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Statistical analysis of flood risk perception: a case study for Eastern Black Sea Basin, Turkey

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Abstract
It is very essential in terms of flood risk management to consider social expectations such as risk perception, flood awareness, preparedness, and socio-economic dynamics together with engineering designs. Understanding the way people perceive flood risk can enhance our capability of improving existing flood risk management methods, thus helps us creating disaster resilient societies. In this study, results of a questionnaire which was used for a previous study and had been administered to participants from Eastern Black Sea Region of Turkey were further investigated using statistical methods. The main aim was to understand how demographic factors such as age, gender and education level affect people's flood risk perception. It was also desired to see that whether they were aware of the parties responsible for taking mitigation measures, or whether they know about possible flood mitigation measures or not. Using the same data with the previous study, but in addition using SPSS software to do statistical analysis, questionnaire results were investigated using convenient statistical tests for each parameter, analysis results were interpreted, and conclusions were drawn. Same tests were conducted using weight coefficients adopted using a certain methodology which is explained in the paper, in order to make a better investigation. Also, results were compared with the results of the previous study. It was seen that there were some consistencies and contradictions between the results of the previous study and this study's results.

Keywords Risk perception · Flood awareness · Demographic factors · SPSS software

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1 Introduction

Throughout the entire world, floods are one of the most frequently encountered natural disasters and are highly destructive. Especially in Turkey, floods cause loss of life and damages to properties as much as earthquakes do and are in the second place in terms of destructiveness. For these reasons, it is of vital importance for societies to employ a series of measures, called "flood risk management" to reduce the possible undesired consequences of floods.

While flood risk management could only be consisting of some structural and non-structural measures that can be taken in order for us to mitigate flood damages, unless some social factors affecting people's responses before, during and after floods are not considered, the desired mitigation might just not be achieved since it is argued that correct behavioral responses people show might enable us to reduce flood damages at a ratio of 80% (Grothmann and Reusswig 2006; Santoro et al. 2022). Hence, flood risk management policies have been evolving to a state where social factors affecting people's responses to flood, such as flood risk perception, awareness and preparedness are also included in addition to the traditional measures (Lechowska 2022; Santoro et al. 2022). It can be argued that the way people perceive flood risks, level of knowledge they have on flooding, their awareness about the results of flooding and actions they are willing to take to be prepared for the disaster are as important as any of the structural or non-structural flood mitigation measures.

Flood risk is defined using different approaches in the literature. In general, it is said that it has three main components, namely flood hazard, vulnerability, and flood risk (Oubennaceur et al. 2022). Flood hazard is the possible life and property losses that might be caused by future floods and vulnerability might be explained as the potential risk associated with lack of mitigation measures in a region which is flood prone (Liu et al. 2022). Flood risk can be thought of as a combined effect of all negative consequences of floods and vulnerability. Flood risk perception, on the other hand, is a subjective concept; it can be defined as the way people perceive the extent of the negative consequences of floods (Bubeck et al. 2012; Becker et al. 2014). That is why it can differ from person to person, being affected by some demographic, psychological factors, and other factors such as flood experience. It can be said that demographic factors such as age, gender, education level and income level are highly determinant for flood risk perception.

The perceived probability and seriousness of a threat are both factors in risk perception. For initiating the risk-reduction process and motivating action, it is regarded as a legitimate predictor variable (Becker et al. 2014). The perception of flood threats has gained importance among policymakers recently who are concerned with risk management and safety issues. Bubeck et al. (2012) examines influences on private flood mitigation behavior have been reviewed. Risk awareness analysis and strategy design and implementation are also crucial steps in flood risk management, as they facilitate response to flood warnings and the development of initiatives to improve community preparedness (Bodoque et al. 2019). Dealing with flood hazard and risk, it is important to employ methodologies that combine knowledge from natural and social sciences, which in turn promotes the ongoing discussion on socio-hydrology. Communities have various options available to them, including both non-structural and structural measures, to reduce the risk of flooding (Fuchs et al. 2017; Bera and Danek 2018; Rana et al. 2020).

