

ORIGINAL ARTICLES



RADON RISK COMMUNICATION, AWARENESS AND PERCEPTION: RESULTS OF A NATIONAL PUBLIC OPINION SURVEY IN THE REPUBLIC OF MOLDOVA

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ABSTRACT

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| Introduction | Radon is a naturally occurring radioactive gas, recognized as a leading cause of lung cancer among non-smokers. The level of public radon awareness remains low in many countries. The study presents the results of a public opinion survey in the Republic of Moldova within the IAEA STEAM Project (RER9153), aiming to assess public awareness, risk perception, and willingness to undertake radon mitigation measures. |
| Materials and methods | A structured questionnaire was administered to 391 adults across 20 districts and 2 municipalities during December 2020–February 2021. Statistical analysis was used to assess associations among radon knowledge levels and socio-demographic variables. |
| Results | Showed that 75.4% of respondents knew little or nothing about radon, although 64.5% considered home radon testing a priority. More than half were unaware of how testing is performed, and approximately 30% believed that ventilation could replace testing. While 84.9% correctly linked radon to lung cancer, many associated it with unrelated diseases. Family doctors and public health institutions were the most trusted sources but were rarely used, whereas the internet and social media were frequently used but were less trusted. Radon was perceived as posing a lower risk than nuclear accidents and food contamination. |
| Conclusions | The findings revealed significant knowledge gaps and misconceptions among communities, underscoring the need for targeted, evidence-based risk communication strategies using trusted healthcare channels to promote awareness and action regarding indoor radon exposure. |
| Keywords | Radon, opinion survey, risk perception, radon exposure, risk communication, public health. |

COMUNICARE, CONȘTIENȚIZARE ȘI PERCEPȚIE RISCULUI DE RADON: REZULTATELE UNUI SONDAJ NAȚIONAL DE OPINIE PUBLICĂ ÎN REPUBLICA MOLDOVA

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| Introducere | Radonul este un gaz radioactiv natural, recunoscut, la nivel internațional, drept una dintre principalele cauze majore ale cancerului bronhopulmonar în rândul nefumătorilor. În pofida celor menționate, nivelul de informare a populației cu privire la riscurile asociate expunerii la radon rămâne redus în numeroase țări. Studiul prezintă rezultatele unui sondaj de opinie publică, realizat în Republica Moldova, în cadrul Proiectului STEAM (RER9153) al AIEA, având ca scop evaluarea nivelului de informare a populației privind expunerea la radon, a percepției riscului și a disponibilității populației de a aplica măsuri de prevenție. |
| Materiale și metode | Un chestionar structurat a fost propus unui eșantion de 391 de persoane adulte din 20 de raioane și 2 municipii, în perioada decembrie 2020 – februarie 2021. În vederea evaluării asocierilor dintre nivelul de cunoștințe despre radon și variabilele socio-demografice, s-a efectuat analiza statistică a datelor. |
| Rezultate | Rezultatele au demonstrat că 75,4% dintre respondenți posedau puține informații sau nu știau nimic despre radon, deși 64,5% considerau testarea locuinței la radon drept o prioritate. Majoritatea nu cunoșteau metodele de testare, iar aproximativ 30% au considerat, în mod eronat, că aerisirea locuinței poate substitui testarea. Deși, 84,9% dintre subiecți au asociat corect expunerea la radon cu riscul de cancer bronhopulmonar, au fost raportate și asocieri greșite cu alte afecțiuni. Medicii de familie și instituțiile de sănătate publică au fost considerate drept cele mai credibile surse de informare, dar la care s-a apelat în rare cazuri. În ansamblu, radonul a fost perceput ca un risc mai redus, comparativ cu accidente nucleare sau contaminarea alimentelor cu radionuclizi. |
| Concluzii | Constatările studiului evidențiază lacune semnificative la nivel de cunoștințe ale populației vizând radonul și relevă necesitatea aplicării unor strategii mai eficiente de comunicare a riscului pe care îl prezintă acesta, prin canale credibile din domeniul sănătății publice. |
| Cuvinte-cheie | Radon, sondaj de opinie, percepția riscului, expunere la radon, comunicarea riscului, sănătate publică. |

INTRODUCTION

Radon is a naturally occurring radioactive gas formed by the decay of uranium in soils and rocks. Of the radon isotopes found in nature, the isotope ^{222}Rn is the most relevant for public health because it is produced continuously in the environment and can accumulate indoors. Radon and its decay, with a physical half-life of 3.8 days, can migrate through the ground and enter buildings, where they may accumulate, particularly in enclosed or poorly ventilated spaces (1). Once inhaled, its progeny can deposit in the respiratory tract and contribute significantly to the radiation dose. Globally, radon represents the leading contributor to natural background radiation exposure for the general population, accounting for more than half of such exposure (2). Prolonged exposure to elevated indoor concentrations has been established as a significant risk factor for lung cancer and represents the leading cause of this disease among non-smokers (3, 4). Although the health impacts of radon have been known for decades, awareness in many countries remains limited. Effective radon risk reduction depends heavily on public understanding of the issue, access to reliable information, and the availability of home testing and mitigation measures (5,6).

International bodies, including the World Health Organization (WHO) and the International Atomic Energy Agency (IAEA), emphasize that countries should develop coordinated radon programs aimed at assessing indoor levels, informing the public, and reducing preventable exposures (7). Current safety standards recommend that national authorities provide clear information on indoor radon and implement action plans when necessary. According to Requirement 50 of the IAEA General Safety Requirements Part 3, “The government shall provide information on levels of radon indoors and the associated health risks and, if appropriate, shall establish and implement an action plan for controlling public exposure due to radon indoors.” (3). Clear and effective communication with stakeholders, including the general population, forms a key component of these radon action plans.

