statistical package [9]. The relationship between questions from the questionnaire regarding the effect of indoor environmental factors on human population and qualitative variables like age was analysed by using Kruskall-Wallis test since the distribution of the variables was non-normal. In case of quantitative variables like sex, place of residence, level of education and professional status was used the $\chi^2$ (chi-square) test. The statistical significance was estimated at p value $< 0.05$.

Participation in the study was spontaneous and voluntarily and included chat rooms users, newsgroups and online forum participants. Such approach enables participation of a large population using internet in the area of Silesian Voivodeship and assures full confidentiality. The study is not representative for the entire population of Silesia. According to Central Statistical Office of Poland, in 2009 access to Internet declared 53.4% house-

holds, so the number of persons participating in the study was certainly limited. Moreover, the highest percentage of Internet users, as much as 97%, were young people, mainly pupils and students, whereas the largest group of respondents were pupils/students (34.2%). The average age of respondents was 31.5 years [7, 8].

The study participants completed the questionnaire containing the metrics and 7 questions. The main questions were closed with the possibility of giving multiple answers (Table I). During the period of 3-months study 552 subjects participated in the survey and 450 responded. The database was created by an export of the questionnaire data from the website www.moje-ankiety.pl to the Microsoft Excel worksheets. The analysis of the data was performed by using the STATA 8 SE statistical package [9]. The relationship between the effect of indoor environmental factors on human population and qualitative variables like age was analyzed by using Kruskall-Wallis test since the distribution of the variables was non-normal. In case of quantitative variables like sex, place of residence, level of education and professional status was used the $\chi^2$ (chi-square) test. The statistical significance was estimated at p value $< 0.05$.

**Table I**. Questionnaire
**Tabela I**. Kwestionariusz

| Questions | Answers |
|---|---|
| What in your opinion has the greatest impact on health? | Lifestyle<br>Health care<br>Genetic conditionings<br>Quality of outdoor environment<br>Quality of indoor environment |
| The most common health hazards occurring in confined spaces are: | Impurities formed during cooking, baking, etc.<br>Pollutants emitted from carpets, furniture, wallpapers, and other objects made of plastic<br>Pollution caused by humans and pets (tobacco smoke, volatile substances, skin, hair, fur, dust mites, etc.)<br>Pollutants infiltrating from the outdoor environment<br>Pollution from building and finishing materials<br>Biological contaminants (bacteria, molds, fungi)<br>I do not know |
| Which of the mentioned factors can increase the concentration of pollutants in the air of the living quarters? | Limited/poor ventilation<br>High temperature<br>Low temperature<br>High humidity<br>Low humidity<br>I do not know |
| From which components of construction and items synthetic components can be released? | Walls, partitions, finishings<br>Windows<br>Furniture<br>Carpets<br>Wallpapers<br>Cosmetics<br>Chemical cleaners<br>Clothes<br>Kitchenware<br>I do not know<br>Other, which? |

| | |
|---|---|
| Which of the mentioned synthetic chemicals compounds are most harmful to health? | Asbestos<br>Benzene<br>Formaldehyde<br>Xylene<br>Polychlorinated biphenyls (PCBs)<br>Toluene<br>Heavy metals (lead, cadmium)<br>Radon<br>Polyvinyl chloride<br>I do not know<br>Other, what? |
| What could be health effects (symptoms) of exposure to indoor pollution? | Disorders of the respiratory system including allergy and asthma<br>Irritability<br>Disorders of the cardiovascular system<br>Syncopes<br>Headaches<br>Irritation of mucous membranes and eyes<br>Weakness<br>Cancers<br>Hyperactivity<br>Memory dysfunction<br>Disorders of the digestive system<br>Sleeping disorders<br>Chronic fatigue<br>I do not know<br>Other, what? |
| In what way can you reduce exposure to indoor air pollution? | The use of organic cleaning products<br>Efficient ventilation<br>Ensuring the proper temperature and humidity<br>Maintaining cleanliness indoors<br>Changing the method of heating from fuel to electricity<br>Avoiding furniture and objects made of polyvinyl chloride<br>I do not know |

## Results

The analyzed data consisted of 450 (100%) individuals living in the Silesian Voivodeship: women (n = 248, 55.1%) and men (n = 202, 44.9%). The mean age was 31.5 ± 16.5 years. Nearly 70% of respondents lived in cities over 100.000 inhabitants (Table II).