Modern flood risk management considers understanding how the public perceives risk to be essential since it directs the creation of effective and efficient flood mitigation solutions. In order to searched for to examine at risk perception and disaster preparedness, information about respondents' sociodemographic characteristics and life experiences was also gathered. The majority of respondents appeared to be fairly well equipped to handle a future flood disaster according to the overall findings. The results of correlational and regression analysis showed that risk perception and disaster preparedness were positively correlated (Miceli et al. 2008; Kellens et al. 2011). Additionally, prior experiences and demographic characteristics, followed by civil society and the influence of public institutions, have the greatest impact on how people perceive the risk of flooding. Given that these are variables that can be improved, Ardaya et al. (2017) concentrated on the analysis of civil society and governmental institutions' influence. To create a complete framework for flood risk, it is ideal to consider all potential harms (direct and indirect), including the social, psychological, and environmental effects of flood losses (Shen et al. 2020; Oubennaceur et al. 2022). Numerous connections between the aforementioned parameters have been discovered in earlier investigations. For instance, it has been discovered that demographics, psychometric variables, or prior flood experiences might predict behavior, awareness, risk perception, and the possibility of future floods (Diakakis et al. 2018; Lechowska 2018; Huang et al. 2020). Eryılmaz Türkkan and Hırca (2021) suggests building a flood risk framework for the social characteristics of individuals that would make flood management plans more efficient and sustainable.

In Anılan and Yüksek (2017), in order to evaluate the way people perceive flood risk and level of knowledge they have on flooding, a questionnaire consisting of four Yes/No and two open-ended questions was designed and administered to over 1000 participants from Eastern Black Sea Basin (EBSB) in Turkey. After eliminating invalid responses, a group of data gathered from 897 participants was obtained. Using these data, flood risk perception level of the people and their knowledge about possible flood mitigation measures and parties responsible for taking them were determined. As independent variables, demographic factors age, gender, and education level, and also flood experience and expectations were used to determine risk perception. However only graphs were obtained, percentage distribution of responses was given, and conclusions were drawn.

In this study, which can be thought of an extension of the mentioned previous study, it was aimed to use statistical methods to further investigate the effects of some demographic and other factors on flood risk perception and mitigation measure knowledge of 897 participants, using the data obtained in Anılan and Yüksek (2017), and also to make a comparison between the results of this study and of Anılan and Yüksek (2017). Data set was analyzed using different statistical tests through SPSS software. Independent Sample T-test was employed to determine whether flood risk perception (FRP) level was affected by gender, flood experience, the fact that the resident is under risk, damage expected after a probable future flood and belief in parties which are responsible for damage mitigation. One-way ANOVA and Post Hoc tests were conducted to see whether FRP level was affected by age and education level; while two-way ANOVA and Post Hoc tests were used to examine the combined effects of education level and age, education level and gender, and age and gender on FRP level. Since Likert Scale had not been employed in Anılan and Yüksek (2017), data was digitized using different methods to make it possible to use it in SPSS software. Same analyses were conducted in two ways: In one, weighting coefficients were not used and in the other they were. A comparison of results obtained by the analyses without and with weighting coefficients was made; also a comparison of the results of this study and of them was made.

2 Data collected and methodology

2.1 Questionnaire design

In Anılan and Yüksek (2017), a questionnaire which was administered to 897 people was used to investigate the flood risk perception and knowledge level of participants from Eastern Black Sea Basin (EBSB) of Turkey. Flood disasters frequently occur in the EBSB. This region is classified as a flood basin, and it poses a serious threat to residents in the nearby settlement area. It has a mountainous topography and high amount of precipitation. The detailed features and maps of the basin can be found in (Anılan et al. 2020).