Recent scientific literature emphasizes that radon risk communication remains one of the most challenging components of national radon action plans, due to the invisible nature of exposure, delayed health outcomes, and persistent public misconceptions. Systematic reviews and population-based studies conducted in Europe and beyond confirm that low awareness, confusion between radon and other radiation sources, and overreliance on ineffective protective behaviors (e.g., ventilation alone) are common across countries with different socio-economic profiles (5,8). Moreover, recent studies highlight that risk perception and behavioral intentions related to radon are not driven solely by knowledge levels, but also by trust in information sources, perceived controllability, and social norms (9,10). A review by Cori et al. demonstrated that low perceived personal relevance, misunderstanding of mitigation effectiveness, and limited self-efficacy are recurrent barriers preventing households from testing for radon or implementing remediation measures (11). More recent empirical research confirms that increased concern alone does not automatically translate into protective behavior. Pacella et al. showed that although a majority of respondents recognized radon as a health risk, fewer than one-third had practical knowledge of testing procedures or mitigation options (12). Similarly, Perko and Hevey demonstrated that risk perception and intention to act are strongly influenced by message framing and trust in information sources rather than by factual knowledge alone (13). These findings highlight the need to move beyond awareness-raising and to better understand how knowledge, perception, and communication channels interact in shaping preventive behavior – a gap that the present study explicitly addresses in the Moldavian context.

In 2019, a population survey was carried out in the Republic of Moldova on the population’s knowledge of the radon risk exposure and its health effects (14).

A questionnaire was developed in the Radiation Hygiene and Radiobiology Laboratory based on the European EU-project RADPAR (Radon Prevention and Remediation) recommendations (15). The survey results showed that the general public is insufficiently aware of the health risks associated with radon exposure. The STEAM public opinion survey was developed within the IAEA Technical Cooperation Project RER9153 to support participating countries in understanding how well populations comprehend radon-related risks (16). The present study extends the scope of investigation by incorporating additional dimensions recommended by the IAEA STEAM methodology. In particular, the questionnaire included new items addressing: (i) comparative perception of radon risk relative to other radiation-related hazards; (ii) perceived personal versus societal risk; (iii) behavioral intentions and perceived barriers related to radon testing and mitigation; (iv) patterns of use and trust in different information sources. These additions allow a more nuanced understanding of how knowledge, perception, and communication interact, and provide actionable insights for designing targeted radon risk communication strategies within the future national radon action program.

Twenty-two countries, including the Republic of Moldova, implemented a harmonized questionnaire that explore knowledge, perceptions, and readiness to undertake radon testing and mitigation. Results already published by countries such as Bulgaria, Albania, Romania, and others show consistently low awareness of radon and its health impacts and highlight the persistent communication barriers that exist across various cultural and socio-economic settings (17–20).

In this context, the Republic of Moldova carried out its own national survey. The *goal* was to identify the population's level of understanding, perceived health risks, their willingness to measure indoor radon, and the extent of trust placed in different information sources.

MATERIALS AND METHODS

The Republic of Moldova, situated in Eastern Europe, covers an area of 33 851 km² and stretches approximately 350 km from northwest to southeast and around 150 km from west to east. From a geological standpoint, most of the land lies on deep sedimentary formations, with crystalline rocks surfacing only in the northern regions. According to demographic data provided by the National Bureau of Statistics (NBS) (21), the usual resident population of the Republic of Moldova as of January 1, 2020, was 2,643,675 persons. This includes 1,262,198 males (47.7%) and 1,381,477 females (52.3%). The adult population (aged 18 years and older) was 2,071,559 persons, accounting for 78.4% of the total population, while 16.7% were aged 65 and above. The rural population exceeds the urban population (58.7% versus 41.3%). Nearly one quarter of Moldova's population is concentrated in the capital Chişinău, which in 2020 had around 661 798 inhabitants.

Study design and Data collection

A cross-sectional study was conducted using a structured questionnaire administered to adult residents (≥ 18 years) of the Republic of Moldova. The survey was led within the framework of the IAEA Technical Cooperation Project RER9153 (STEAM), using a harmonized methodology applied across participating countries. The project questionnaire was adapted into Romanian for national implementation. It comprised several thematic sections, covering socio-demographic characteristics, general health status, radon awareness and knowledge, perceived risks, and preferred information sources.

The survey was carried out between December 2020 and February 2021. The study encompassed 20 districts of the Republic of Moldova and the two largest municipalities, Chişinău and Bălţi. The sampling model was developed according to demographic data from the National Bureau of Statistics of the Republic of Moldova, taking into account sex, age group, region, and type of settlement. Data were collected through the regional Public Health Centers, where designated specialists administered questionnaires to residents within their respective jurisdictions. Participation was entirely voluntary.

Completed questionnaires were forwarded to the Laboratory of Radiation Hygiene and Radiobiology of the National Agency for Public Health (NAPH) for verification and quality control, including the identification of potential errors or missing data. Responses were collected using predefined categories of Likert-type ordinal scales. Response options for each question also included “no answer” or “prefer not to answer”. A feature of the question “What risk factors can most affect the health of Moldavians?” was the possibility of open-ended responses, from which six main categories were formed by the type of factors. All responses were coded and entered into a standardized Excel database. The verified survey responses were used for statistical analysis.

