



The Relation Between Socioeconomic Status and Risk Attitudes: A Nuclear Accident Scenario in Sweden

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Abstract

Nuclear power plant (NPP) disasters are complex and dreaded scenarios. However, existing recovery plans presuppose that citizens will return to live in decontaminated areas following evacuation. Research on natural disasters has shown that high socioeconomic status (SES) influences people to continue living in their homes in recovery areas. This study examines the association between SES and citizens' risk attitudes to a radiological emergency scenario and demonstrates instead that high SES implies a greater likelihood to move away from the accident-affected area. This is substantiated by survey data of Swedish citizens' ($N=2,291$) attitudes to a scenario where an NPP accident, evacuation, and remediation occur. More specifically, the study provides statistically significant results to show that high income is associated with less worry over ionizing radiation. Still, high-income individuals also appear to be more likely to move if their neighborhood is affected by radioactive fallout than low-income individuals. Moreover, the results for education show that low education is associated with remaining in the decontamination area, and the relation between education and worry over ionizing radiation provides some support for assumptions about the "anxious middle." Overall, this study finds that decontamination is complicated by a majority of people preferring permanent relocation as well as by indications that more resourceful citizens are generally more likely to leave the area permanently, which may impede the fulfillment of state agencies' plans for recovery.

Keywords Nuclear disasters · NPP accidents · Radiological risk · Socioeconomic status (SES) · Risk attitude · Risk management · Public perception

JEL Classification Q30 · Q40 · P48

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Introduction

In recent debates in the field of energy and climate, nuclear power has been described as a clean and safe energy source under normal conditions while also presenting risks regarding both serious accidents and radioactive waste management (Davis 2012; Horvath and Rachlew 2016; Wheatley et al. 2016). Large-scale radiological accidents are considerably less common than citizens assess them to be (Huhtala and Remes 2017), but when they occur, they present complex, long-term, and potentially catastrophic implications. In such events, resilience requires broad prior knowledge and planning preparedness. Continued use of nuclear power arguably requires rigorous security and realistic policies in case of a radiological release. However, while many human and technological safety issues *in* nuclear facilities are well researched (e.g., Hamer et al. 2021), less is known about community attitudes, perceptions, and behaviors and how they affect risk management in the event of an accident. The principal safety measure of governments in the event of a radiological accident involving emissions in populated areas encompasses evacuation and decontamination, followed by return migration (International Atomic Energy Agency [IAEA] 2013). However, for such extensive measures and investments to be worthwhile, a sufficient number of people must be willing to return.

Research on the most recent case, the Fukushima Daiichi nuclear accident, which occurred on 11 March 2011, shows a slow pace of return migration after bans on returning were lifted (Do 2020) and that public concerns with health risks have been widespread (Murakami et al. 2015). In 2012, the number of evacuated citizens reporting a willingness to eventually return was 12,882, less than eight percent of the total number of evacuees from the exclusion zone. The cost of decontamination has since been estimated at USD 3.36 million per returnee (Nagamatsu et al. 2020), and the recovery strategy has resulted in aging and depopulation problems in radiation-contaminated areas. Furthermore, slow recovery has had the effect of inhibiting further return migration (Zhang et al. 2014). Studies of demographic variables show that women, parents with children at home, and young adults rate risks higher and are more reluctant than others to return to a decontaminated area (Morita et al. 2018; Murakami et al. 2015; Rasmussen et al. 2020; Rasmussen and Wikström 2022; Zhang et al. 2014). However, other demographics may also be important.

