


Environmental risk perception in small villages in Hajdu-Bihar county, Hungary

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ABSTRACT

Purpose: This study investigated public perception of environmental risks, with a focus on domestic heating in Hungarian villages, and explored associations between risk perception and education, livelihood, gender, and other socio-economic factors by means of a questionnaire survey. **Materials/methods:** Using standardised questionnaires, 533 participants were interviewed in small villages in Hajdu-Bihar County. The collected data were processed using Excel and RStudio software for statistical analysis. The chi-square test and logistic regression were used to examine the relationships between risk perception and socio-economic factors. **Results:** The study found that public perception of risk in relation to environmental hazards – in this case, air pollution from domestic heating and nuclear power – was often irrational. The Hungarian nuclear power plant (located at least 180 km from the study sites) was incorrectly assumed to be a source of air pollution, while emissions from domestic heating were underestimated. Logistic regression analysis indicated significant associations between risk perception and factors such as education, livelihood, and gender (expressed as odds ratios and 95% confidence intervals). Education was both positively and negatively associated with certain risk factors. Higher economic status was associated with the perception of air pollution as a health risk. Women generally perceived the risks as more serious than men did. **Conclusions:** The results of the study highlight the importance of understanding and addressing risk perception among the general public in rural Hungary in the context of environmental health risks. A targeted risk communication strategy is necessary to overcome bias in risk perception.

KEYWORDS

environmental risk perception, air pollution, risk communication, indoor air pollution, risk management

INTRODUCTION

Environmental risks are responsible for 23% of mortality and 22% of disability-adjusted life years (DALYs) globally. Air pollution is the leading environmental risk factor, comprising approximately 70% of the environmental burden of disease. Indoor and ambient air pollution caused more than 7 million deaths in 2012 [1]. Indoor air pollution from the domestic burning of solid fuels is responsible for more than 3 million deaths each year [2]. In Hungary, the use of solid fuels, which contributes to air pollution, is more prevalent among people living in more difficult socio-economic conditions [3].

The perception of these risks among the general public often runs counter to the scientific evidence. When discussing risk perception, two theoretical frameworks are worth mentioning.

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The first is the psychometric paradigm, which assumes that risk perception is subjective and determined by psychological, cultural, social, and institutional factors. Every community selectively considers a few of the potential risks to be important while ignoring others, and each society develops a set of institutions to control some of the risks [4]. The psychometric paradigm assumes that, using a properly designed survey, these factors and their interrelationships can be quantified and modelled to explore the responses of individuals and communities to risks [5].

The key finding to emerge from earlier research is that risk perception is irrational. While experts are not immune to subjective bias, the problem is significantly more pronounced when it comes to the general public. One of the most well-researched topics within the field is people's perception of the risk of nuclear energy. Studies consistently show that people significantly overestimate the risks of radiation. Risk perception differs between the sexes: women tend to attribute greater risk to factors such as pollutants. There are also differences between people with dissimilar socio-economic and educational backgrounds [5].

These findings have been replicated in risk perception research focusing specifically on air pollution. In a review article [6], Bickerstaff noted that research often highlights the difference between objective and subjective risk, as public perception tends to differ from expert assessment. Many studies in the review attribute this discrepancy to the 'deficit model', which suggests that non-experts' perception of risk differs significantly from that of experts due to their ignorance of scientific facts, while enhancing their understanding of the facts might reduce the disparity in risk perception. According to the review, personal experiences, media exposure, and the social context significantly influence perceptions of air pollution risk.

Quintyne and Kelly [7] found that there is a pronounced difference in how non-experts perceive the risk of air pollution at national and local level. Members of the public seem to be aware, in a general sense, that air pollution is a risk, but they do not seem to connect this risk to their local environment and are unaware of specific sources of risk and potential health outcomes. Women and members of the younger generations are more likely to rate the risk of local air pollution as being high.