The questionnaire included six items, four of them being Yes/No questions, and the rest being open ended (Table 1). In this study, it is aimed to further investigate perceptions of flood risk and flood damage mitigation measures of those participants through statistical methods using SPSS software. Since the questionnaire used in Anılan and Yüksek (2017) did not employ Likert Scale, in order for the data to be used for a statistical analysis, it had to be converted into scaled data, that is, it had to be numerical. For these reasons, to digitize the data, an approach based on Liu and Li (2015) and Liu et al. (2018) was taken as basis. Since demographic factors such as age, gender and education level are of utmost importance for the determination of FRP scores, they were also considered.

With the first four questions, it was tried to determine the participants' flood experiences, personal awareness, risk and concern perception and potential of coping proficiency with Yes/No questions. In the fifth open-ended question given to measure the level of knowledge, options stream improvement, afforestation, preventing settlement in stream beds or relocation, infrastructure works, awareness of public and other were completed. In the 6th open-ended question asked to measure expectations, options state, municipality, citizen, general directorate of state hydraulic works, district governorate, governorate and other were given. It was possible to make an explanation with the other option in questions 5 and

Table 1 Determinants of flood risk perception ($N=897$)

Questions	Purpose	Choice
Have you ever experienced a flood?	Flood experience	Yes/no
Do you think that your residence is under risk?	Personal awareness	Yes/No
If a flood occurs, do you think that you will experience any loss of life or property?	Risk and concern perception	Yes/No
Do you believe that any measure may be taken to mitigate flood damages?	Potential of coping proficiency	Yes/No
Which measures may be taken to mitigate flood damages?	Knowledge level	Open ended
Who is responsible for the measure?	Expectation	Open ended

Table 2 Demographics structure of participants (N=897)

Participants	Number	%
Age interval		
15–24	139	16
25–34	189	21
35–49	261	29
50+	308	34
Gender		
Male	777	87
Female	120	13
Education		
Elementary School	248	28
Secondary School	119	13
High School	299	33
University	231	26

Table 3 Fundamental statistics (%) for Yes/No questions (1–4), (N=897)

Question	Yes	No
Have you ever experienced a flood?	62	38
Do you think that your residence is under risk?	60	40
If a flood occurs, do you think that you'll experience any loss of life or property?	90	10
Do you believe that any measure may be taken to mitigate flood damages?	85	15

Table 4 Frequency analysis for Yes/No questions (Q1-Q4)

		Flood experience	Personal awareness	Risk and concern perception	Potential of coping proficiency
N	Valid	896	893	897	871
	Missing	1	4	0	26
Frequency	No	341 (38.0%)	354 (39.5%)	354 (17.4%)	129 (14.4%)
	Yes	555 (61.9%)	539 (60.1%)	539 (82.6%)	742 (82.7%)

6. The demographic structure of the participants was determined according to age, gender and educational status which is presented in Table 2.

2.2 Fundamental statistical analysis

In Tables 3 and 4, the fundamental statistical results and frequency analyzes of the answers are given for the first 4 questions, respectively. According to the answers given, it was revealed that most of the participants had experienced (62%) floods before and considered themselves at risk of floods (60%). In addition, a large majority of the participants think that they will experience losses in case of any flood (90%) and that precautions can be taken to prevent this situation (85%).

According to the answers to the open-ended questions, the results of which are given in Table 5, preventing settlement in stream beds or relocation (36.9%) is seen as the most effective method to reduce flood risk among the participants. In the second open-ended question, which asks about the people responsible for taking measures, the state comes first with 45.7%.

All digitized data had a mean value of 5.37 and a standard deviation. Adopting the "mean ± 1 standard deviation" approach, interval of the scores was determined to have the minimum value of 3.31 and maximum value of 7.44 (Liu et al. 2018, 2022). Grouping was made so as to the values below 3.31 were to be "low", values above 7.44 were to be "high", while the values in between were to be "moderate". Accordingly, 137 participants had low risk perception, while 649 and 110 participants had moderate and high-risk perceptions, respectively.