Socioeconomics has been found to be important in explaining behavior after natural disasters (Fussell et al. 2009; Landry et al. 2007; Thiede and Brown 2013). In general, high socioeconomic status (SES) is associated with relatively low risk perception. Moreover, in terms of behavioral reactions to natural disasters, affluent citizens are more likely to keep their homes than others (Fussell et al. 2009). However, there is a dearth of research on the association between SES and risk attitudes in the event of a technological disaster, such as a serious NPP accident. In the present article, we tackle this issue using an NPP accident and recovery scenario. It demonstrates that higher SES is associated with less worry over radiation risk but a greater inclination to move permanently from one's home in an affected area and thus avoid potential radiation risk. Therefore, a government's plans for recovery could be hampered, resulting in the decline of the decontaminated areas. Indeed, a population with higher education and income implies higher employment rates, tax revenue (Berger and Fisher 2013), and civic engagement (Gaby 2017). Furthermore, it would be unfortunate if those characterized by low SES remain in a decontaminated area for economic reasons rather than preference. The consequences could include an increase in costs associated with mental ill-health and other social problems, as indicated in some of the public health research on the Fukushima area (Fukasawa et al. 2017; Maeda et al. 2018).

We used survey data from Sweden ($N=2,291$) to study citizens' risk attitudes regarding an NPP accident scenario. By risk attitudes, we refer to "intentions to evaluate a risk situation in a favorable or unfavorable way and to act accordingly" (Rohrman 2008, p. 4). These attitudes encompass both risk evaluation and behavioral intentions. The indicators of risk attitude used here are prevalence of worry over radiation and likeliness to leave a decontaminated area, that is, aspects of both risk evaluation and preferred action orientation. Furthermore, we approached worry as the negative feelings and relatively irrepressible thought processes that people experience when facing a risk (Borkovec et al. 1983), while action orientation is about whether one can accept to live in the decontaminated area or prefers a "path that does not touch on the risk" (Aven and Renn 2010, p. 122). Thus, by studying citizens' SES and attitudes to an NPP accident scenario, we hope to contribute a more fine-grained understanding of the interdependence between the economic and social contexts (Asad 2014; Hellmich 2017).

The following section provides a summary of the existing research on socioeconomics, citizens' risk appraisal, and safety-seeking migration, along with theme-by-theme study hypotheses. Subsequently, the research design and methodology are presented, followed by the empirical analysis. The concluding section discusses the results in relation to previous research and explores implications for risk management.

Previous Research and the Study Hypotheses

A key question regarding the government strategy to decontaminate areas affected by an NPP accident is whether people are going to live there. This includes understanding migration volume and selection and public attitudes to risk (Hunter 2005). In what follows, we provide a brief overview of the relevant research.

A general pattern found in the research is that people with high education or income rate risks lower and report less worry compared to others (Finucane et al. 2000; Slovic 2000). This pattern is found in research on perceptions of the risk of flooding (Botzen et al. 2009), terrorism (Stevens et al. 2011), climate change and genetically modified foods (Lo 2014), and a reactor incident in Sweden (Hedberg and Holmberg 2009). Higher SES seems to lessen the degree of concern over risk because the higher degree of welfare and economic security entails a greater degree of control over one's life and community (Olofsson and Rashid 2011; Olofsson and Öhman 2015). Nevertheless, the existing results are not unambiguous. Research focusing on concerns over radiation following the Fukushima accident, which is comparable to our study, is yet to find a negative association between education and worry over radiation risk (Kusama et al. 2018). However, there is no explanation regarding this discrepancy. Thus, in line with the majority of the research presented above, the following hypotheses are proposed:

Hypothesis 1: Education is negatively associated with worry over the risk of ionizing radiation exposure.

Hypothesis 2: Income is negatively associated with worry over the risk of ionizing radiation exposure.