In their review, Cori et al. [8] also highlighted the effect of socio-economic factors on public perceptions of air pollution risks. They noted that individuals of lower socio-economic status often report greater concerns with regard to air pollution. Additionally, many studies in the review indicated that higher levels of awareness are strongly associated with more behavioural changes aimed at reducing risks.

The aim of the present study was to explore environmental risk perception in small villages in Hajdu-Bihar County, Hungary, focusing on domestic heating and air pollution, while also examining the influence of socio-economic characteristics such as education, livelihood, age, and gender on risk perception. Our hypothesis was that significant differences would be observed between perceptions of

risk in different groups of the population. We compared the perceived risk of air pollution from nuclear power as a control. Since nuclear power plants are not important emitters of air pollution, and the closest nuclear power plant is at least 180 km from the study site, it represents a negligible risk in reality, thus clearly reflecting misconceptions among the population. We expected the perception of the risk of nuclear power to exceed the rational level.

MATERIALS AND METHODS

The survey was carried out with the assistance of student health visitors from the University of Debrecen, who, as part of their internship in Hajdu-Bihar County, interviewed permanent residents in Hungary, aged 18 years or above, living in small villages in the county. The questionnaire was compiled by the authors for the purposes of the study. The student health visitors conducted the survey on a house-to-house basis in small settlements in the county. The survey specifically targeted people living in small settlements, where census data indicate a high ratio of solid fuel use in households. The population of these settlements is disproportionately affected by the adverse impacts of air pollution from domestic heating. Excel and RStudio software were used for data processing and statistical analysis. Descriptive statistical analysis gave an overall picture of the sample. The most relevant data were plotted in graphs, and logistic regression was used to explore statistical relationships between socio-economic factors. In the case of education level and economic status, the four categories were merged by combining the bottom two and top two education and economic status levels into two new categories. The following self-reported data were collected: age, sex, education, income, income type, living conditions (including heating methods used and drinking water source), self-reported symptoms, perceived risks of various environmental factors, and pollution and health-related beliefs. Among the risk factors, the nuclear power plant – which does not affect either air quality or the health of the participants – was used as a control for risk perception bias.

In the case of most questions, participants had to choose from a predefined set of answers, although there were also questions on environmental risks requiring free text responses (see [Appendix](#)).

RESULTS

Of the 533 participants, 523 answered the question regarding their sex: 372 answered "female" and 151 answered "male". Most of the survey participants had either a secondary school qualification ($n = 229$) or a university degree ($n = 196$). In terms of income status, 471 had a regular income and most reported their economic status to be either satisfactory ($n = 191$) or barely satisfactory ($n = 200$). The youngest participant was 18 years old and

the oldest was 85, the median age being 43. Most lived in households connected to the water utility system ($n = 510$) and 87% considered the quality of their drinking water to be adequate.

The majority reported regularly being aware of smoke ($n = 342$), odours ($n = 294$), and suspended dust particles ($n = 362$) in the air. The majority were not regularly aware of soot ($n = 397$).

The overwhelming majority of participants considered all the listed factors to represent significant risks to human health (Table 1). The burning of waste for heating, industrial emissions, and chemicals in food were perceived most often as a serious threat (75–77% of responses). Although the nuclear power plant was considered to be a high risk by the fewest participants (54%), only 15% were in agreement with the scientific consensus that nuclear power plants (especially in this location) pose a negligible risk to health.

In terms of air pollution sources, road traffic, industry, and the use of agricultural chemicals were considered the biggest contributors to air pollution locally by 83.52, 95.64, and 83.8% of participants respectively (Fig. 1).

A large proportion of respondents (36.5%) thought that the nuclear power plant caused significant local air pollution, despite living some distance from the plant. In terms of solid fuels, mixed waste, plastic and rubber, and textiles were

considered very polluting by most participants (63, 70.6, and 61% respectively), while lignite and coal were considered very polluting by half this proportion (29.2 and 32.3%) (Fig. 2).