3 Hypotheses and method

Since for each parameter that might affect the FRP level, the nature of the data is different, some of them required different types of statistical tests to be correctly analyzed. Since it was convenient to use independent sample T-test for the investigations of the effects of gender, flood experience, residence risk, expectation of loss and belief in responsible; T-tests were performed to investigated these. One-way ANOVA was suitable for the investigation of the effects of age and gender on FRP level, while Two-way ANOVA was convenient for the determination of the combined effects of demographic factors age, gender, and education level on FRP level. Hypotheses and types of tests used to evaluate them are shown in Table 6. In each case, null hypothesis "H_0" says that there is no difference between variances, which is the parameter of interest does not affect the dependent variable which is FRP level. On the other hand, alternative hypothesis "H_1" says that the variances differ significantly, that is; variables affect the FRP level in a statistically significant manner.

Table 5 Fundamental statistics for open-ended questions (Q5-Q6)

Options	N	Percent (%)
Stream improvement	143	13.1
Afforestation	173	15.9
Preventing settlement in stream beds or relocation	402	36.9
Infrastructure works	41	3.8
Awareness of public	131	12.0
Other	199	18.3
Total	1089	100.0
State	526	45.7
Municipality	134	11.6
Citizen	268	23.3
General directorate of state hydraulic works (DSI)	42	3.6
District governate	36	3.1
Governate	60	5.2
Other	85	7.4
Total	1151	100.0

Table 6 Hypotheses and tests

Independent T-test
Is FRP affected by gender?
Is FRP affected by flood experience? (Q1)
Is FRP affected by the fact that the residence is under risk? (Q2)
Is FRP affected by expected loss of life or property? (Q3)
Is FRP affected by the belief that the responsible are taking the necessary measures? (Q4)
One-way ANOVA, Post Hoc Test
Is FRP affected by age?
Is FRP affected by education level?
Two-way ANOVA, Post Hoc Test
Is FRP affected by a combination of education level and age?
Is FRP affected by a combination of education level and gender?
IS FRP affected by a combination of age and gender?

Table 7 Values used to digitize the data for SPSS

Age	Gender	Education	Q1	Q2	Q3	Q4	Q5	Q6
15–24 (1)	Male (1)	Elementary school (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Stream improvement (1 – 0)	State (1 – 0)
25–34 (2)	Female (2)	Secondary school (2)	No (0)	No (0)	No (0)	No (0)	Afforestation (1 – 0)	Municipality (1 – 0)
35–49 (3)		High school (3)					Preventing settlement in stream beds or relocation (1 – 0)	Citizen (1 – 0)
50+ (4)		University (4)					Infrastructure works (1 – 0)	DSI* (1 – 0)
							Awareness of public (1 – 0)	District governorate (1 – 0)
							Other (1 – 0)	Governorate (1 – 0)
								Other (1 – 0)

* General directorate of state hydraulic works

In order to analyze the data in the SPSS package program, it must be converted into a software language. 4 categories were arranged for the independent variables of age and educational status, and 2 categories were arranged for the independent variable of gender. In classifying the dependent variables for the program, 2 categories were determined for the first 4 questions, which are Yes/No questions, and 6 and 7 categories were determined for the last 2 questions respectively, which are open-ended questions. In the first 4 questions, '1' was assigned to the yes answer and '0' was assigned to the no answer. In open-ended questions, '1' was assigned to the options that the participant chose for each option, and '0' was assigned to the options that the participant did not choose (Table 7).

Taking the methodology of Liu et al. (2018) as the basis for the determination of FRP, scores for each individual were calculated and categorized into three classes as "high", "moderate" and "low", based on some fundamental statistical approaches (regarding mean and standard deviation values). Each participants' impression of flood risk was calculated using the mean (MV) and standard deviation (SD) of the FRP scores. If the FRP score was larger (lesser) than 1 SD from the MV, a household's opinion of its flood risk fell into the high (low) category, whereas other participants fell into the moderate category 'moderate'. In this instance, the FRP scores' SD, MV, minimum, and maximum values were 2.06, 5.37, 0, and 12, respectively. Therefore, the ranges for participants' perceptions of low, moderate, and high flood risks were (0, 3.31), (3.31, 7.44), and (7.44, 12), respectively.

