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An investigation on the awareness, attitude, and performance about environmental and household radiation sources among residents of southeastern Iran

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Abstract

Background: Public awareness and knowledge of radiation sources are crucial for protecting individuals and the environment from harmful exposure. This understanding enables health officials to make informed medical decisions and minimize risks associated with everyday radiation. It also facilitates the creation and enforcement of regulations to control radiation exposure.

Methods: This cross-sectional study involved 120 citizens of Zarand County in 2023. Three researcher-developed questionnaires, assessing awareness, attitude, and performance, were used in this study. The validity and reliability of these questionnaires were assessed using CVI, CVR, and Cronbach's Alpha, respectively. Data were analyzed using SPSS version 22 (SPSS Inc./IBM, Chicago, IL, USA). The chi-square test was employed to examine relationships among the research variables.

Results: Around 73% of participants had medium to low knowledge of radiation sources. Only 28% showed a positive attitude towards domestic and environmental radiation, while 86% practiced good preventive and protective behaviors. Social networks and mobile platforms were the main sources of information on radioactivity. A significant correlation was found between participants' awareness and education level ($P=0.01$). However, no significant relationships were found between awareness, behaviors, or attitudes and the variables of age, gender, occupation, or socioeconomic status ($P>0.05$).

Conclusion: This study reveals that over two-thirds of the population has a medium to low level of awareness and understanding of radiation sources. Despite this, their health behavior is high, reflecting their importance on health issues. It is recommended that authorities prioritize educational programs on radiation sources and protection strategies to improve public awareness.

Keywords: Radiation exposure, Surveys and questionnaires, Educational status, Social networking

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Introduction

Humans are constantly exposed to natural radiation from terrestrial (e.g., uranium, radium), atmospheric, internal (through food and water), and cosmic sources. However, Anthropogenic activities, including nuclear power generation, medical applications (e.g., radiotherapy and diagnostic imaging), industrial processes (e.g., radiography and gauging), and historical nuclear weapons testing, have further contributed to the presence of radioactive materials in the environment (1,2). Understanding the sources and distribution of radioactivity is crucial for assessing potential risks and implementing appropriate safety measures.

The effects of radioactive sources on human health and the environment are complex and depend on several factors, including the type and energy of radiation, the duration and route of exposure, and the sensitivity of the exposed organism or ecosystem. Ionizing radiation can damage biological molecules, including DNA, leading to cellular dysfunction, mutations, and increased cancer risk. In the environment, radioactive contamination can disrupt ecological processes, affect biodiversity, and accumulate in food chains, posing risks to wildlife and human populations through the consumption of contaminated resources. The long-term consequences of radioactive contamination can persist for decades or even centuries, necessitating careful monitoring and remediation efforts (3,4).

Despite the potential risks, radioactive sources play a significant role in various human endeavors. In medicine, radiation is used for diagnostic imaging techniques (e.g., X-rays, CT scans, and PET scans) to visualize internal organs and tissues, enabling early detection and diagnosis of diseases (4,5). Radiotherapy, which uses high-energy radiation to kill cancer cells, is a crucial treatment modality for various types of cancer. In industry, radioactive sources are used for non-destructive testing, gauging, and sterilization processes. Nuclear power, although controversial, accounts for a substantial portion of the world's electricity supply and reduces reliance on fossil fuels, thereby mitigating greenhouse gas emissions (4).

The responsible management and utilization of radioactive sources are crucial for maximizing their benefits while minimizing potential risks. Strict regulatory frameworks, safety protocols, and effective management strategies are essential to minimize exposure. However, many ordinary people are unaware of the various sources of radiation and how to use electronic devices that emit radiation safely. In addition to unhealthy lifestyles, the widespread and unrestricted use of these devices has exposed everyone, including vulnerable groups such as children, the elderly, the disabled, and the sick, to radiation due to a lack of public awareness about the harmful effects of radiation. Over 80% of human radiation exposure is attributed to natural sources of ionizing radiation (4,5). By disseminating accurate information about radiation sources and their associated health impacts, it is feasible to reduce the likelihood of future adverse health outcomes. Some common sources of radiation are illustrated in Figure 1 (4,6,7).