Statistical analysis

The sample size was determined using a standard statistical formula available through an online calculator (22). We selected a 95% confidence level and a 5% margin of error, which are widely accepted standards in social research (23). Questionnaires from 391 respondents were selected for statistical analysis, with a minimum required number of 385. Descriptive statistics were used to summarize categorical variables as absolute frequencies and percentages. For Likert-scale items (1 = strongly disagree, 5 = strongly agree), mean values (M) and standard deviations (SD) were calculated to facilitate comparisons across groups and variables. Associations between ordinal variables were assessed primarily using Spearman correlation coefficients, given the approximately symmetric distribution of responses and the use of numeric coding for Likert-scale categories. Correlation strength was interpreted using conventional thresholds from the National Institutes of Health (NIH) (weak/poor: $|r| < 0.39$; moderate: 0.4-0.69; strong: > 0.7) (24). Statistical significance was evaluated at $p < 0.05$ and $p < 0.01$ levels. All tests were two-tailed.

To verify robustness, correlation patterns were additionally examined using nonparametric Spearman’s rank correlation coefficients, which yielded comparable directions and significance of associations (data not shown). Correlation coefficients were interpreted as indicators of directional association rather than causal relationships, providing insight into how perceived knowledge and risk appraisal co-vary within the population. Data were analyzed using Microsoft Excel and Statgraphics Centurion software.

Sample characteristics

Of the total number of verified responses (391 respondents), 62.4% were female, and 37.6% were male. The age distribution of respondents was close to the national average: 32.0% were under 45 years old, 52.2% were 45-64 years old, 14.8% were 65 years old and older, and 1.0% did not indicate their age.

Regarding educational attainment, 49.1% of respondents held a university degree, 32.2% had completed community college, 14.1% had completed high school, and 4.6% did not disclose their education level. A vast majority (95.14%) reported not being employed in fields involving ionizing radiation. About 50% of respondents lived in a single-detached house, whereas 36% lived in an apartment in a high-rise building. Approximately 45.78% of participants reported an average income, while 21.74% did not respond to this question.

RESULTS

Risk factors affecting the health

The assessment began with two introductory questions: “How do you think your health is in general?” and “How do you think the health of Moldavians in general is?” Nearly half of the participants (47.8%) rated their own health as “fair,” while 33.5% described it as “good.” A combined 65% of responses characterized the health of Moldavians as either “fair” or “good,” whereas 26.3% of participants regarded the general health status of the Moldavian population as “poor.” Respondents tended to perceive their personal health more positively than that of the broader Moldavian population (81.3% vs. 65.0%, respectively ($t = 5.22, p < 0.001$)). A considerable proportion of respondents (62.7%) reported being aware of health risk factors, whereas only 12.8% reported lacking such awareness. Typically, individuals demonstrate a higher level of awareness regarding their personal health risks than those they attribute to the general population (25).

When asked, “Which risk factors can most affect the health of Moldavians?”, participants were invited to list at least three perceived threats without being given predefined options. Based on their open-ended responses, several broad categories of risk factors were identified (tab. 1). The social environment emerged as the most frequently cited determinant, mentioned by 63% of respondents. This category encompasses lifestyle-related behaviors such as smoking, substance abuse, excessive alcohol consumption, poor diet, physical inactivity, domestic violence, inadequate hygiene, and unsafe sexual practices. The natural environment ranked second, named by approximately 60% of participants, with concerns centered on climate change, air pollution, extreme weather events, and floods. The living and working environment ranked third (32.5%), encompassing aspects such as housing and workplace conditions, indoor air quality, poverty, the quality of the healthcare system, migration, unemployment, political instability, and other socio-economic factors that indirectly shape public health outcomes. Technological risks ranked fourth, which were given greater importance by men (19.7%) than women (8.2%).

Table 1. Data for risk factors affecting the health of Moldavians.

| What risk factors do you think can affect the health of Moldavians the most? | All respondents | Gender | | Age | | | | I prefer not to answer |
|------------------------------------------------------------------------------|-----------------|--------|--------|-------|-------|-------|---------|------------------------|
| | | Male | Female | 18-24 | 25-44 | 45-64 | over 65 | |
| <i>Total, abs.</i> | 391 | 147 | 244 | 9 | 116 | 204 | 58 | 4 |
| Natural environment, % | 59.8 | 57.1 | 61.5 | 66.7 | 52.6 | 65.2 | 55.2 | 50.0 |
| Technological risks, % | 12.5 | 19.7 | 8.2 | 11.1 | 12.9 | 12.2 | 13.8 | 0.0 |
| Living and working environment, % | 32.5 | 27.2 | 35.7 | 11.1 | 32.8 | 32.8 | 36.2 | 0.0 |
| Social environment (lifestyle), % | 62.9 | 59.2 | 65.2 | 33.3 | 58.6 | 62.2 | 79.3 | 50.0 |
| Health conditions and genetics, % | 6.9 | 4.8 | 8.2 | 0.0 | 6.9 | 7.3 | 6.9 | 0.0 |
| Others, % | 8.2 | 14.3 | 4.5 | 11.1 | 6.0 | 10.3 | 5.2 | 0.0 |
| No responses, % | 10.0 | 7.5 | 11.5 | 22.2 | 17.2 | 7.3 | 0.0 | 50.0 |

Almost half of Moldavians (55.5%) claimed to know how to protect themselves from potential health risks, and 30.7% believed they were able to control all risk factors affecting their health (tab. 2). Also, more than half of the respondents (57.0%) agreed that decisions concerning health risks should be made by experts. The statement “Indoor air quality is very important for health” received the strongest support, with 97.7% of respondents agreeing. Finally,

84.4% of participants reported that, regardless of weather conditions, they make an effort to keep their homes well-ventilated, combining those who “agree” and “strongly agree” with this statement – an encouraging indicator of public awareness regarding indoor environmental health.