Research on attitudes toward migrating, or actual migration, in connection with large-scale accidents and emergencies shows a range of results regarding different types of hazardous events. Generally, emergency victims who could opt to migrate compare the origin and destination contexts with regards to job opportunities, education, community services,

distance to family members, and other citizens' attitudes toward evacuees (Asad 2014). Regarding natural disasters that do not spread toxic or radioactive materials in the living environment, like large-scale technological accidents often do, there are indications that high education and income imply a greater likeliness to return after evacuation (Fussell et al. 2009). Less advantaged citizens tend to return more rarely or slowly because they reside in more risk-prone areas, take fewer preventive measures, and suffer more damage to their homes (Asad 2014; Botzen et al. 2009; Fussell et al. 2009; Hak et al. 2016; Hunter 2005; Reininger et al. 2013). Moreover, studies on soil pollution management in China (Zhou et al. 2020) and radiation protection after the Fukushima accident (Aruga 2016) indicate that higher SES is associated with taking more precautionary measures. These studies cannot be generalized directly to the object of study in the present paper, however, in part because their focus is undefined protective action, food choice after the Fukushima accident, or other environmental risks.

We believe that one of the main differences between natural and technological disasters is the general public's perception of dread risk in some cases involving the latter. This pertains particularly to radiological accidents involving the release of radioactive materials (Slovic 1996). Therefore, there is reason to believe that citizens who have the financial means to avoid an area affected by a risk that is dreaded by many will, to a greater extent than others, express intentions to avoid the area and move elsewhere. Thus, we propose the following hypotheses:

Hypothesis 3: Education is positively associated with the preference to move from a decontaminated area.

Hypothesis 4: Income is positively associated with the preference to move from a decontaminated area.

Further support for our above hypotheses may be that socioeconomic vulnerability stands as an obstacle and provokes caution in the face of major life changes. There are related mediating psychological factors that reflect and reinforce vulnerabilities such as perceived control over life outcomes, optimism/pessimism, and trust (Mittal and Griskevicius 2017). Moreover, studies show that a high degree of civic trust is associated with higher readiness to deal with crises (Reininger et al. 2013). After the Fukushima Daiichi accident, low trust in government and science had a negative impact on willingness to return following decontamination (Murakami et al. 2015). These results support the inclusion of a trust indicator among our control variables in addition to more basic demographic factors.

Materials and Methods

With the aim to investigate the relationship between SES and public attitudes to an NPP accident scenario, this study analyzed survey data collected during the period 22 February 2019 to 28 March 2019. The survey was sent by e-mail as part of Swedish citizen research conducted by the Laboratory of Opinion Research (LORE) at the University of Gothenburg. Altogether, 3,800 adult Swedish citizens were invited to participate in the study, from which 2,291 participated in the survey (a maximum of three reminders were sent out). A probability-based selection stratified by geographical location, gender, age, and income was designed to provide a representative sample of adult Swedes and secure a sufficient level of

inclusion of respondents from the country's three counties with nuclear power plants. Sample errors consisted of some instances of missing data. Between two and six percent of the units lacked a response to some of the questions under study and were excluded. Therefore, the response count (N) may vary slightly from one question to another. The significance level was set at $p < 0.05$.

Before answering the survey questions, we presented the respondents with the hypothetical scenario in which a nuclear accident has occurred in Sweden and that their neighborhood, affected by the nuclear fallout, has undergone remediation. We omitted all answers from respondents who spent less than five seconds reading the instructions (46 respondents). The scenario description and raw data are available as supplementary information, SI 1. Scenario and SI 2. Dataset.

Response Variables

To measure worry concerning radiation exposure, we asked the respondents, "To what extent would you feel worried over radioactive substances in your home, despite the fact that measurements show that the radiation levels are harmless to one's health?" The answer choices were "To a very small extent," "To a somewhat small extent," "Neither a small nor large extent," "To a somewhat large extent," and "To a very large extent." The question was formulated as such because relocation would only be recommended by the authorities if measured radiation is below limit values.

To determine how respondents felt about choosing where to settle down after decontamination, the following variable was formulated: "How likely is it that you would move away from your home in the decontaminated area after it has been declared safe by the authorities?" The answer choices provided were as follows: "Not at all likely," "Not very likely," "Somewhat likely," and "Very likely."