Participants were also asked if they observed various indicators of air pollution or experienced symptoms during the heating period (Fig. 3). Of the listed phenomena, respondents most frequently reported unpleasant odours, the noticeable presence of smoke outdoors, and poor outdoor air quality (34.7, 30.9, and 36.6% respectively). Over half the participants experienced increased coughing or sore throats to some extent in this period (Fig. 3).

The survey also collected information on heating practices. The solid fuel most frequently used for heating was dry wood: the number of people who responded “very frequently” ($n = 150$) was higher than the combined total of “very frequently” responses for the other seven options ($n = 138$). When asked whether their heating method polluted the environment, most participants responded either “Yes, to a small extent” or “Yes, to a large extent” (55 and 53% respectively). However, a far lower proportion of respondents assumed that their heating method polluted the indoor air in their home and was harmful to their family’s health or their neighbours’ health. This was true in the case of all the listed heating methods or fuels. In the case of wood

Table 1. Perception of risks to human health associated with selected environmental factors among study participants, in response to the question “To what extent do the following factors pose a serious threat to human health?”

	Industry	Traffic	Chemicals in food	Cigarette smoke	Climate change	Burning waste for heating	Nuclear power plant
No risk	8	3	22	17	23	6	78
Somewhat	124	142	110	199	174	118	165
To a large extent	397	386	395	313	334	407	283

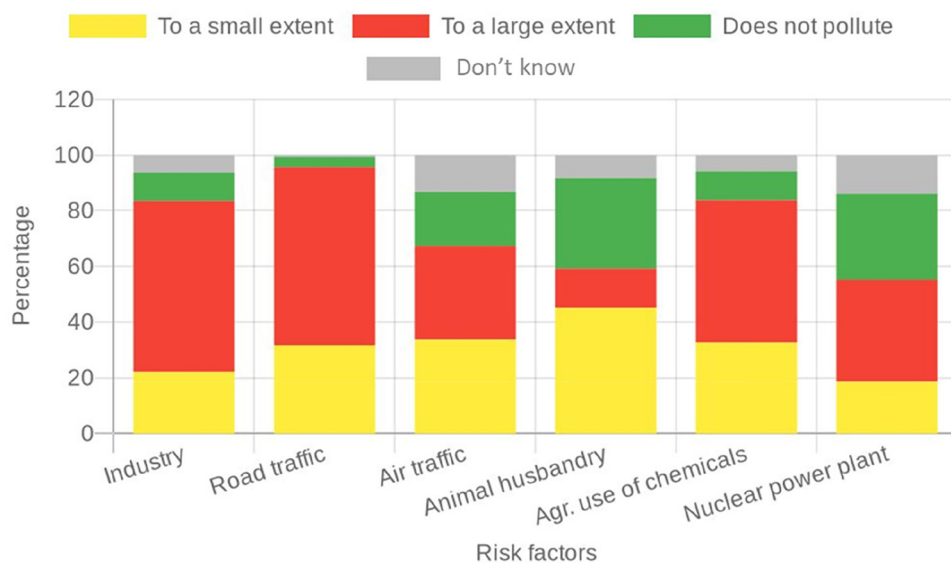


Fig. 1. Subjective ratings of the importance of external pollution sources near the respondents’ place of residence, in response to the question “In your opinion, to what extent do the following factors pose a serious threat to human health?”