Zarand, a city in southeastern Iran, is heavily industrialized due to its rich mineral resources (coal, iron ore, copper). This industrialization has significantly increased its population. However, Zarand is located in a highly earthquake-prone area with four active faults. Mining activities in Zarand, particularly those involving coal and copper, may lead to increased radiation exposure for workers and the surrounding environment. Further research is needed to assess the full extent of radiation risks (8). Malakootian et al reported the maximum and minimum concentrations of dissolved radon gas around the Lalehzar fault as 26.88 and 0.74 becquerels per liter, respectively (9). Furthermore, a study conducted by Asadi et al reported maximum and minimum radon concentrations in drinking water samples from the Anar region of Rafsanjan to be 13.9 and 0.32 becquerels per liter, respectively. For agricultural well water samples from the same region, the corresponding values were 3.68

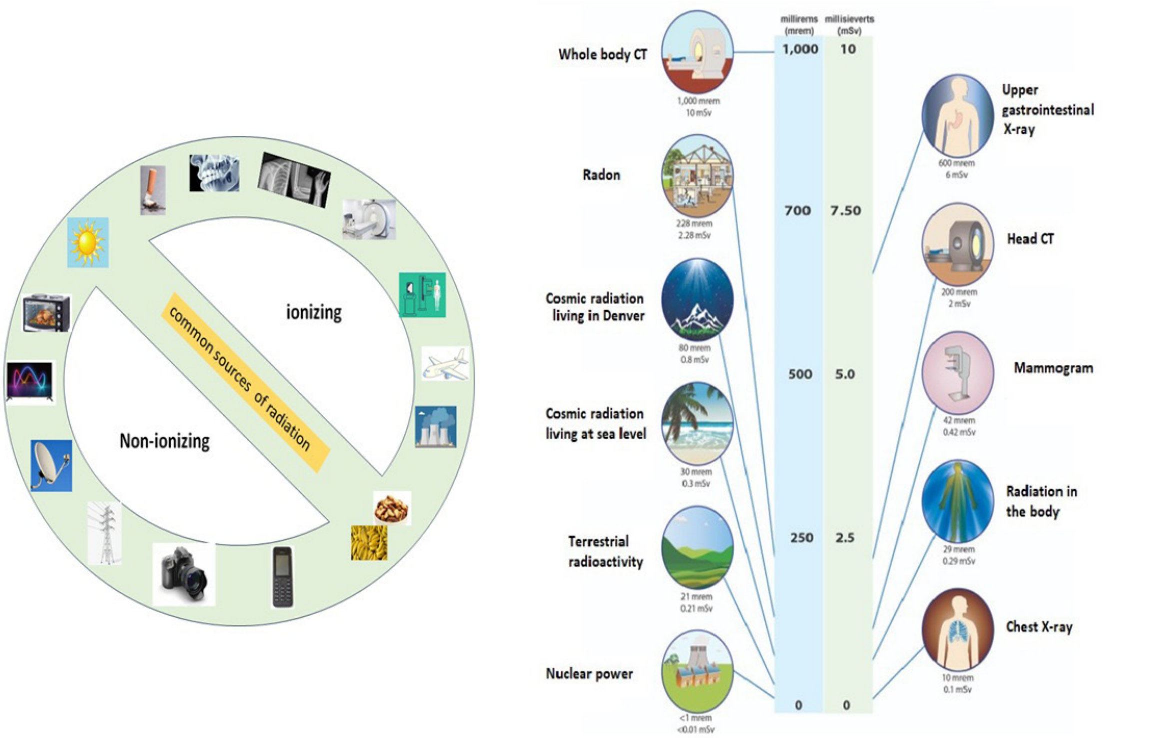

Figure 1. Common sources of radiation

and 24.5 becquerels per liter (7).

The widespread use of radiation-emitting devices necessitates public awareness and understanding of radiation sources. Due to the invisibility of ionizing radiation, people often lack a comprehensive understanding of its sources, resulting in limited implementation of protective measures. This result highlights the importance of educating the public about radiation hazards and how to reduce unnecessary exposure, aligning with the principles of radiation protection (3).

To influence behavior and encourage participation in radiation safety, it is crucial to identify the problem, raise awareness, and address people's needs and desires. A combination of awareness and a desire to act forms an attitude that is key to changing behaviors and promoting effective radiological protection practices. Addressing misconceptions and providing accurate knowledge is crucial for motivating individuals to make informed choices and actively participate in radiation safety (3).

Several studies have investigated public awareness and attitudes regarding radiation risks and protection. These include a study by Bahakeem in Saudi Arabia (2024), which assessed the awareness and understanding of the Saudi public concerning radiation risks and protection (3); Sherfad's study in Libya (2024), which assessed the awareness, attitude, and practice of fluoroscopy-utilizing doctors at Misurata Medical Centre (10); and M. Hussein's study in Egypt (2024), which assessed the awareness, attitude, and practice of radiation safety among dentists in Ismailia City (11).