Variables of Interest

The socioeconomic variables used in the study (individual and household income and educational attainment) are all reliable indicators of SES (Darin-Mattsson et al. 2017). The income questions were placed at the end of the survey and asked the respondents to report their individual and household gross monthly income. The education variable was constructed from a question asking the respondents to report their highest educational degree out of nine options specific to the Swedish educational system. These options were then bundled together into three groups to ensure that each group included at least 25% of the sample. The groups were as follows: "Upper secondary education," which includes respondents who have graduated from elementary school (74 respondents), upper secondary education for three years or less (191 respondents), and upper secondary education for three years or more (279 respondents); "post-secondary education," which includes respondents with a post-secondary education, not from a college or university, for less than three years (235 respondents); post-secondary education, not from a college or university, for more than three years (62 respondents); post-secondary education at a college or university but no degree (278 respondents); and "university degree," which includes respondents holding a degree from a university or college (911 respondents) or a doctoral degree (113 respondents).

Control Variables

The control variables used in our multivariate statistical models included family situation, gender, age, and trust in government institutions. The first three demographic variables were shown to be significant for risk attitudes in Japan after the Fukushima accident. It has also been shown that lower trust in government institutions increases concerns about radiation risk and reduces compliance with advice regarding settlement decisions (Murakami et al. 2015; Zhang et al. 2014), thereby justifying the inclusion of a control variable measuring government trust. We use a variable of a five-point Likert scale for this purpose. Furthermore, Paxson and Rouse (2008) found that home ownership is a critical factor in relocation decisions, naming it “location-specific” capital. Other research has also indicated that the possession of property in the affected area influences people to stay (or return home after evacuation) independently from his/her SES (Do 2020; Landry et al. 2007). We control for this by using four dummy variables indicating if the respondent is a tenant, owns an apartment, owns a house, or any other housing situation. Moreover, having job obligations have been shown to be another factor influencing the settlement decision (Do 2020; Landry et al. 2007). We asked the respondents whether they considered employment to be an important factor when taking decisions under the proposed scenario. We include this binary variable as a final control.

Statistical Analysis

We performed both non-parametric and regression testing. Non-parametric testing was performed to identify the overall (unconditional) relationship between our response variables and variables of interest without assuming any underlying data distribution. For this purpose, we performed Mann–Whitney U-testing to identify between-group differences in attitude. We complemented this analysis with Pearson’s chi-squared tests to assess the overall relationship between two categorical variables. We also performed multivariate regression analysis to identify the effect of the variables of interest while controlling for possible confounding factors. In this analysis, the response variables were used as dependent variables, and different combinations of the variables of interest and control variables were used as regressors. Since the response variables were ordinal, we utilized the ordered logit model to estimate the outcome effects.

We present three regression model specifications. Model 1 comprised univariate models where we included separate variables of interest as regressors. Model 2 includes the separate variables of interest together with all the control variables. Model 3 simultaneously includes all the variables of interest and control variables as regressors. For readability, we present the coefficients as adjusted odds ratios (aORs).

Results

We begin by presenting basic data for the variables studied. Table 1 presents counts and ratios of respondent answers to the response variables and variables of interest. Detailed descriptive statistics of all the variables are in the SI 3. Table.

Table 1 Respondents by response variables and variables of interest

Response variables	N	%
Worry over radiation exposure		
To a very small extent	132	6.0
To a somewhat small extent	444	20.2
Neither small nor large extent	348	15.8
To a somewhat large extent	830	37.8
To a very large extent	444	20.2
Total	2198	100
Likeliness to move from one's home in the decontaminated area		
Not at all likely	218	10.0
Not very likely	732	33.5
Somewhat likely	890	40.7
Very likely	345	15.8
Total	2185	100
Variables of interest		
Income group		
<2,600 EUR	725	35.4
2,600–3,700 EUR	640	31.2
>3,700 EUR	686	33.5
Total	2051	100
Educational level		
Upper secondary education	544	25.4
Post-secondary education	575	26.8
University degree	1024	47.8
Total	2143	100