Table 2. Respondents' agreement with statements related to their health control, %.

| Answer options | Statements | | | | |
|----------------------------|--------------------------------------------------------------------|----------------------------------------------------|------------------------------------------------------------|---------------------------------------------------------------------|------------------------------------------------------------------------|
| | I protect myself from any risk factors that could affect my health | I have control over all risk factors for my health | Decisions about health risks should be left to the experts | The indoor air quality from my home is very important for my health | Regardless of the weather, I make sure that my home is well ventilated |
| Strongly Disagree | 1.0 | 2.0 | 1.8 | 0.3 | 0.5 |
| Disagree | 24.3 | 40.7 | 25.8 | 1.0 | 2.8 |
| Neither agree nor disagree | 16.9 | 22.8 | 8.4 | 0.8 | 7.4 |
| Agree | 48.6 | 24.3 | 46.5 | 75.4 | 67.8 |
| Strongly Agree | 6.9 | 6.4 | 10.5 | 22.3 | 16.6 |
| I don't know | 0.8 | 3.1 | 3.8 | 0.3 | 4.1 |
| I prefer not to answer | 1.5 | 0.8 | 3.1 | 0.0 | 0.8 |

Awareness of radon exposure and associated risks

The level of knowledge of the respondents regarding indoor radon exposure was initially measured by self-assessment using two types of statements: respondents were asked to assess the amount of knowledge they have about “indoor radon” and “health risk due to exposure to indoor radon” (tab. 3). Overall, public awareness of radon and the health risks associated with its exposure in the Republic of Moldova was found to be relatively low. Nearly half of respondents (46.6%) reported knowing very little or nothing about radon, and only 23.5% reported having significant knowledge (“quite a lot” or “a lot”). Regarding health risks, 48.6% reported minimal or no knowledge, and only 23.8% reported being sufficiently aware.

Table 3. Respondents' answers on knowledge about radon and health risk due to indoor radon, %.

| Answer options | Questions | |
|-----------------------------|----------------------------------------------------|---------------------------------------------------------------------------|
| | How much would you say you know about indoor radon | How much do you say you know about the health risk due to radon exposure? |
| Nothing, (%) | 18.2 | 20.2 |
| Only a little, (%) | 28.4 | 28.4 |
| Something, (%) | 28.9 | 27.6 |
| Quite a bit, (%) | 13.0 | 13.6 |
| A lot, (%) | 10.5 | 10.2 |
| I prefer not to answer, (%) | 1.0 | 0.0 |
| Mean value* (M) | 2.69 | 2.65 |
| Standard Deviation (SD) | 1.22 | 1.23 |

*In the IAEA questionnaire, responses to these two questions are rated on a Likert scale from 1 to 5, where 1 = nothing and 5 = a lot

An analysis of the correlation between the level of knowledge about radon and its impact on health and socio-demographic variables (tab. 4) has shown strong and significant positive correlations between perceived knowledge about radon and knowledge of health risks ($r = 0.88, p < 0.01$), weak and significant correlations between radon knowledge and income ($r = 0.14, p < 0.05$). No statistically significant correlation was observed between age and knowledge of radon and radon-related health risks. Education showed no meaningful association with radon knowledge, while income was moderately correlated with education ($r = 0.37, p < 0.01$). Overall, socioeconomic factors are associated with knowledge more than age or education alone, but the effects are small.

Table 4. The correlation (r) between the level of knowledge about radon and its impact on health and socio-demographic variables.

| | How much would you say you know about radon? | How much do you say you know about the health risk due to radon exposure? | Age | Education | Income |
|---------------------------------------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------|------|-----------|--------|
| How much would you say you know about radon? | - | 0.88** | 0.05 | -0.01 | 0.14* |
| How much do you say you know about the health risk due to radon exposure? | | - | 0.04 | 0.03 | 0.15** |
| Age | | | - | 0.01 | -0.07 |
| Education | | | | - | 0.37** |
| Income | | | | | - |

** The correlation is significant at $p < 0.01$

* The correlation is significant at $p < 0.05$

A considerable majority of respondents – 84.9% (those who selected “agree” or “completely agree”) – correctly recognized radon as a causative factor for lung cancer (tab. 5). Nevertheless, despite the provision of contextual information prior to the survey, a notable share of respondents attributed radon exposure to other unrelated health conditions. Specifically, 40.7% of respondents associated it with asthma, 34.0% with allergies, 41.7% with skin diseases, and 45.0% with other respiratory ailments. Such responses reflect the presence of uncertainty and the risk of distorted perceptions – conditions under which myths about radon could easily proliferate if communication strategies lack scientific rigor and clarity.

Table 5. Respondents' agreement with the statement "Radon exposure in high concentrations increases the risk of developing the following diseases", %.

| Answer options | Disease | | | | | |
|----------------------------|---------|-----------|-------------|---------------|------------------------|------------------------------|
| | Asthma | Allergies | Lung cancer | Skin diseases | Other types of cancers | Other respiratory conditions |
| Strongly Disagree | 0.5 | 0.5 | 0.3 | 6.4 | 0.0 | 0.3 |
| Disagree | 13.3 | 13.3 | 0.0 | 6.9 | 5.1 | 3.6 |
| Neither agree nor disagree | 17.1 | 17.6 | 4.9 | 17.6 | 22.5 | 22.0 |
| Agree | 37.6 | 32.0 | 65.7 | 37.9 | 39.4 | 38.9 |
| Strongly Agree | 3.1 | 2.0 | 19.2 | 3.8 | 2.8 | 6.1 |
| I don't know | 23.8 | 28.9 | 9.5 | 24.0 | 26.6 | 24.6 |
| I prefer not to answer | 4.6 | 5.6 | 0.5 | 3.3 | 3.6 | 4.6 |

Risk perception

Responses concerning the perception of radon as a significant health threat and the prioritization of home testing (fig. 1) were markedly inconsistent. One third of respondents (32.2%) disagreed with the statement that radon poses a health risk to them personally, while 14.1% expressed uncertainty (“neither agree nor disagree”) and 18.9% don’t know the answer to this question. Conversely, 28.4% viewed residential radon exposure as a serious health hazard, and a large majority (71.4%) believed that testing one’s home for radon should be a priority.