Given the lack of comprehensive studies on public awareness and attitudes toward radiation sources, this study investigates the level of knowledge, attitudes, and behaviors of people regarding radiation sources, particularly those encountered in daily life. Due to the significance of this topic, this study was conducted.

Innovation in the study

Given the significant importance of radiation exposure and radiation protection, particularly for radiation workers, relevant organizations have implemented radiation protection regulations and provided necessary training for radiation workers.

Contemporary lifestyle changes, including the increased use of electronic devices and dietary habit changes, have increased exposure to diverse environmental radiation sources. The absence of comprehensive regulatory frameworks in this domain underscores the imperative for enhanced public awareness regarding household and environmental radioactivity, coupled with the promotion of effective radiation protection behaviors to mitigate potential adverse health consequences. Contemporary lifestyle factors, including increased electronic device usage and dietary shifts, have elevated human exposure to environmental radiation sources. The absence of comprehensive regulations in this field necessitates enhanced public awareness and the adoption of protective measures to mitigate potential health consequences.

However, there have been no studies conducted, either in Iran or in other countries, regarding public awareness, attitudes, and behaviors toward radiation sources.

Due to the significance of this topic in contemporary society, this study was conducted to investigate the level of awareness, attitudes, and behaviors of the people of Zarand city in Kerman.

Materials and Methods

This cross-sectional study was conducted among residents of Zarand County, Iran, in 2023. Located in Kerman Province, Zarand is approximately 75 kilometers from the provincial capital, Kerman City.

A pilot study involving 30 participants was conducted to determine the appropriate sample size for the main study. Based on the pilot study results, with a positive attitude percentage of 34%, $Z_{1-\alpha/2}=2$, the accuracy of $d=0.1$, and $\alpha=0.05$, and considering 10% attrition rate, the sample size of the study was estimated to be 120 persons. We divided the city into four sections: north, south, east, and west. Based on the population size in each section, participants were chosen through convenience sampling, and the questionnaire was filled out for them.

The inclusion criteria include residence in the city of Zarand for the past two years and individuals aged 15 years or older. Non-Iranian participants and immigrants were excluded from the study.

In this study, the following tools were assessed:

- A researcher-designed checklist was employed to collect demographic data, including age group (15-25,25-35, 35-45,45-55, and upper 55 years), gender (male and female), education level (below diploma, diploma, undergraduate, master, and postgraduate), occupational status (employed, other), and income level (high, medium, and low)
- The researchers developed three questionnaires to assess awareness, attitude, and performance, respectively. These instruments were designed based on a comprehensive literature review. The awareness section of the questionnaire consisted of six true/false/unknown questions regarding domestic and environmental radiation sources and protective measures (true = 1, false = 0, and I do not know = 0). Total scores were categorized into three levels of awareness (< 11 as low, 12-19 as medium, and ≥ 20 as high awareness) using visual binning in SPSS version 22. The second section assessed participants' attitudes using a seven-item Likert scale (absolutely disagree, disagree, no idea, agree, and absolutely agree). The resulting total score indicated the overall attitude towards domestic and environmental radiation

sources and related protective measures. The total score was categorized into three levels: weak (scores below 24), medium (scores between 24 and 28), and good (scores 29 and above) using visual binning in SPSS version 22. The third section focused on assessing participants' protective behaviors regarding domestic and environmental radiation sources. This tool consisted of 7 dichotomous items (yes = 1, no = 0). The total performance score was categorized into two groups (lower and higher performance) based on visual binning analysis in SPSS version 22, with the top five scores designated as higher performance and the remaining scores as lower performance (12,13).

To assess content validity, the final questionnaire was disseminated to an expert panel via email. A panel of nine people, comprising environmental health specialists, environmental pollution specialists, and epidemiologists, reviewed the questionnaire and suggested modifications. The content validity of the modified questionnaire was quantitatively assessed using the Content Validity Index (CVI) and Content Validity Ratio (CVR).

The CVR was calculated for each item based on a three-point scale: "necessary", "useful but not essential," or "not necessary." Responses of experts were calculated based on the CVR formula (13,14):

$CVR = (n_E - N/2)/(N/2)$

Where N is the total number of reviewers and n_E is the number of reviewers who have a positive response to the necessity of each question.