Income

Figure 1 displays the mean score for worry over radiation exposure by income group (A) and educational level (B). People's income appears to be one of the explanations for their levels of worry. In the five-point Likert scale, respondents in the two lower income

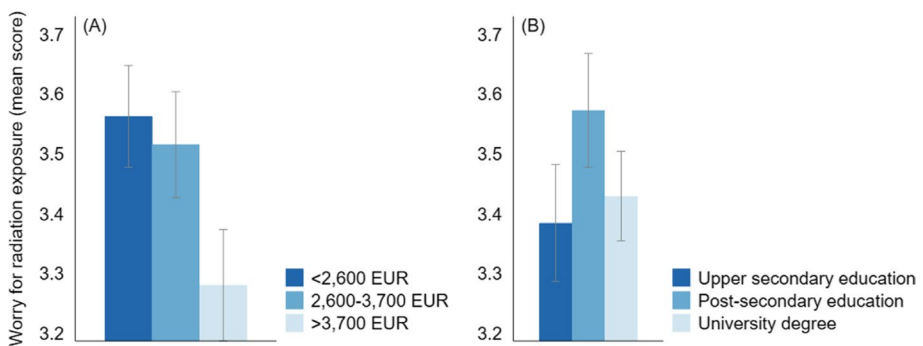


Fig. 1 Worry over radiation exposure by income group (A) and educational level (B) (confidence intervals are displayed at the 95% level)

groups reported an average score of 3.54 (the 95% confidence interval is 3.48–3.60), while respondents in the highest income group reported an average score of 3.28 (3.19–3.37). This difference is statistically significant. A non-parametric Mann–Whitney (MW) test reports a p-value of <0.001 . Furthermore, a Pearson’s chi-squared test provides an overall p-value of <0.001 , indicating an overall negative relationship between income and worry over radiation exposure. We expanded this analysis by running ordered logit models and found that the highest income group stands out as being strongly related to lower levels of worry (statistically significant aORs <1 ; see Table 2). Upon adding control variables to the model (Model 2 and 3), the predicted relationship is similar and, in fact, strengthened.

In Fig. 2, where the mean score of preference for moving and avoiding potential risk is displayed, we observe that the two highest income groups report the highest mean scores for leaving the decontaminated area. The difference between the lowest and highest income groups is weakly statistically significant (MW p-value = 0.087). A Pearson’s chi-squared test results in an overall p-value of 0.225. Thus, there does not seem to be a clear relationship between income and the preference for moving and avoiding potential risk. However, when controlling for other factors in the regression analysis (Table 3), a positive statistically significant relationship is identified.

Table 2 Ordered logit model for worry over radiation exposure (the effect of income and educational level)

	Model 1	Model 2	Model 3
Income group			
< 2,600 EUR (reference category)			
2,600–3,700 EUR	0.91 (0.09)	0.90 (0.09)	0.90 (0.09)
> 3,700 EUR	0.66*** (0.07)	0.74** (0.09)	0.74*** (0.09)
Educational level			
Upper secondary education (reference category)			
Post-secondary education	1.35*** (0.14)	1.24** (0.14)	1.27** (0.15)
University degree	1.10 (0.10)	1.02 (0.10)	1.10 (0.12)
Control variables			
Income: joint chi-square p-value	No	Yes	Yes
Education: joint chi-square p-value	0.000	0.034	0.033
Pseudo-R-squared (average)	0.012 (0.002)	0.071 (0.046)	0.098 (0.047)
Observations (average)	(2095)	(1981)	1937

Model 1: Univariate model

Model 2: Control variables included (income and education were included separately)

Model 3: All variables included

The coefficients are presented as adjusted odds ratios. The lowest income and educational levels serve as reference groups. Heteroscedasticity-consistent standard errors are in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