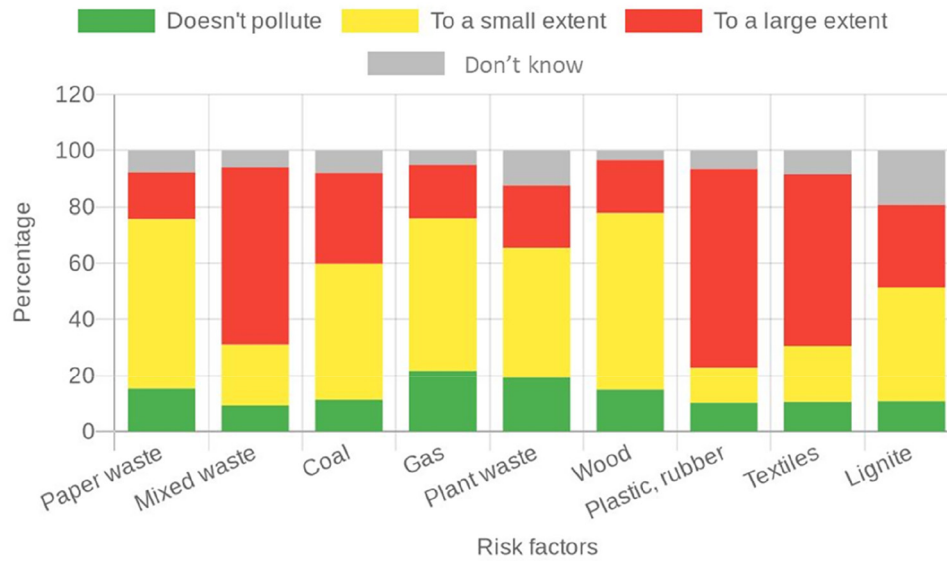


Fig. 2. Subjective rating of the contribution to air pollution of the listed heating methods at the respondents' place of residence, in response to the question "In your opinion, how much do the following pollute the air where you live?"

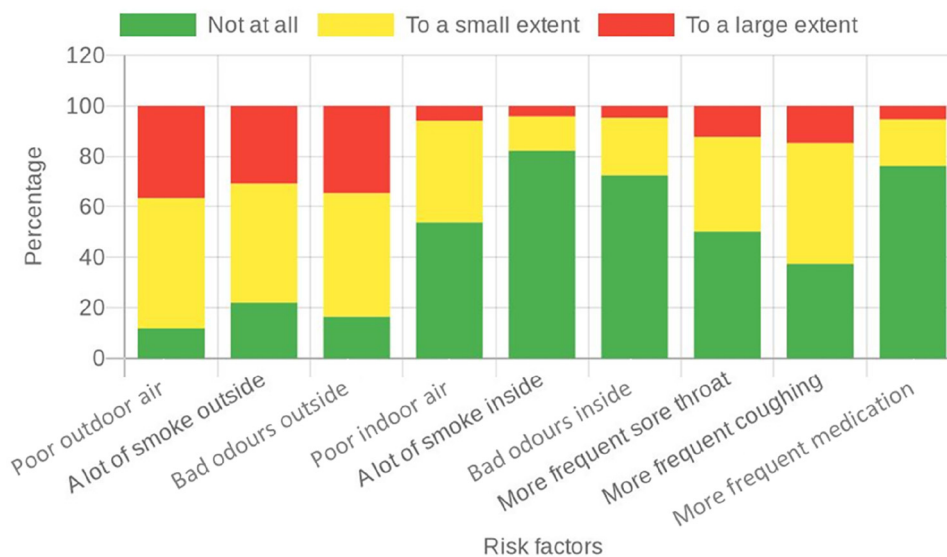


Fig. 3. Self-reported symptoms and experiences of survey participants during the heating season, in response to the question "To what extent do you experience the following during the heating season?"

heating, for example, 72% responded that it polluted the environment to a large extent. However, only 22.8% thought that it polluted the air inside their home, 16.7% that it was harmful to their family's health, and 27.3% that it was harmful to their neighbours' health to a large extent. The same pattern was observed for all heating methods and fuels.

Only 9% of respondents reported frequent health problems in response to the question "How often do you feel unwell or suffer from other physical problems?", while 20% answered "never" and 71% "sometimes". Eight percent of respondents indicated that their child suffered from some sort of health problem. Only 16 and 11% assumed that their symptoms or their children's symptoms were associated with pollution, and a similar proportion assumed that

heating was harmful to their or their children's health. At the same time, 55% agreed that the long-term effects of air pollution from heating may cause or aggravate health problems in the local community.