According to the findings, 650 participants (72.5%) of all questioned respondents indicated that there was a moderate probability of flooding. Only 110 and 137 participants, or roughly 12.3% and 15.3% of all surveyed individuals, respectively, reported high and low levels of flood risk perception. A statistical analysis was made using only calculated scores; and as proposed in Ullah et al. (2020), using weighting coefficients, another analysis was performed for comparison purposes. Significance level was selected as 0.05 (5%), meaning that when the significance value is lower than 5% this means there is difference between variances and the effects are statistically significant, and vice versa.

4 Results

Although there are many studies about flood risk perceptions (Liu et al. 2018; Wang et al. 2018; Ullah et al. 2020; Liu et al. 2022), there is no clear consensus on whether weights should be used in statistical approaches. Therefore, in this study, analysis was conducted using both without weighting FRP values and weighting coefficient values. In this way, it was possible to compare results without weighing and weighting coefficient analysis.

4.1 Statistical analysis without weighting coefficients

4.1.1 Independent T-test results

Table 8 shows the independent sample T-test results. It is seen that significance and two-tailed significance values are 0.324 and 0.411 for the variable gender, respectively. First one being higher than 0.05 implies that the distribution is homogeneous. The fact that two-tailed significance value is greater than 0.05 reveals that there is no statistically significant difference between variances; that is, independent variable gender does not affect the dependent variable FRP level. In this case, we fail to reject to null hypothesis. When the effects of other parameters on FRP levels are investigated in a similar manner, it can be seen that all other independent variables affect FRP levels significantly; that is, when flood experience, risk of the residence, expectations of life and property loss and belief in responsible parties' change, FRP levels also change.

It can be said that those who had past flood experiences naturally felt themselves under higher risk, because of the fact that they had witnessed the destructive aspect of the disaster in real life. For the third parameter, it can easily be said that when the person thinks that his/her residence is under risk, he/she would perceive the risk as higher. It can be said that when people expect loss of life and property in the case of a possible future flood, they might see themselves under a higher risk. It can even be said that the opposite of this might be the case; that is, when the risk perception is higher, they might expect more losses. It can be argued that when people think that the responsible parties are fulfilling their roles properly, they tend to feel safer, leading to a lower level of risk perception.

Table 8 Independent T-test results

Is FRP affected by gender?	Gender	N		Sig.	Sig. (2-tailed)
	Women	120	Equal variances assumed	0.324	0.411
	Man	777	Equal variances not assumed		0.420
Is FRP affected by flood experience? (Q1)	Flood experience	N		Sig.	Sig. (2-tailed)
	Yes	555	Equal variances assumed	0.000	0.000
	No	341	Equal variances not assumed		0.000
Is FRP affected by the fact that the residence is under risk? (Q2)	Personal awareness	N		Sig.	Sig. (2-tailed)
	Yes	539	Equal variances assumed	0.000	0.000
	No	354	Equal variances not assumed		0.000
Is FRP affected by expected loss of life or property? (Q3)	Risk and concern perception	N		Sig.	Sig. (2-tailed)
	Yes	741	Equal variances assumed	0.000	0.000
	No	156	Equal variances not assumed		0.000
Is FRP affected by the belief that the responsibles are taking the necessary measures? (Q4)	Potential of coping proficiency	N		Sig.	Sig. (2-tailed)
	Yes	742	Equal variances assumed	0.122	0.000
	No	129	Equal variances not assumed		0.000