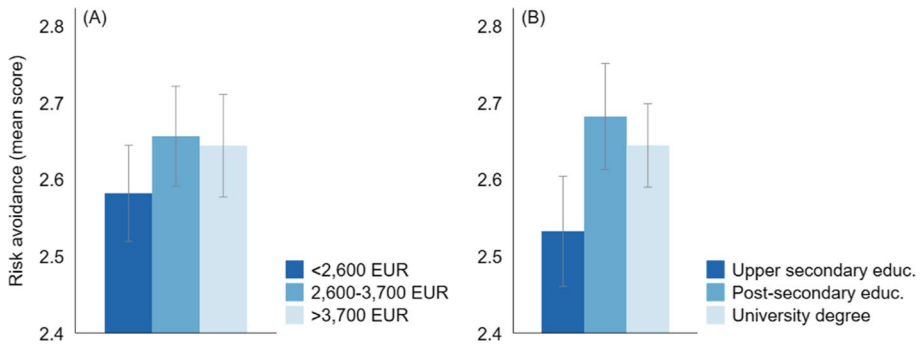


Fig. 2 Levels of preference concerning moving away from the decontaminated area by income group (A) and educational level (B) (confidence intervals are displayed at the 95% level)

Table 3 Ordered logit model for preferences concerning moving away from the decontaminated area (the effect of income and educational level)

	Model 1	Model 2	Model 3
Income group			
<2,600 EUR (reference category)			
2,600–3,700 EUR	1.16 (0.11)	1.21* (0.13)	1.20* (0.13)
> 3,700 EUR	1.15 (0.12)	1.35** (0.16)	1.33** (0.16)
Educational level			
Upper secondary education (reference category)			
Post-secondary education	1.36*** (0.15)	1.29** (0.15)	1.20 (0.14)
University degree	1.27** (0.12)	1.25** (0.13)	1.11 (0.12)
Control variables			
Income: joint chi-square p-value	0.228	0.035	0.056
Education: joint chi-square p-value	0.010	0.050	0.283
Pseudo-R-squared (average)	(0.001)	(0.043)	0.043
Observations (average)	(2090)	(1977)	1933

Model 1: Univariate model

Model 2: Control variables included (income and education were included separately)

Model 3: All variables included

The coefficients are presented as adjusted odds ratios. The lowest income and educational levels serve as reference groups. Heteroscedasticity-consistent standard errors are in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In sum, there are strong indications that the richest households express less worry regarding radiation. We also found support that high-income individuals are more likely to move if their neighborhood is affected by radioactive fallout than low-income individuals.

Education

Figure 1B shows that the groups characterized by low and high educational levels express less worry regarding radiation exposure than the middle group (MW p-values were 0.016 and 0.004). This pattern also holds true in the regression analysis (Table 2; see also SI 4. Table).

In Fig. 2B, which presents a graph of the relationship between educational level and level of preference regarding risk avoidance, a similar pattern can be seen. However, here, the group with the lowest educational level displays lower preference levels for moving away and avoiding potential radiation risk than the groups with the middle and highest educational levels (MW p-values are 0.004 and 0.016). These results are validated by the multivariate analysis in Table 3. However, the education variables are no longer statistically significant when income is included in the regression (joint chi-square p-value of 0.283; Model 3), indicating that an important part of the educational effect depends on income.

Robustness Tests

There are many measures of income. To account for a measure besides individual income, we also asked the respondents about the income of their entire household. Thus, we ran the same regression models as above but with household income as a regressor (see SI 5. Table). The results are largely similar (see also SI 8. Fig. and SI 9. Fig. for univariate results). However, there is one important difference. When using household income as the income variable, there is no longer a statistically significant relationship with worry over radiation exposure.

Previous research analyzing similar datasets has opted for other estimators. Thus, as further robustness testing, we re-estimated our models on household income using the two most commonly used models. First, we estimated a logit model using binary versions of the dependent variables to indicate whether the respondents had opted for any of the two most recently ordered options of the respective Likert scale (SI 6. Table). Second, we treated the dependent variables as continuous and ran the regression models again, now with an ordinary least squares estimator (SI 7. Table). No major differences were found compared to the results from the ordered logistic estimator.