Using logistic regression, we examined how education level, financial situation, and gender influenced responses to the question of whether the listed risk factors were thought to contribute to air pollution in and around the participants' homes.

Respondents with higher education (Fig. 4, section C) were significantly more likely to believe that industrial activity poses a general health risk (OR: 1.6, 95% CI: 0.99–2.58) and that car traffic causes air pollution around the home (OR: 1.6, 95% CI: 1.02–2.52). Higher education was

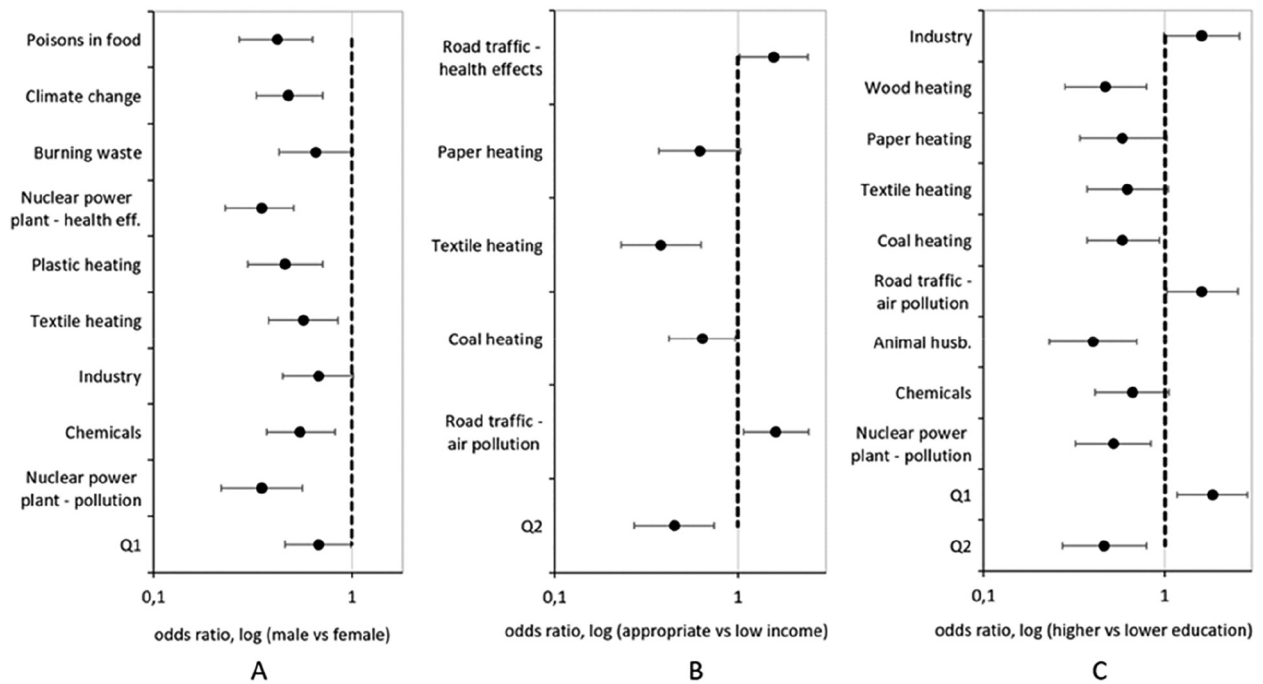


Fig. 4. Associations between gender (A), socio-economic status (B), and education (C) and perceived risks related to the listed factors, and responses to two questions analysed using logistic regression. Q1: Do you think that any of your illnesses or health problems are caused by pollution in your living environment? Q2: Do you think any of your child’s illnesses or problems are caused by air pollution from heating?