**Table II.** Characteristics of study group
**Tabela II.** Charakterystyka badanej grupy

| Respondents | n | % |
|---|---|---|
| Total | 450 | 100 |
| Sex | | |
| Women | 248 | 55.1 |
| Men | 202 | 44.9 |
| Education | | |
| Primary | 6 | 1.3 |
| Grammar school | 69 | 15.3 |
| Vocational school | 41 | 9.1 |
| Secondary | 176 | 39.1 |
| Higher | 158 | 35.1 |
| Professional status | | |
| Student | 154 | 34.2 |
| White-collar worker | 126 | 28.0 |
| Manual worker | 85 | 18.9 |
| A person who does not work ever | 6 | 1.3 |
| Unemployed | 34 | 7.6 |
| Pensioner | 29 | 6.4 |
| Other, what? | 16 | 3.6 |
| Residence place | | |
| Village | 30 | 6.7 |
| The city up to 50 thousand inhabitants residents. | 35 | 7.8 |
| The city from 50–100 thousand inhabitants | 74 | 16.4 |
| The city of more than 100 thousand inhabitants | 311 | 69.1 |

Only 83 (18.4%) respondents were not aware that indoor environment may have adverse effects on human health. In the respondents opinion (n = 388, 86.2%) the lifestyle was an important factor of health status. Other factors included quality of indoor environment (n = 133, 29.6%), genetic conditionings (n = 124, 27.6%) and level of health care quality (n = 116, 25.8%).

Members of the target group the indoor risk factors are biological contaminants having the greatest impact on health (n = 297, 66.0%), pollution produced by occupants and pets (n = 209, 46.4%) and pollutants penetrating from the outdoor environment (n = 185, 41.1%) (Fig. 1).

The most often factors that may cause an increase in the concentration of pollutants in indoor air, respondents most often indicated limited access or poor ventilation (n = 346, 76.9%), high humidity (n = 226, 50.2%) and high air temperature (n = 124, 27.6%). The factors which were most rarely indicated included: low temperature and low humidity – appropriately (n = 62, 13.8%) and (n = 25, 5.6%).

Respondents, as potential sources of emissions of harmful substances and chemicals most frequently indicated cleaning products (n = 238, 52.9%), carpets (n = 216, 48.0%), walls, partitions and finishing (n = 209, 46.4%), wallpapers (n = 170, 37.8%), cos-

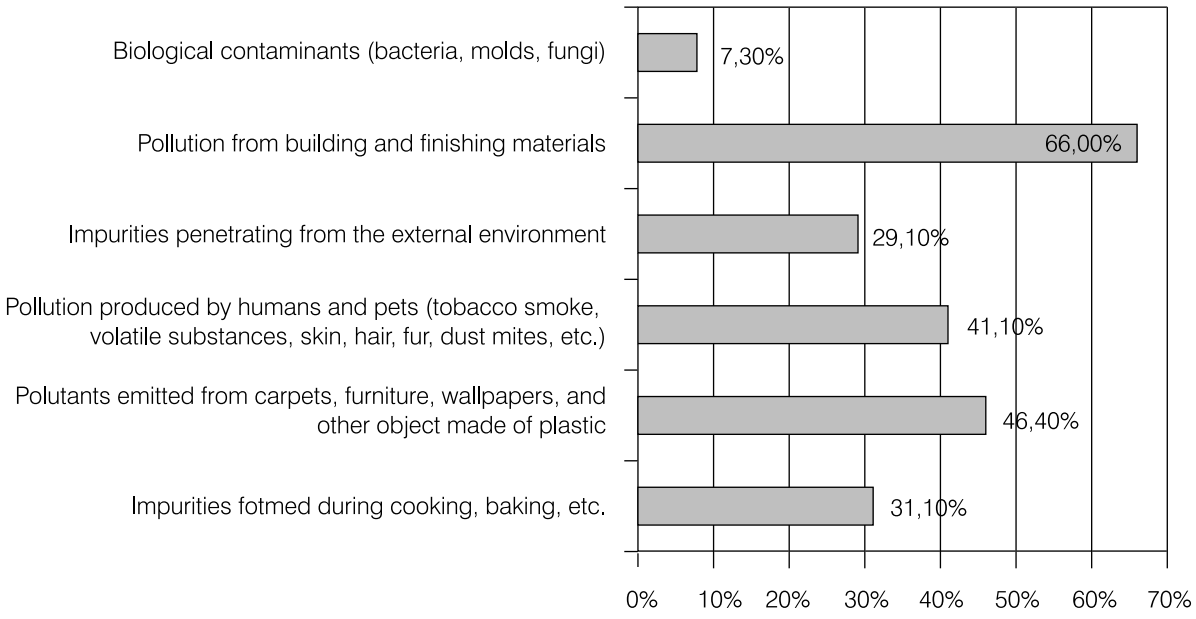


**Figure 1**. Percentage of respondents' answers on indoor health hazard
**Rycina 1**. Procent odpowiedzi respondentów odnośnie zagrożenia zdrowia w pomieszczeniach