Discussion and Conclusion

The present study used survey data from Sweden to investigate the role of SES in public attitudes to an NPP accident and decontamination scenario. There were multiple motivations behind our focus. The prevailing international strategy of the IAEA, and thus of most governments, focuses on decontamination in the event of a large-scale radiological accident and calls on citizens to live in decontaminated areas (IAEA 2013). Moreover, following natural disasters, socioeconomic factors have been found to be important in explaining citizen behavior. SES has generally been found to be associated with relatively low risk perception, and studies show that affluent citizens are more likely to keep their homes in affected areas compared to others (Fussell et al. 2009; Landry et al. 2007; Thiede and Brown 2013). However, the prevalence of citizens perceiving dread risk and stigma if affected by an accident involving the release of radioactive material (Slovic 2012) motivated us to hypothesize

that the more affluent are, on average, more likely to leave an area recovering from radioactive contamination. The main result of this study also provides some support for this trend reversal in comparison to citizens' behavior in natural disasters, that is, those characterized by higher SES are more likely to leave an accident-affected neighborhood. The analysis thus provides some support for H3 and H4, although income appeared as the dominant variable over education in our multivariate analysis. Nevertheless, in line with studies of natural disasters, income was negatively associated with concern about risk, thereby confirming H2. Paradoxically, less concern about radiation risk did not imply a lower inclination to move and avoid potential risk, as in the case of those with higher income in our study. Overall, given that about half of all respondents preferred to move from the affected area, recovery following an accident in Sweden could be similar to that in Japan, where return migration to decontaminated areas was low and slow, entailed demographic imbalances, and remediation became very expensive per returnee (Do 2020; Nagamatsu et al. 2020).

The results of the study are, however, not free from ambiguity. Individual income was found to be associated with less worry over risk, but in our robustness test, household income was not, thereby showing the importance of distinguishing between different income measures. The effect of education proved to be even more complex. We found that the groups with low and high educational levels expressed somewhat less worry regarding radiation exposure than the middle group. Upon adding all our control variables to the regression analysis (Table 2), only the low educational level and middle groups remained statistically significant (see also SI 4. Table). Therefore, we could not confirm the negative association between education and worry postulated in H1. Furthermore, we investigated H3 on whether education was associated with moving away from the decontaminated area. Both the univariate and multivariate analyses provided some degree of validation to H3, in that, the lowest educational level group was less inclined to move than both the middle and highest educational level groups. This effect was however dominated by the effect of income when both variables were included simultaneously in the model.

One reason that the study could not confirm a negative association between education and worry over risk might be that a subset of our sample was not large enough to enable sufficient statistical strength in relation to lower education compared to upper secondary school, which in Sweden equals about 12 school years. The level of inequality in education may therefore be too small to yield an effect. The result could be interpreted as support for the idea that greater equality reduces differences in risk perception (Olofsson and Rashid 2011). For education and worry, however, we found some support for the existence of an "anxious middle" (Thrupp 2001). We can only speculate as to why. It may be due to the fact that citizens who strongly support green policies are mainly clustered in the middle class (Dolezal 2010) and, thus, may also be more concerned than others about the adverse effects of radiological accidents.

There is reason to discuss explanations regarding the finding that the group characterized by low education was least likely to move from the remediation area and that individual income was associated with lower concern over radiation risk—two results that were clear and statistically significant for all the controls. Previous studies have found that low income implies greater exposure to hazards, limited protection, limited choice (Hunter 2005; Link et al. 1993; Sawano et al. 2019; Taylor et al. 1997), and generally higher levels of distress due to financial strain (Linander et al. 2014), all adding to perceptions of the world as more dangerous and worrisome. We might understand the risk attitudes among the wealthy as resulting from their experience of greater control over their current and future situation and seeing the world as relatively safe. In addition, they are more involved in and benefit from a hi-tech society, which entails certain

environmental risks and greater trust in institutions (Olofsson and Öhman 2015). Varying levels of worry may therefore be understood as resulting from different but equally real conditions.