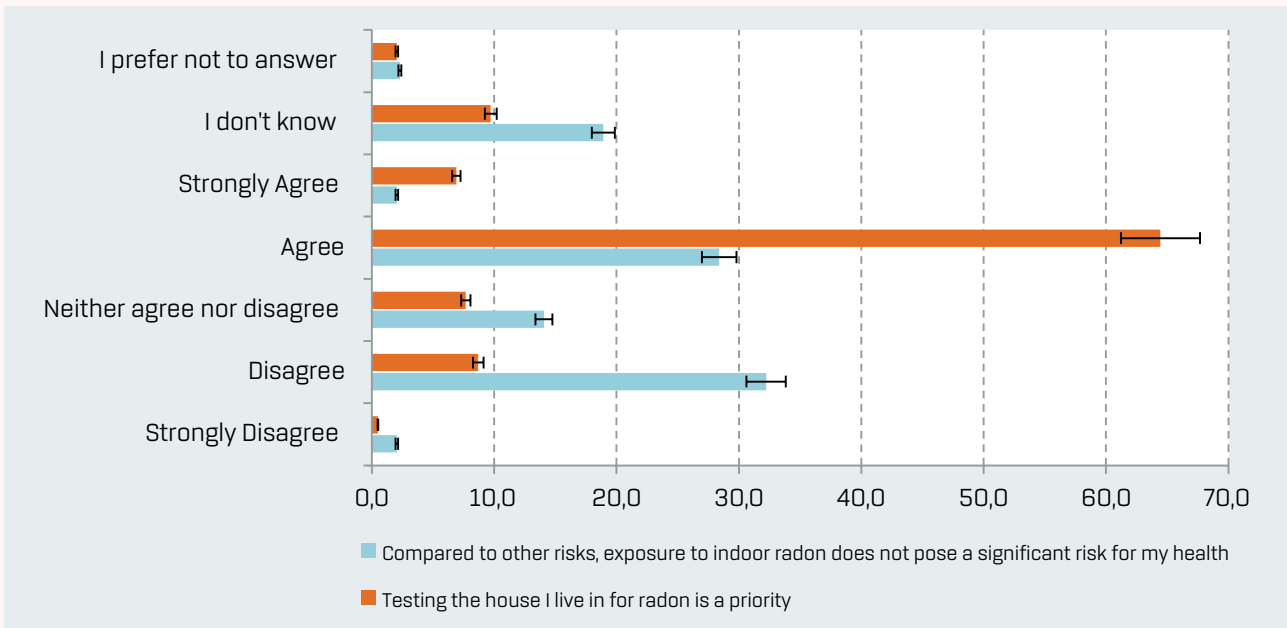


Figure 1. Respondents' assessment of their awareness of residential radon risk perception and home radon test priority, %.

Pearson correlation analysis (tab. 6) revealed several statistically significant associations between perceived radon risk, awareness and susceptibility indicators. Perception of radon risk to one’s own health showed a moderate positive correlation with the belief that radon is a problem in the area of residence ($r = 0.55$, $p < 0.01$), indicating that personal risk perception is strongly linked to local risk awareness. A weaker but statistically significant relationship was found between perceived personal risk and self-reported knowledge of radon ($r = 0.18$, $p < 0.01$) and of health risks associated with radon exposure ($r = 0.13$, $p < 0.05$). No statistically significant correlations were found between perceived radon risk to one’s health and the statement that indoor radon exposure does not pose a significant health risk compared to other risks ($r = -0.03$), indicating a lack of systematic association between these perceptions.

Table 6. The correlation (r) between the level of knowledge about radon and its impact on health and socio-demographic variables showed that.

| | Perception of radon risk to one's own health | How much would you say you know about radon? | How much do you say you know about the health risk due to radon exposure? | Radon is a problem in the area where I live | Compared to other risks, exposure to indoor radon does not pose a significant risk for my health |
|--------------------------------------------------------------------------------------------------|----------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------|
| Perception of radon risk to one's own health | - | 0.18** | 0.13* | 0.55** | -0.03 |
| How much would you say you know about radon? | | - | 0.88** | 0.10 | 0.03 |
| How much do you say you know about the health risk due to radon exposure? | | | - | 0.14* | -0.01 |
| Radon is a problem in the area where I live | | | | - | -0.07 |
| Compared to other risks, exposure to indoor radon does not pose a significant risk for my health | | | | | - |

* The correlation is significant at $p < 0.05$
 ** The correlation is significant at $p < 0.01$

A pronounced knowledge gap was also identified regarding practical aspects of radon measurement in residential environments. More than half of respondents reported not knowing how radon levels are assessed in homes. Only one-third regarded radon testing as a simple procedure, whereas 10% perceived it as difficult or overly complex.

To explore respondents' attitudes toward radon exposure and mitigation, participants were presented with a series of statements designed to gauge their opinions and intended behaviors. Five key questions focused on the actions they would consider taking to reduce radon levels in their homes (fig. 2).