The cut-off point for CVR was based on Lawshe's table (15).

The CVI assessed the simplicity, clarity, and relevance of each question for the purpose of the study using a four-point Likert scale (ranging from not relevant/unclear to completely relevant/clear) (Likert Scale: Explored and Explained). Total CVI for each item was calculated by the mean value of three criteria. The minimum acceptance CVI for each question was 0.79 (16).

Questionnaire reliability refers to the degree of consistency with which it measures the construct of interest. To assess the reliability of the knowledge, attitude, and performance questionnaires, the internal consistency method was used. To assess the internal consistency of the knowledge, attitude, and performance scales, Cronbach's Alpha was calculated for each scale based on the inter-item correlation coefficient among the 60 participants. The Cronbach's alpha coefficient of 0.70 or greater was considered the minimum acceptable threshold for demonstrating adequate internal consistency (16,17,1).

Data analysis

Data were analyzed using SPSS version 22 (SPSS Inc./IBM, Chicago, IL, USA). The descriptive statistics for qualitative variables were reported as frequency and percentage. The significance level was considered $P < 0.05$. The chi-square test was used to examine the relationship between the demographic variables and awareness, attitude, and performance of participants.

Results

In the present study, 120 people were recruited. The response rate of the participants in this study was 100%. More than half of them were females, and only 7% of people had master's degrees. About 47% of participants were in the 25-45 age group. Only 10% of them had high income (Table 1).

The preliminary questionnaire had 24 items. CVI and CVR results of the first section of the tool (awareness) showed that all questions except for two questions had a score higher than 0.78. After assessing the CVI and CVR of the second and third sections of the questionnaire, one question from the attitude section and one item of the performance tools were removed. The remaining items had a value of 79% or higher, indicating that they were recognized as relevant and necessary. The 20-item questionnaire was assessed for reliability. Cronbach's alpha calculated the internal consistency of awareness, attitude, and performance tools to be 0.89, 0.70, and 0.71, respectively.

Moreover, 36% of participants had low knowledge about radiation sources, while 37% of participants demonstrated a medium level of knowledge. Overall, about 73% of participants had intermediate to low knowledge, while 25% exhibited a high level of knowledge. Only 28% of citizens had a high attitude towards domestic and environmental radioactive sources. However, a high percentage of participants (approximately 86%) exhibited good behavior and performance in protecting

Table 1. Descriptive statistics of the citizens of Zarand country.

Variables		Frequency (%)
Sex	Male	45 (37)
	Female	75 (62)
Age group (years)	15-25	42 (35)
	25-35	38 (31)
	35-45	20 (16)
	45-55	12 (10)
	>=55	8 (6)
Education level	Under diploma	11 (9)
	Diploma	38 (31)
	Associate Degree	18 (15)
	Bachelor's degree	46 (38)
	Master	7 (5)
Occupational status	Employee	32(26)
	Others	88 (73)
Income level	High	13 (10)
	Medium	61 (50)
	low	46 (38)

against household and environmental radiation sources (Figure 2).

Almost half of the citizens of Zarand were aware of radioactive sources such as mobile phones, televisions, etc. Additionally, 44% of them were aware of the beneficial applications of radioactive materials. Only 18% of the citizens knew natural sources containing radioactive materials (Table 2).

More than two-thirds of the citizens had a positive attitude toward the dangers of radioactive materials, and about 85% of them believed that radioactive materials used in medical treatments could still pose a risk. Only 13% of citizens believed that radioactive materials could not be present in the food they eat and the water they drink. Approximately 63% of the participants agreed that radioactive materials are present in household items (such as clocks, glass, ceramics, etc.). More than two-thirds of the citizens believed that radioactive materials, once inside the body, could remain for some time and cause harm to both themselves and others (Table 3).

Social media platforms and mobile applications emerged as the primary sources of information regarding household and environmental radiation among participants. Moreover, radio, television, and public or government organizations had the lowest roles (Figure 3).

The relationship between public awareness, attitudes, and behaviors regarding household and environmental radioactivity was examined based on the demographic characteristics (age, gender, occupation, socioeconomic status, and education) of residents in Zarand County.

A significant relationship was found between the participants' awareness and education levels ($P < 0.05$). Over two-thirds of university-educated participants exhibited moderate to high levels of knowledge, while only 7.5% of those with less than a diploma reported similar levels. Conversely, no significant relationships were observed between knowledge, performance, and attitudes and the variables of age, gender, occupation, and socioeconomic status ($P > 0.05$) (Table 4).