also positively associated with the belief that pollution contributed to illnesses in the respondents (OR: 1.83, 95% CI: 1.17–2.86). However, education was inversely associated with the belief that specific activities contributed to air pollution at the respondents’ place of residence, including heating by burning wood (OR: 0.47, 95% CI: 0.28–0.79), paper (OR: 0.58, 95% CI: 0.34–1.02), textiles (OR: 0.62, 95% CI: 0.37–1.04), or coal (OR: 0.58, 95% CI: 0.37–0.93). Similarly, education was inversely associated with the belief that car traffic, animal husbandry (OR: 0.4, 95% CI: 0.23–0.7), or agricultural chemicals (OR: 0.66, 95% CI: 0.41–1.05) contribute to air pollution. Finally, education was also inversely associated with the perception that air pollution causes illnesses in children (OR: 0.46, 95% CI: 0.27–0.79).

Respondents with a higher economic status (Fig. 4, section B) were significantly more likely to perceive car traffic as a health risk (OR: 1.57, 95% CI: 1.02–2.41), while higher economic status was also associated with the perception that air pollution causes illnesses in children (OR: 0.45, 95% CI: 0.27–0.74).

In the case of gender (Fig. 4, section A), logistic regression revealed significant associations between participants’ gender and their beliefs concerning health risks from chemicals in food (OR: 0.42, 95% CI: 0.27–0.63), climate change (OR: 0.48, 95% CI: 0.33–0.71), wood burning (OR: 0.66 95% CI: 0.43–1.02), and the nuclear power plant (OR: 0.35, 95% CI: 0.23–0.51). Gender was also significantly associated with the respondents’ perceptions of the causal effect of pollution on illness (OR: 0.68, 95% CI: 0.46–0.99). In each of the above cases in which gender was a significant factor, women worried more than men.

DISCUSSION

The results of the research show that perceptions of environmental risks among inhabitants in the small villages were in many cases irrational, in the sense that people overestimated some risks and underestimated others. Although education did influence risk perception in some cases, the relationship was not always linear – in other words, higher education did not necessarily mean a more accurate perception of risk. A similar conclusion can be drawn from the data on income and socio-economic status. In some cases, a person’s economic situation influenced their perception of risk, although the relationship was not linear, as some risks were perceived more accurately by those living in more modest circumstances. Perhaps the most striking finding is that there were significant differences between men’s and women’s perception of risk. In line with the international literature [6], women perceived several risk factors as being far more serious than men did. The other striking finding from the data is that perceptions of nuclear power plants were significantly irrational in terms of both the general risk to human health and the risk they pose as sources of local air pollution. This is also in line with previous findings [9].

The severity of everyday, known, and understandable risks is typically underestimated by the public [6], while more complex risks, such as those posed by nuclear power plants, are overestimated [9]. Risks related to heating with dry wood or paper waste, smoking, and climate change are perceived as far less severe than is justified. As demonstrated

in their responses to the respective questions, the participants also seemed unable or unwilling to link their knowledge and experience of air pollution to their own health or the health of their environment. They were aware of air pollution during the heating season, and they were generally aware that it is harmful to health, but, due to the factors discussed above, this did not lead to a rational perception of risk, making them less likely to take appropriate risk management measures.

In many cases, the success of risk communication is influenced by other relevant factors [10], and if a given segment of the population cannot afford to engage in risk-reducing behaviour – that is, if they can only afford to use wood, waste, or other polluting fuels – public intervention may be justified to protect public health.

LIMITATIONS

Although the aim of this research was to study risk perception in rural populations, this also represents a limitation, as the findings may not be generalisable to urban or more diverse populations in different socio-economic, cultural, or environmental contexts. Additionally, the distribution of the surveyed individuals according to educational level may not be typical of residents of small, rural, Hungarian settlements, which might further limit the applicability of the study's conclusions.