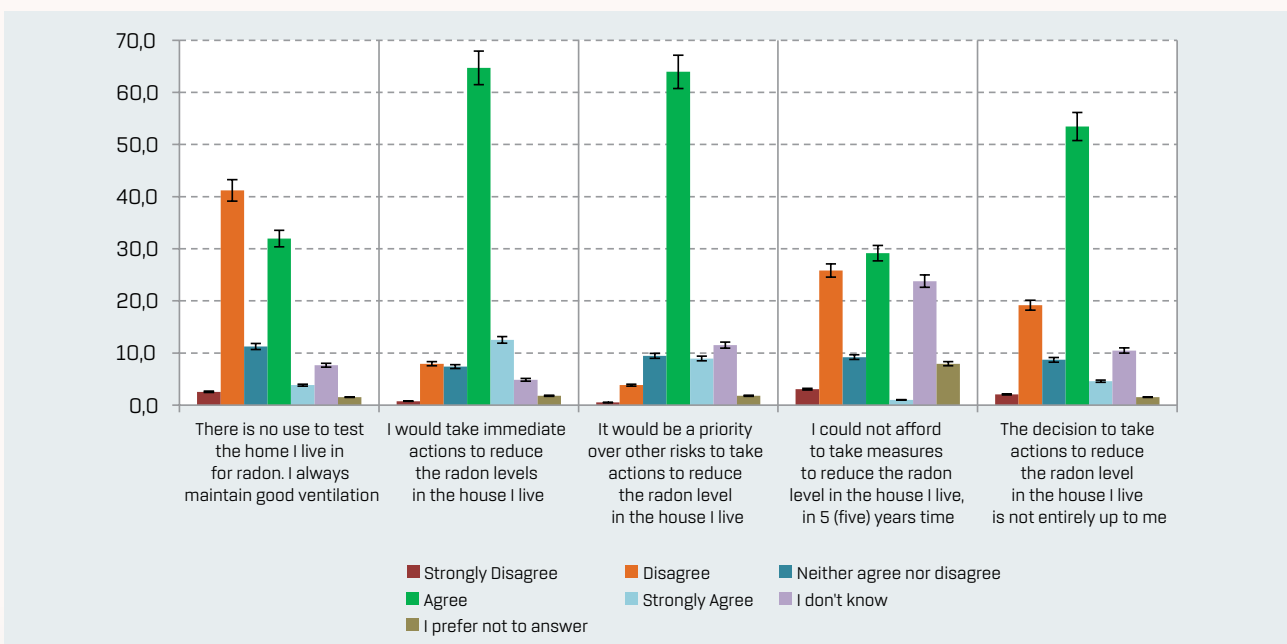


Figure 2. Respondents' assessment of the actions they would take to reduce radon levels, %.

The responses revealed a diverse range of perceptions: 32.0% of participants believed that testing their homes for radon is unnecessary because they already ventilate their living spaces adequately. In contrast, 41.2% disagreed, acknowledging that ventilation alone may be insufficient and that their homes should be tested for radon. Encouragingly, a large majority (77.2%) stated that they would take immediate measures to reduce radon levels if elevated concentrations were detected, and an equivalent proportion viewed such measures as a health priority, even above other potential household risks. However, financial and motivational barriers remain substantial. Nearly one-third of respondents indicated that they would not be able to afford radon mitigation measures within the next five years. Another third reported being ready to act immediately, while the remaining group remained undecided, uncertain whether addressing radon now would justify the required effort and costs (“I don’t know” responses). Moreover, approximately 60% reported that they could not make independent decisions regarding mitigation actions within their households, suggesting that decisions are often shared or contingent on other family members or authorities.

Findings from our survey indicated a marginal difference between perceptions of radon at the personal and societal levels. Figure 3 presents a comparative overview of how respondents perceive radon in relation to other radiation-related hazards. When considering personal risk, 77.8% of participants viewed ionizing radiation from nuclear power plants or reactors as the greatest threat to their own health.