More than two-thirds of the citizens strive to reduce their exposure time to radioactive materials, identify the types of these substances they may encounter in daily life, and minimize their potential harm. Approximately 81% of the participants avoid unnecessary medical treatments involving radiation (e.g., radiotherapy through the ingestion of radioactive substances, X-ray exposure, radiology, etc.) to reduce their exposure to radioactive materials. Additionally, 93% of the citizens update their knowledge about radioactive materials and their sources. About 84% of the participants also refrain from certain cosmetic procedures that involve radiation exposure (Table 5).

Discussion

The findings of the present study indicated a predominantly low to moderate level of public awareness and attitude towards environmental and household radiation sources among residents of Zarand County. A possible explanation for these findings is the limited public perception of these sources as significant threats. Since the effects of many low-dose radiation sources show themselves in the long term, therefore, many people are not even aware of their danger. Low levels of public awareness of radiation sources and emission pathways is a multifaceted issue rooted in the inherent properties of radiation, the complexities of its health effects, and the challenges of risk communication. Addressing this deficiency requires integrated efforts to improve scientific literacy, develop effective risk communication strategies, provide accessible information, and foster public trust. Effective educational programs, clear communication from credible sources, and transparent regulatory practices are all essential to empower individuals to make informed decisions and manage radiation-related risks responsibly (18,3,19,20). This is a continuous process that requires ongoing evaluation and adaptation to address evolving scientific knowledge and technological advancements.

Interestingly, despite the lower levels of awareness and attitude, a substantial proportion of the population (86%) exhibited appropriate behaviors in response to radiation hazards.

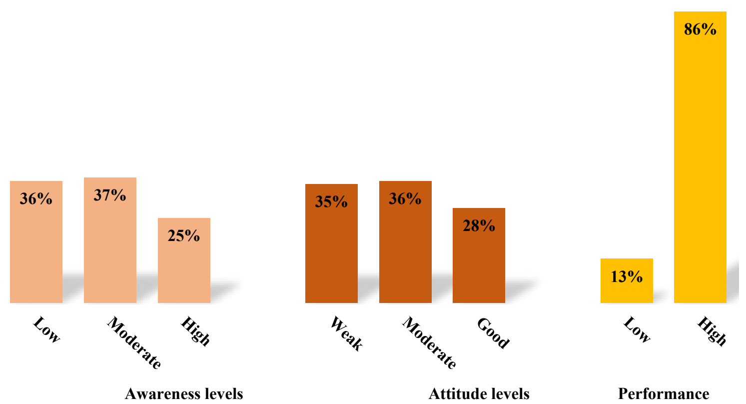

Figure 2. Frequency of Zaran citizens' awareness, attitude levels, and performance toward domestic and environmental radiation sources.

Table 2. Descriptive statistics of questions related to awareness

Items	True Frequency (%)	False Frequency (%)	Unknown Frequency (%)
Mobile, television, microwave, power towers, batteries, and radiology and photography of teeth and body are considered radioactive sources.	59 (49.16%)	41 (34.17%)	20 (16.67%)
Skin burns, cancer, abortion, genetic disorder and transmission to the next generation, decreased lifespan, depression, Alzheimer's, nervous disorders, and premature aging are the side effects of radiation exposure.	51 (42.5%)	33 (27.5%)	36 (30%)
Diagnosis and treatment of diseases, fire detection, household use, the study of rocks and fossils, energy supply, use in electrical appliances, and atomic energy are some useful uses of radioactive materials.	53 (44.17%)	45 (37.5%)	22 (18.33%)
Brazil nuts, pepper, salt, ginger, rice, Banana, red meat, chicken, and water naturally contain radioactive substances	18 (15%)	72 (60%)	30 (25%)
The air we breathe, food and drink, plants, animal fertilizers, paper, and car exhaust smoke contain radioactive materials.	35 (29.17%)	57 (47.5%)	28 (23.33%)
Clock, air conditioner, lamp, tiles, television, disposable dishes, and glass containers are devices that exist in the home environment and are radioactive materials.	32 (26.67%)	48 (40%)	40 (33.33%)