metics (n = 159, 35.3%), furniture (n = 155, 34.4%), plastic made windows (n = 118, 26.2%), kitchenware (n = 102, 22.7%), clothes (n = 70, 15.6%) and other materials used inside (n = 4, 0.9%). As many as 78 (17.3%) respondents did not answer.

Furthermore indoor synthetic chemical compounds of greatest impact on health were asbestos (n = 382, 72.9%) and heavy metals (n = 261, 58.0%).

Respondents were well aware of possible symptoms and health effects of exposure to indoor air pollution. The complaints mainly referred to respiratory disorders, including allergies and asthma (n = 345, 76.7%), headache (n = 296, 65.8%), irritation of mucous membranes and eyes (n = 213, 47.3%) and cancer (n = 184, 40.9%) (Fig. 2).

Respondents are well aware of possible ways of prevention against exposure to indoor air pollution. Among the most common methods of preventing exposure participants indicated: efficient ventilation (n = 367, 81.60%), cleanness in the rooms (n = 300, 66.70%), adequate temperature and humidity (n = 276, 61.30%), use of organic cleaning products (n = 181, 40.2%), avoiding furniture and things made from polyvinyl chloride (n = 154, 34.2%) and switching heating system from fuel into electricity (n = 151, 33.6%).

Women were more aware of the risks and more frequently indicated lifestyle as a major determinant of health status (n = 229, 59.0%, p = 0.0001). Among the most common threats was pollution from occupants and pets (n = 133, 63.6%, p = 0.001). As far as domestic sources of exposure to synthetic chemicals are concerned women more frequently chose cosmetics (n = 101, 63.1%, p = 0.011) and cleaning products (n = 153, 64.3%, p = 0.0001), and men plastic made windows (n = 64, 54.2%, p = 0.017). As to the most effective way to reduce pollution risk women were inclined to mention use of organic cleaning products (n = 111, 61.3%, p = 0.03), adequate temperature and humidity (n = 168, 60.9%, p = 0.002) and change of heating system (n = 95, 62.9%, p = 0.018). In case of dangerous synthetic compounds majority of men pointed to xylene (n = 36, 59.0%, p = 0.017), radon (n = 53, 60.2%, p = 0.001) and toluene (p = 0.011).

Place of residence also affected responses given by different groups of respondents. Statistically significant differences were observed in questions concerning health hazards resulting from exposure to indoor air pollution. Residents of rural area and urban area below 50.000 indicated pollution produced by man and domestic animals (n = 163, 78.0%, p = 0.0001), while pollution emitted from carpets, furniture, wallpaper and objects made of plastic were most frequently mentioned by respondents from bigger cities over 50.000 population (n = 106, 75.7%, p = 0.0001). Furthermore residents of large cities much more often claimed that faulty ventilation may cause increase in pollutants concentration in the air (n = 287, 82.9%, p = 0.018). Among health effects, this group, statistically more often indicated respiratory system disorders (n = 96, 76.2%, p = 0.001), cardiovascular disorders (n = 69, 75.0%, p = 0.002) and headache (n = 246, 83.1%, p = 0.03).