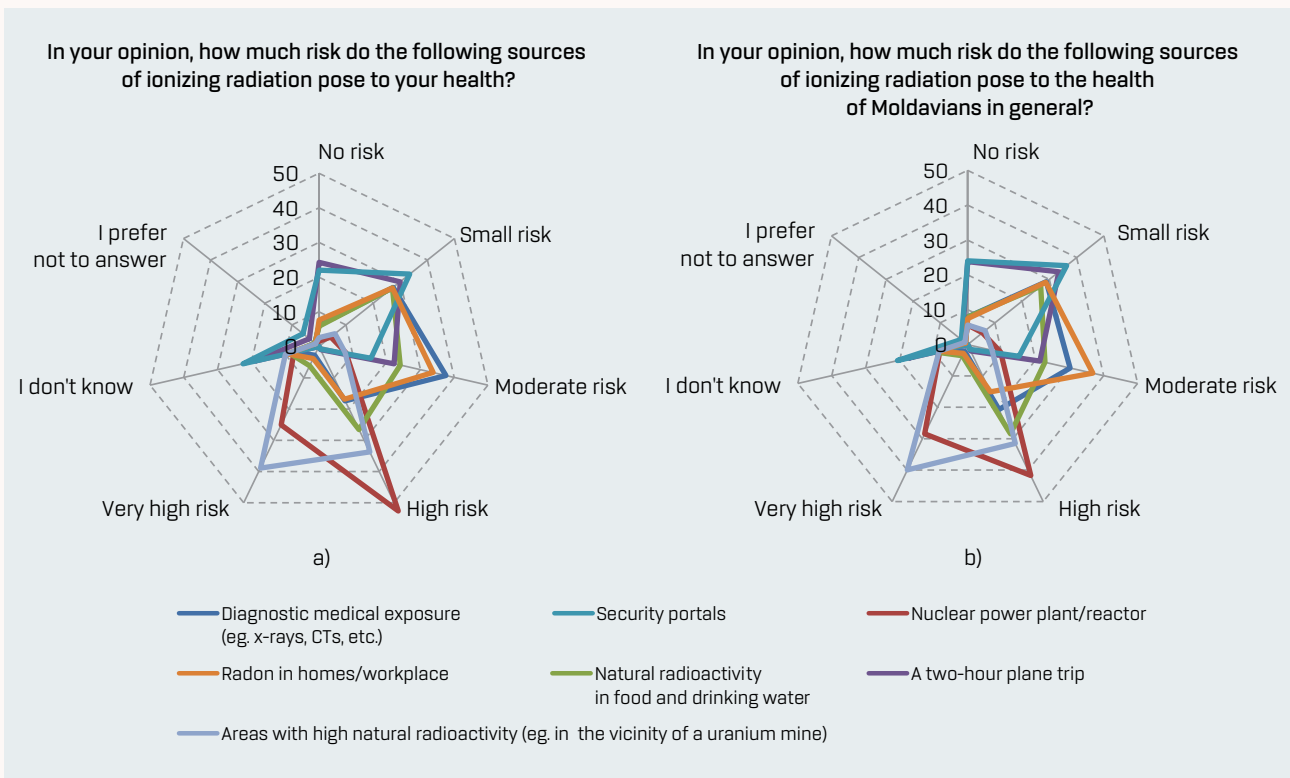


Figure 3. Comparison of respondents' perception of radon as a risk with other radiation risks: a) for themselves personally, and b) for Moldavians in general, %.

However, when assessing risks to the population as a whole, respondents identified areas with naturally high radioactivity (e.g., those surrounding uranium mines) as the most significant source of risk.

After receiving introductory information about radon during the survey, respondents ranked radon as the fourth most serious radiation-related health hazard, after exposure from nuclear power plants, highly radioactive areas, and natural radioactivity in food and drinking water. Notably, over two-thirds of respondents (68.5% for personal risk and 72.9% for societal risk) classified radon risk as “moderate,” “low,” or “absent.” Only 20.7% perceived it as “high” or “very high” risk for themselves, and an even smaller proportion (17.9%) expressed similar concern for the general public. These results suggest that while radon is increasingly recognized as a potential hazard, it remains comparatively underestimated relative to more visible or dramatized radiation risks.

Information sources about health risk

To evaluate the potential of different information channels in supporting effective radon risk communication, the survey also included questions about how respondents access and trust health-related information. Statistical analysis of responses regarding use and trust of informational sources confirm a misalignment between use and trust, where highly trusted health sources are underused, while accessible but less credible channels are overused (tab. 7). To avoid subjective interpretation, predefined thresholds for mean values, variation coefficients, and mismatch categories were applied, as detailed in the table footnote. *Internet* – high mean for use (3.4) but lower for trust (3.0) indicates it is widely relied on but only moderately credible. The similar standard deviation (1.0) for both suggests relatively consistent opinions. Variation is moderate, showing some differences in individual behavior. *Family doctor* – use (2.7) and trust (3.2) are both moderate, with low SD (1.0; 1.0), indicating stable and shared perceptions.

This confirms family doctors as a consistently trusted and reliable source, though not the most used. *Friends/Family* – moderate mean values for both use (2.6) and trust (2.7) and low SD (0.8) show frequent reliance, but limited credibility. This reflects dependence on informal sources despite a modest level of trust. *Social media* – similar means for use (2.6) and lower trust (2.5). A correlation analysis of social media use by age showed that the relationship was weak but statistically significant, indicating a tendency: the older a person is, the less often they use this source of information ($r = -0.17, p < 0.001$). This suggests that social media use acts as a stratifying factor contributing to response dispersion. Despite low trust, it remains in use, posing a risk of exposure to misinformation. *Public health experts (National Agency for Public Health)* are estimated to have a high level of use and trust (3.1 and 3.2) as sources of information for the public.

Table 7. Comparison of respondent's Use vs Trust of various sources of information about health risk*.

| Source | Mean | | SD | | CV, % | |
|-----------------------------------|------|-------|-----|-------|-------|-------|
| | Use | Trust | Use | Trust | Use | Trust |
| Internet | 3.4 | 3.0 | 1.0 | 1.0 | 30.5 | 33.2 |
| Family Doctor | 2.7 | 3.2 | 1.0 | 1.0 | 35.8 | 32.4 |
| Friends/Family | 2.6 | 2.7 | 0.8 | 0.8 | 31.9 | 28.9 |
| Social Media | 2.6 | 2.5 | 0.9 | 0.9 | 39.3 | 35.6 |
| National Agency for Public Health | 3.1 | 3.2 | 1.2 | 1.1 | 39.9 | 33.8 |
| Television/Radio | 3.0 | 2.8 | 1.0 | 1.0 | 33.0 | 35.2 |

* SD – standard deviation, CV (%) – coefficient of variation, calculated as $(SD / Mean) \times 100$

A comparison of patterns in information use and trust (tab. 7) underscores several key insights:

- Medical professionals and public health institutions remain the most credible and trusted sources of information.
- The Internet and personal networks serve as the most frequently accessed channels but are regarded with only moderate trust.
- Social media and traditional media (radio, television, newspapers) suffer from pronounced credibility deficits.
- There is a clear communication gap: institutions that already command strong public trust (such as family doctors and the National Agency for Public Health) are not yet fully utilized as strategic conduits for disseminating accurate and accessible information on radon and related health risks.

DISCUSSION

The Moldavian STEAM survey, like the other published national surveys (Bulgaria, Albania, Romania, and others), reflects a general pattern regarding the persistently low awareness of the population about radon and its impact on health. Although people generally showed interest in maintaining health and recognized the importance of environmental factors, awareness of radon remained strikingly low (11–13,26,27).