Table 3. Descriptive statistics of questions related to attitude

Items	Absolutely agree	Agree	No idea	Disagree	Absolutely disagree
I think radioactive materials are dangerous and cause serious damage if they are present in our living environment.	50 (41.67%)	61 (50.83%)	4 (3.33%)	5 (4.17%)	-
I think radioactive materials can still be harmful and cause damage when they are used in the treatment process (e.g., X-ray treatment, radiology, etc.).	36 (30%)	66 (55%)	5 (4.17%)	13 (10.83%)	-
I think radioactive materials can be present in the food we eat and the water we drink	30(25%)	58 (48.33%)	18(15%)	11(9.17%)	3 (2.50%)
I think radioactive substances can exist in the air we breathe.	37 (30.83%)	61 (50.83%)	16 (13.33%)	5 (4.17%)	1 (0.83)
I think radioactive materials can be found in household items (such as watches, glass, ceramics, etc.).	23 (19.17%)	52 (43.33%)	29(24.17%)	16 (13.33%)	-
I think that after radioactive materials enter our body, these materials can remain in our body for some time and harm our body and even others.	38 (31.67%)	56 (46.67%)	12 (10%)	12 (10%)	2 (1.67%)
I think that only people who work in special environments (medical and industrial) need training and care about radioactive materials, and ordinary people do not need such training.	15(12%)	18(15%)	4(3.33%)	25 (20.83%)	58 (48.33%)

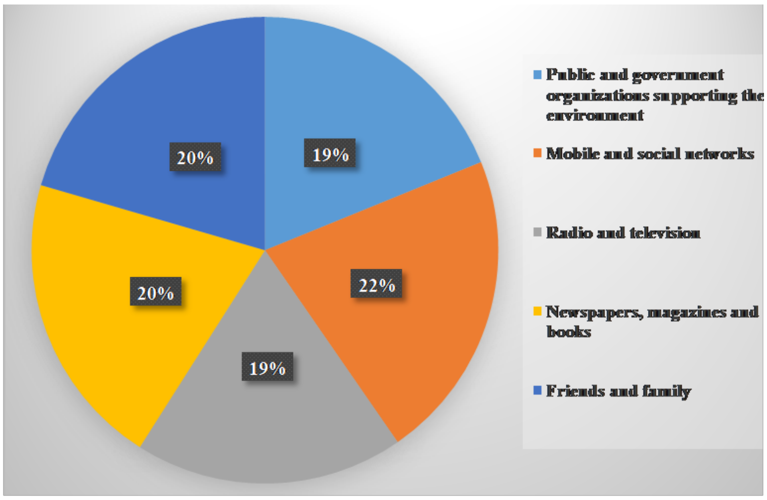

Figure 3. Sources of environmental and household radiation information for the citizens of Zarand Country in 2023.

Despite generally low levels of public awareness concerning the diverse sources of radiation and their associated risks, a considerable segment of the population exhibits behaviors aligned with minimizing potential radiation exposure. This apparent paradox can be partially attributed to several factors. Primarily, these behaviors are often driven by passive assimilation of information, adherence to established safety protocols, and regulatory mandates. Individuals may implicitly follow instructions for medical procedures, use consumer electronics according to manufacturers' guidelines, and adhere to radiation safety practices in their workplaces, even without a thorough comprehension of the underlying physics or health effects of radiation. This suggests that behavioral compliance can often be decoupled from a deep understanding of the risk (21,12,1).

Table 4. The relationship between awareness, attitude levels, and performance toward domestic and environmental radiation sources with demographic characteristics of Zarand county's citizens in 2023.