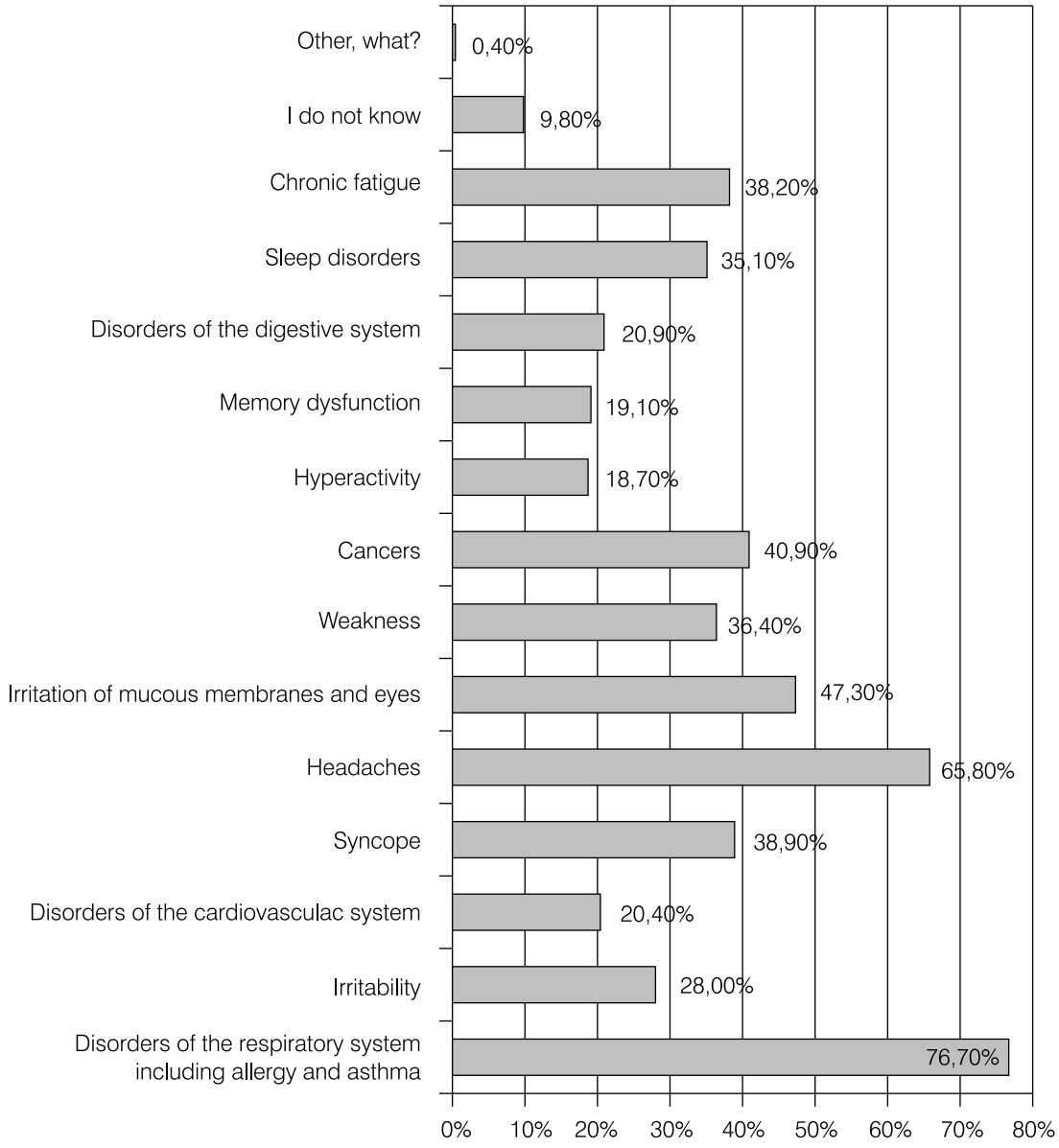


**Figure 2.** Percentage of answers on health effects (symptoms)
**Rycina 2.** Procent odpowiedzi odnośnie skutków zdrowotnych (objawów)

The level of education plus gradually developed awareness were also statistically significant. The better education the better knowledge on issues related to indoor pollutants, therefore statistically more often lifestyle was named as the main determinant of health (n = 302, 77.8%, p = 0.0001) whereas asbestos (n = 268, 81.7%, p = 0.0001), benzene (n = 116, 81.1%, p = 0.0001) and heavy metals (n = 208, 79.7%, p = 0.003) were named as factors adversely affecting health. Also poor ventilation (n = 273, 78.9%, p = 0.0001) was the factor causing increase of indoor pollutants concentration for respondents with better education. Harmful synthetic compounds in carpets (n = 176, 81.5%, p = 0.0001), wallpaper (n = 137, 80.6%, p = 0.0001 and cleaning products (n = 202, 84.9%, p = 0.0001) were highlighted much more often by respondents with secondary and higher education too. Respiratory disorders (p = 0.0001), irritation of mucous membranes (p = 0.0001) and cancer (p = 0.001) derived most frequently.

The analysis also found statistical significance between the frequency of provided satisfactory responses (which showing high awareness of the risks) and the age of respondents. The more advanced age the lower level of knowledge on indoor air pollution.