According to our study, 75.4% of respondents indicated “nothing”, “very little”, and “some” regarding knowledge about radon, and 76.2% regarding risks associated with it. A strong correlation between these indicators ($r = 0.88$, $p < 0.01$) is apparently due to the same sources of information. A majority of respondents (over 70%) correctly identified radon as a radioactive gas; however, more than one-third (36.6%) were unsure whether it posed a problem in their residential area.

The weak correlations between knowledge about radon, risk perception, and behavioral intentions suggest limited practical significance rather than predictive relationships.

Compared with the earlier Moldavian survey on radon risk perception (14) the present study shows a modest improvement in general awareness and interest in radon-related issues, particularly regarding preparedness to test residences for radon.

Bulgarian respondents also indicated minimal familiarity with radon (non-acquaintance, 76.9%) and the risks associated with it (78.1%) (19). In Albania, survey data showed better results, where 53% knew about radon and 43% about its risks, with the options “quite a bit” and “a lot”, the rest did not have sufficient knowledge on this topic (46% and 56%, respectively) (17). Preliminary data from Croatia (18) confirmed widespread unfamiliarity (68%); 50% of participants reported not knowing whether they lived in areas with potentially elevated radon levels. However, 85% would immediately take measures to reduce it (64.5% in our study).

In contrast to the Romanian study, where awareness of radon as a local problem did not translate into higher perceived personal health risk ($r = 0.38$, $p < 0.01$) (20), the Moldavian data reveal a moderate positive association between perceived radon risk to one’s health and recognition of radon as an issue in the area of residence ($r = 0.55$, $p < 0.01$). However, the overwhelming majority of Moldavian respondents (85%) correctly identified the link between radon and lung cancer. The frequent attribution of radon exposure to non-specific conditions such as asthma, allergies, or skin diseases indicates not only limited

knowledge, but also a tendency to generalize health risks in the absence of clear guidance. This pattern reinforces the importance of precise, disease-specific messaging in radon communication strategies, particularly emphasizing lung cancer risk and evidence-based mitigation measures beyond ventilation alone.

A synthesis of the responses about the actions they would take to reduce radon levels illustrates several important behavioral tendencies:

- Approximately one-third of the population would choose not to test their home for radon radiation.
- The majority indicated willingness to act if high radon concentrations were confirmed in their home environment.
- More than half of the respondents acknowledged that the decision to implement radon-reduction measures does not rest entirely with them.
- Although most participants considered home testing for radon a personal priority, fewer than one-third found the testing process straightforward or accessible.
- Roughly 30% of Moldavians believe that regular ventilation renders radon testing unnecessary, while an additional 10% remain ambivalent, neither agreeing nor disagreeing with that assumption.

This suggests that curiosity or perceived responsibility may motivate behavior even in the absence of detailed knowledge. However, financial barriers, uncertainty about procedures, and limited confidence in one's ability to take corrective actions may hinder follow-through. Similar discrepancies between high willingness to test and limited procedural knowledge were reported in Romania (20) and England and Wales (27), where awareness campaigns increased concern but did not automatically translate into action without clear guidance. These results underscore a complex blend of awareness, concern, and constraint: while the perceived importance of radon mitigation is rising, limited knowledge, financial capacity, and self-efficacy continue to hinder proactive testing and remediation behavior.

Compounding this, about one-third of participants believed that adequate home ventilation alone provides sufficient protection against radon exposure – a misconception that persists in many populations. This inconsistency between perceived and actual protective behaviors demonstrates features of the Dunning-Kruger effect (28), where individuals with limited understanding may overestimate their ability to manage risk effectively.

Respondents also tended to rate other sources of radiation, such as nuclear accidents, as far more dangerous than radon, reflecting a broader trend in radiation-risk perception: people often fear rare but dramatic events more than continuous, everyday exposures. These perceptions make radon a challenging risk to communicate effectively.

The survey also revealed a clear mismatch between the sources people rely on for health information and those they trust most. The Internet is heavily used but not considered highly reliable, whereas family doctors and public health institutions are trusted yet underutilized. Strengthening communication efforts through these trusted channels would likely improve the population's understanding and encourage proactive radon testing and mitigation. While the sample size was sufficient for statistical analysis, there was some heterogeneity in responses, which may reflect differences in information sources and individual interpretations of questionnaire items.

CONCLUSIONS

The STEAM survey in the Republic of Moldova indicates that, although the population expresses concern about general health and environmental conditions, awareness and understanding of radon risks remain critically low. The main conclusions of the study are:

1. **Low Radon Awareness:** Over 75% of the population lacks sufficient knowledge about radon and its health effects, despite acknowledging its link to lung cancer.
2. **Discrepancy between Risk Perception and Behavior:** A significant portion of respondents view radon as a low-priority risk, yet express interest in testing and mitigation, suggesting confusion and insufficient information.
3. **Misconceptions Persist:** Many Moldavians believe good ventilation is an adequate defense against radon, and myths about radon causing unrelated illnesses (e.g., skin conditions, allergies) were identified.
4. **High Trust in Health Professionals:** Family doctors and national health institutions are the most trusted sources of health risk information, but they are currently underused for radon communication.
5. **Need for Targeted Communication:** There is a pressing need for culturally adapted, clear, and actionable public health messaging to raise radon awareness and promote testing and mitigation actions.

These results contribute to a better understanding of radon risk perception patterns in Moldova and provide a baseline for future research and monitoring.

CONFLICT OF INTEREST The authors declare no conflict of interest.

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