Variables		Awareness levels n(%)			P value	Attitude score n(%)			P value	Performance n(%)		P value
		High	High	High		Good	Moderate	Weak		High	Low	
Age group (year)	15-25	10 (23.8)	17 (38.6)	15 (44.1)	0.05	15 (34.1)	12 (26.7)	15 (48.4)	0.5	4 (25)	38 (36.5)	0.8
	25-35	10 (23.8)	18 (40.9)	10 (29.4)		12 (27.3)	19 (42.2)	7 (22.6)		5 (31.3)	33 (31.7)	
	35-45	11 (26.2)	3 (6.82)	6 (17.6)		8 (18.2)	8 (17.8)	4 (12.9)		3 (18.7)	17 (16.4)	
	>45	11 (26.2)	6 (13.7)	3 (8.8)		9 (20.4)	6 (13.3)	5 (16.1)		4 (25)	16 (15.4)	
Sex	Male	15 (35.7)	18 (40.9)	12 (35.3)	0.84	12 (27.3)	22 (48.9)	11 (35.5)	0.1	5 (31.3)	40 (38.5)	0.6
	Female	27 (64.3)	26 (59.1)	22 (64.7)		32 (72.7)	23 (51.1)	20 (64.5)		11 (68.7)	64 (61.5)	
Occupational status	Employee	9(21.4)	12 (27.3)	11 (32.4)	0.56	12 (27.3)	13 (28.9)	7 (22.6)	0.8	6 (37.5)	26 (25)	0.3
	Others	33 (78.6)	32 (72.7)	23 (67.6)		32 (72.7)	32 (71.1)	24 (77.4)		10 (62.5)	78 (75)	
Socio-economic levels	High	3 (7.1)	7 (15.9)	3 (8.8)	0.61	2 (4.5)	4 (8.8)	7 (22.6)	0.06	3 (18.8)	10 (9.6)	0.5
	Medium	24 (57.1)	19 (43.2)	18 (52.9)		26 (59.1)	25 (55.6)	10 (32.3)		8 (50)	53 (51)	
	low	15 (35.7)	18 (40.9)	13 (38.3)		16 (36.4)	16 (35.6)	14 (45.2)		5 (31.3)	41 (39.4)	
Education level	Under diploma	8 (19.1)	2 (4.5)	1 (3)	0.01*	2 (4.5)	4 (8.9)	5 (16.1)	0.4	0	11 (10.6)	0.4
	Diploma	15 (35.7)	15 (34.1)	8 (23.5)		16 (36.4)	15 (33.3)	7 (22.6)		6 (37.5)	32 (30.8)	
	Academic	19 (45.2)	28 (61.4)	20 (73.5)		26 (59.1)	26 (57.8)	19 (61.3)		10 (62.5)	61 (58.6)	

P value based on the Chi-square test.
*$P<0.05$ was considered a significant level.

Table 5. Descriptive statistics of questions related to performance

Items	Yes Frequency (%)	No Frequency (%)
I should act in such a way as to reduce the time of contact and exposure to radioactive materials.	114 (95)	6 (5)
I should know as much as possible the types of radioactive substances that I may encounter in my daily life and the extent of their damage.	114 (95)	6 (5)
As much as possible, I should not use unnecessary medical treatments with radiation (radiotherapy through eating radioactive substances, contact with X-rays, radiology, etc.) to reduce the exposure and contact with radioactive substances.	98 (81.67)	22 (18.33)
I should learn as much as possible about the latest news related to radioactive materials and keep my information up to date.	112 (93.33)	8 (6.67)
Before a nuclear accident occurs (accidents that lead to excessive radiation, contamination of air and food with radioactive materials, etc.), I try to learn the necessary training to take care and deal with them.	113 (94.17)	7 (5.83)
I should know as much as possible the radiation sources that can enter the body.	115 (95.83)	5 (4.17)
If I know that doing some beauty work will cause radiation, I will refrain from doing those services.	101 (84.87)	18 (15.13)

Furthermore, societal norms, readily available safety information, and the influence of regulatory bodies contribute to shaping behavioral responses. Even without actively seeking detailed knowledge, individuals are exposed to information through media, public health campaigns, and environmental regulations that inform their actions, often without conscious deliberation of the risks. This also means that they can simply be following social norms in reducing exposure, even when they do not entirely understand the reasoning behind them (12,22,23).

Several studies have been conducted to investigate the level of public awareness and attitudes about radiation hazards and radiation protection, including a study conducted by Bahakeem in Saudi Arabia, which assessed the awareness and understanding of the Saudi public about radiation hazards and protection. In their study, conducted on 1074 participants (62.3% female), the results revealed that only 9.2% had good knowledge of radiological imaging, while 48.6% had moderate, and 42.2% had poor knowledge. Regarding radiation hazards, 26.3% had good knowledge, 45.5% moderate, and 28.2% poor. Awareness of radiation protection measures was good for 24.1%, neutral for 49.2%, and poor for 26.7%. The study concluded that the Saudi public's knowledge, attitudes, and understanding of radiation hazards and protection are insufficient (3).

In a study conducted by Younesi Heravi in Iran, the level of awareness, attitude, and performance of radiology staff on the basic principles of radiation protection in hospitals in northern Iran was investigated. The participation rate of radiology staff was 80.55%. The average levels of knowledge, attitude, and performance concerning radiation protection were 45%, 78%, and 44.9%, respectively. A significant relationship was found between the level of education and the staff's knowledge, attitude, and performance (20). This is because the individuals working in radiation-related jobs receive training and must have the necessary knowledge and awareness to get a job.