## Discussion

According to the World Health Organization reports on indoor air pollution takes the 8th place in ranking of main causes of mortality, accounting for 2.7% of the global burden of disease [10]. In addition, the Environmental Protection Agency (EPA) ranks poor indoor air quality as five major threats to public health from the environment [11]. Also research on the effects of exposure to indoor air pollution leaves no doubt that air quality has a significant impact on the efficiency of respiratory and circulatory system, and observed health effects have varied in intensity from irritation to eyes and mucous membranes, upper respiratory tract, through attacks of asthma, to exacerbation of symptoms of chronic respiratory diseases, premature deaths of the terminally ill person [12, 13].

The content of residential indoor air depends on many factors such as ambient air quality in the area and the efficiency of ventilation. Re-use of conventional air ventilation systems means that the level of dust, bacteria, viruses, molds and other chemical pollutants are rising, and their number increases. The important factors are air temperature and air humidity. Low humidity, especially during the heating period leads to increase in concentration of pollutants indoors [11]. Study on perception of the influence of temperature and humidity showed that with the increase of these two factors, indoor air is less properly [14]. Other studies suggest that worse air quality may result in discomfort due to colliding of irritating smells with inappropriate temperature and humidity. Inadequate or unsatisfactory temperature and humidity level may lead to decreased cognitive performance in humans and neurological disorders [15, 16].

Harmful chemicals in indoor environment are primarily emitted from building materials, furniture, floor coverings, windows and decorative textiles. An important source of indoor air pollution are also cleaning products, cosmetics, adhesives and solvents. The relative contribution of each source depends on the size of emission and toxic substances released. Some pollutants are emitted continuously (from furniture and carpets), others occasionally depending on habits like smoking and work practices: cooking, cleaning etc. [17, 18].

Among the most harmful chemicals indoors are: formaldehyde, benzene, toluene and xylene which are mainly used like components of adhesives, varnishes, paints and impregnation products [4].

The study showed that the level of awareness of exposure to indoor environmental factors in the population under study in Silesia Voivodeship was unsatisfactory. Only 83 (18.4%) respondents considered indoor air pollution as harmful to health. Most of the respondents indicated, however, better knowledge on health effects resulting from exposure to indoor air pollution and the methods of prevention. Respondents showed high awareness of possible health effects resulting from exposure to indoor air pollution. Majority of them pointed to most frequent health consequences like: respiratory disorders including allergies and asthma – 345 (76.7%), headache – 296 (65.8%), irritation of mucous membranes and eyes – 213 (47.3%) and cancer – 184 (40.9%). Prevention of exposure to indoor air pollution according to the respondents were efficient ventilation of spaces – 367 (81.60%), cleaning the rooms – 300 (66.70%) and having proper temperature and humidity indoors – 276 (61.30%). Level of awareness of residents on risk arising from the exposure to indoor air pollution is insufficient of answers depended on sex, place of residence, educational level and age.

Study in Oke Oyi (Kwara State, Nigeria) among 384 inhabitants in this region revealed that the majority of respondents (322 – 83.9%) indicate the threat from indoor air pollutants and health effects. Among the well-known symptoms of exposure to indoor air pollution, the respondents in Nigeria had indicated cough – 305 (79.4%), rhinitis – 317 (82.6%), eye irritation – 252 (65.6%), headache – 208 (54.2%) and asthma – 123 (32.0%) [19].

However, the results of other studies conducted in the population of Polish women have shown lower level of awareness about the risks resulting from exposure to indoor environmental contaminants [20]. Respondents rarely indicated interdependence between the quality of indoor environment and health, recognizing the outdoor environment as the most dangerous. Most of the respondents did not know about the grace period for the use of certain new building and finishing materials. Moreover most women replied that factors which determined the purchase of new homes were price and location not the materials of which the building is constructed.

Lack of knowledge about the impact of indoor hazards is distracting because of complex interactions between health status and the effect of exposure to chemical substances present in the closed spaces. The study of views, beliefs and knowledge is an important and essential element, determining kinds of health policy which should be developing and implemented. Increasing public awareness of the effect of exposure to indoor air pollution remains one of the most pragmatic ways that might help in taking effective preventing actions. In the consequence it reduces the health effects resulting from exposure to indoor air pollution.

## Conclusions

1. Despite the low perception of environmental health hazards indoors the majority of respondents were able to indicate health effects and ways to reduce exposure to indoor air pollution.

2. Both gender, place of residence, education level and age are statistically significant factors which affect the level of perception of respondents about the risks associated with exposure to indoor air pollution.

3. It is necessary to continuously raise public awareness of environmental health hazards in indoor environment, the sources of exposure, types, health effects and first of all the ways to prevent these threats.

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