CONCLUSIONS

The overarching conclusion is that risk communication efforts in small Hungarian villages need to be improved, since both the under- and overestimation of risks can have negative impacts. The overestimation of the risks of nuclear power can have major economic consequences, for example, while the underestimation of risk factors related to air pollution can have serious health consequences. A more targeted risk communication plan, based on risk perception surveys, would probably be more effective in improving risk perception among the population. It would probably be useful to target men and women separately and, where appropriate, to tailor risk communication materials according to education level and livelihood.

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Editing, AF: Methodology, Writing - Review & Editing, MM: Methodology, Writing - Review & Editing.

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Appendix 1

Survey questions:

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1. Do you regularly smell smoke in the air (yes, no)?
 3. Are you regularly aware of particulate matter in the air (yes, no)?
 5. In your opinion, what are the main sources of air pollution in your living environment (e.g., industry, agriculture, heating, etc., possibly specific to your place of residence)? Please list up to three sources in order of importance.
 7. In your opinion, how much do the following pollute the air where you live: heating with wood; heating with waste paper; heating with plastics and rubber; heating with textiles and rags; heating with coal; heating with lignite; heating with mixed waste; heating with plant residues (seeds, leaves, straw, etc.); heating with gas; industrial pollution; car traffic; air traffic; animal husbandry; agricultural chemicals; nuclear power plant?
 9. To what extent do the following statements describe the impact of the heating in your flat or house (not at all, to a small extent, to a large extent): pollutes the environment; pollutes the air in the home; endangers the health of the family; endangers the health of neighbours?
 11. Do you use tap (mains) water or well water (water piped into the home, water from a public river, well water from a dug or drilled well)?
 13. In your opinion, what are the main causes of surface water and groundwater pollution in your area? If you can, name the three most important ones.
 15. How often do you feel unwell or suffer from other physical problems (never, sometimes, often)?
 17. How do you rate your household income (adequate, just adequate, low, very low)?
 19. Do you think that any of your child's illnesses are caused by pollution in your home environment (yes, no)?
 20. Do you think any of your child's illnesses are caused by air pollution from heating (yes, no)?
 22. Sex (male, female)
 24. Which settlement do you live in?
 26. What is your highest level of education (primary school; secondary school, with or without vocational qualification; vocational training; higher education [college, university, BSc, MSc])?
 2. Do you regularly smell soot in the air (yes, no)?
 4. Do you regularly smell odours in the air (yes, no)?
 6. In your opinion, to what extent do the following factors pose a serious threat to human health: industrial activity; cars, vehicle traffic; toxins in food; cigarette smoke; climate change (global warming); waste incineration for heating; nuclear power plant?
 8. To what extent do you experience any of the following where you live during the heating season (not at all; to a lesser extent; to a great extent): poor outdoor air; a lot of smoke outside; bad odours outside; poor indoor air; a lot of smoke in the house; bad odours in the house; more frequent sore throat; more frequent cough; need to take medication to stop me or my children from feeling ill?
 10. Have you ever used any of the following heating methods (no, to a small extent, to a large extent): heating with dry wood (at least one year old); heating with freshly collected wood; heating with coal; heating with lignite; heating with waste or rubbish; heating with textiles and rags; heating with plastic and rubber; heating with vegetable residues (seeds, leaves, straw, corn cobs, etc.)?
 12. In your opinion, what is the quality of the water you use – mains water or well water?
 14. In your opinion, what are the main causes of soil contamination in your neighbourhood? If you can, please name the three most important ones.
 16. Do you think that any of your illnesses or health problems are caused by pollution in your living environment (yes, no)?
 18. Do any of your children (minors who live with you) suffer from any illness or health problems (yes, no)?
 20. Do you think any of your child's illnesses or problems are caused by air pollution from heating (yes, no)?
 21. Do you think that the long-term effects of air pollution from heating may cause or aggravate health problems in the local community (yes, no)?
 23. Year of birth
 25. How long have you lived in this area (since which year)?
 27. How would you describe your level of income: very low; low; barely satisfactory; satisfactory)?
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