A reasonable explanation for the fact that citizens with lower SES are less likely to move away from a decontaminated area is that, without support, less advantaged households may be forced to accept risk and social stigma in an otherwise relatively stable situation (see Hunter 2005). Moreover, large-scale accidents and emergencies reinforce previous socio-economic patterns in the population, whereby the underprivileged become more vulnerable than before a crisis (Aboda et al. 2019). Without sufficient resources, expectations on migrating and establishing oneself elsewhere may be low (van Houte et al. 2015). Conversely, socioeconomically advantaged households have more resources, giving them more viable options to avoid various risks, both in terms of consumption (Aruga 2016) and other precautionary measures (Kusama et al. 2018). Therefore, risk attitudes cannot be dismissed as irrational or excessive risk aversion but should be regarded as cognitions embedded and conditioned in a social context. Indeed, data point to a higher degree of actual vulnerability to various environmental hazards among those characterized by low SES (Hunter 2005), including radiation (Sawano et al. 2019), most likely because they face more dangerous working conditions (Link et al. 1993) and living environments (Taylor et al. 1997).

Finally, as many as 58% of the respondents expressed fairly high or very high levels of worry about radiation in the home, despite being informed about successful remediation, and 56.5% believed that it was not very likely or not at all likely that they would continue living in the remediated area. In addition, there was some overrepresentation of the affluent in the group preferring to leave the contaminated area. This result implies challenges for the international emergency preparedness and response (EPR) framework, which focuses on evacuation, decontamination, and return migration (IAEA 2013). There appears to be an interpretative gap between international bodies and government agencies and large sections of laypeople, which would likely reduce the effectiveness of recovery management in the event an NPP accident were to occur. Furthermore, with too few people returning to live in a decontaminated area, there is an immanent risk that demographic imbalance may impede the recovery plans of government agencies. Moreover, if underprivileged households live in a decontaminated area out of necessity rather than because they want to, there may be an increase in related social problems (see, e.g., Morita et al. 2018). Conflicting perspectives on risk and safety management, as those described above, are not easily reconciled through top-down information transfer. To prevent historical conflicts over risk management from recurring (Slovic 2012), risk management decision-makers need to weigh in and consider citizens' risk attitudes and perceptions and include such stakeholders in negotiations, as suggested in the emerging risk governance literature (Boholm et al. 2012; Klinke and Renn 2012; Montero et al. 2020; van Asselt and Renn 2011). For the above reasons, there may also be a point in investigating alternative solutions to decontamination, such as state-subsidized compensation and, thus, greater freedom of action for affected households.

Future research focusing on the effect of SES on risk attitudes could remedy a weakness in our study and include samples containing a larger proportion of those with the lowest educational attainment. With larger differences, education is also likely to be a strong SES factor (Darin-Mattsson et al. 2017). Furthermore, in addition to survey research, qualitative studies could add to the growing understanding of lay responses to radiation risk and policy discussions (see, e.g., Rasmussen et al. 2022). With a more substantial knowledge base, governing bodies may also learn more about different stakeholder perspectives on recovery strategies and options in the event of an NPP accident. If incorporated, such knowledge is likely to increase the effectiveness of measures planned by government agencies.

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Author Contributions Both authors contributed to the study conception, design and implementation. Joel Rasmussen was mainly responsible for the data collection, literature review, and hypotheses development, while Jens Ewald was mainly responsible for the statistical analysis. Both authors contributed to drafts of the manuscript. Both authors read and approved the final manuscript.

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Data Availability All data generated or analyzed during this study are included with this article and its supplementary information files.

Declarations

Competing Interests The authors have no relevant financial or non-financial interests to disclose.

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