According to the results of the present study, social media platforms and mobile applications emerged as the primary sources of information regarding household and environmental radiation among participants. Moreover, radio, television, and public or government organizations had the lowest roles. In today's fast-paced world, the ability to access information quickly is of great importance. Individuals have a strong preference for rapid access to the information they seek. Mobile technology has been adopted by the general public at an unprecedented rate, rapidly becoming the predominant mode of accessing information (22). According to a study conducted by Kim et al in 2021, social media platforms, with their vast reach and interactive capabilities, allow for real-time updates, peer-to-peer sharing, and community engagement, making them particularly effective in raising awareness about low-dose radiation sources and health risks (22). This accessibility and interactivity can foster a sense of community and trust among users, potentially leading to a greater willingness to engage with and share information related to radiation safety. Furthermore, the immediacy and breadth of information available through mobile devices enable individuals to seek out detailed information on specific topics, including radiation, at their convenience, thereby facilitating a more informed public. As noted by the World Health Organization (WHO), "mobile technology can be a powerful tool for health promotion and disease prevention," including raising awareness about environmental health risks such as radiation exposure (24). This shift towards digital platforms for health and risk communication underscores the importance of leveraging these tools to educate the public about radiation sources and promote safe behaviors.

Furthermore, the high processing speed of mobile devices is another crucial factor. These devices are perpetually powered on and ready for use. The device can acquire data from multiple sources, thereby facilitating rapid response to events. Increased bandwidth makes internet browsing more convenient. Information is rapidly transmitted to users, who can quickly process and share it. The simplicity of using mobile phones has made them the primary means for exchanging a vast amount of contemporary information (22,23).

The study revealed that after mobile phones, magazines and books are the primary sources of information. This is because radioactivity is a crucial scientific topic of our time, discussed at all levels of education. Given the high percentage of participants with university degrees, they are likely to have access to information on this topic through books and journals.

It was found that television and radio were the least common sources of information for participants. The reduced reliance on television and radio can be attributed to changing lifestyles, where people now prioritize electronic devices and virtual networks over these older forms of media.

A positive correlation between education level and awareness of radiation sources was observed. Individuals with higher educational attainment demonstrated significantly greater knowledge. While age and gender did not significantly affect overall awareness, the 15-35 age group exhibited higher awareness levels compared to older cohorts.

A study by Younesi Heravi et al investigated the knowledge, attitude, and performance of radiology staff of hospitals regarding radiation safety principles in hospitals across northern and northeastern Iran, the study found no significant correlation between gender ($P=0.781$), job position ($P=0.99$), age ($P=0.605$), and protective performance (20).

Davoudian Talab et al conducted a study in Iran (2016) to investigate the influence of radiographers' knowledge, attitude, and performance concerning radiation protection principles. A positive correlation was observed between education level and both awareness and performance. Higher levels of education were associated with increased knowledge and protective behaviors (12). These results are consistent with the results of the present study.

Many research has been done in the literature regarding the attitude and performance of radiographers, but no research has been reported on the knowledge, attitude, and performance of people about radiation sources. Since the radiation dose in people cannot be measured and many people are exposed to radiation without knowledge, perhaps the only way to reduce the effects of radiation is to increase people's knowledge and awareness about radiation sources and their effects. For this reason, the results of this type of study can help the authorities prevent possible and definitive effects of radiation to some extent by informing people.

Based on the existing literature, this type of study has been conducted for the first time, and the unwillingness of some people to complete the questionnaire and the impossibility of selecting the entire population in data collection are the weak points of this type of study, so it can be suggested that this type of study in other areas should also be done.

Conclusion

This study found that many residents in Zarand County possess a fairly good understanding and practice concerning domestic and environmental radiation sources. Mobile phones and social media were the primary means through which this knowledge was acquired. Given that over half of the participants hold university degrees and considering the significant importance of radiation and its protection, which is addressed to some extent in most academic disciplines at various levels, it can be inferred that they are not entirely unfamiliar with this topic. However, given the very few studies on public awareness of radiation sources and protective measures, further studies are necessary. Moreover, governmental organizations, television, and relevant media should increase their efforts to educate the public.

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Authors' contributions

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Competing interests

The authors declare that there is no conflict of interest in this study and all authors are aware of the submission and agree to its publication.

Ethical issues

There is no ethical issue. The authors declare that all data collected during the study are as stated in the manuscript and no data from the study have been or will be published separately elsewhere. The Ethical approval Code is IR.KMU.REC.1403.276.

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