4.1.2 One-way ANOVA test results

Table 9 shows the one-way ANOVA test results. It is seen that variances are homogeneous for the parameter age. However, significance value is 6.9% which is greater than 5%, so we fail to reject the null hypothesis, saying that age does not affect the FRP level. When it comes to the investigation of the effects of education level on FRP, it is seen that the homogeneity of variances does not exist since P-value is lower than 0.05. When significance value is examined, it is seen that the value is much smaller than 0.05 variances differ greatly and there is a statistically significant difference between them. So, we accept the alternative hypothesis, saying that the education level indeed affects FRP level. When a further investigation is conducted using Tukey's test, it is seen that the differences are between the groups "elementary school-university" and "high school-university." Further, Tamhane test

Table 9 One-way ANOVA results

			Sig.	ANOVA Sig.
Is FRP affected by age?	Homogeneity of variances	Based on mean	0.168	0.069
		Based on median	0.572	
		Based on median and with adjusted df	0.572	
		Based on trimmed mean	0.213	
Is FRP affected by education level?	Homogeneity of variances	Based on mean	0.049	0.000
		Based on median	0.020	
		Based on median and with adjusted df	0.020	
		Based on trimmed mean	0.037	

suggests that there are differences between groups “elementary school-secondary school,” “elementary school-university” and “high school-university”.

There might be numerous factors lying behind these differences; one might argue that those who are better educated have a better understanding of the causes and consequences of the floods and of how to prevent the damages to the life and property, and consequently have a lower risk perception. Another reason might be that those who are better educated are generally the ones with higher income, so that they might think coping with the results of the floods, especially with damage to their properties, can be easier.

4.1.3 Two-way ANOVA test results

Table 10 shows the two-way ANOVA test results. Two-way ANOVA tests were conducted in order to investigate the combined effects of the demographic factors considered in this study, namely age, gender and education level. It is seen that the homogeneity of variances does exist except for the case of the combined effects of education level and gender. Since this homogeneity of variance is violated, this test is said to be a failed one. It is seen that parameters age and education level separately effects FRP level since the significance values for them are 0.037 and 0.025, respectively. However, when their combined effects are examined, it is clear that their combination does not affect FRP level since the significance is greater than 0.05. When the separate and combined effects of age and gender parameters are examined, it can be seen that all significance values are much greater than 0.05 and thus it can be concluded that they do not have a separate or combined effect on FRP level according to this test.

4.2 Statistical analysis with weighting coefficients

4.2.1 Independent T-test results

In Ullah et al. (2020); 1, 0.8, 0.6, 0.4 and 0.2 weighting coefficients were adopted for five different suggested risk perception groups, namely extremely high, high, moderate, low, and very low. Since in our study there are three groups, namely high, moderate, and low; it is assumed to be convenient to use weighting coefficients 1, 0.6 and 0.2 for them, respectively.

From the Table 11, it can be seen that in all of the cases except where the effect of flood experience on FRP level is examined homogeneity of variances does exist. When two-tailed

Table 10 Two-way ANOVA results

			Sig.	Tests of between-subjects effects	
Is FRP affected by a combination of education level and age?	Homogeneity of variances	Based on mean	0.084	Sig	
		Based on median	0.200	age	0.037
		Based on Median and with adjusted df	0.201	edu_sta	0.025
		Based on trimmed mean	0.077	age * edu_sta	0.168
Is FRP affected by a combination of education level and gender?	Homogeneity of variances	Based on mean	0.038	Sig.	
		Based on median	0.041	edu_sta	-
		Based on median and with adjusted df	0.041	gender	-
		Based on trimmed mean	0.036	edu_sta*gender	-
IS FRP affected by a combination of age and gender?	Homogeneity of variances	Based on mean	0.292	Sig.	
		Based on median	0.708	gender	0.718
		Based on median and with adjusted df	0.708	age	0.131
		Based on trimmed mean	0.336	gender * age	0.736

significance values are examined, it is clearly seen that all studied items except gender does have effects on FRP level. This was the same case for the analysis which was performed without using weighting coefficients.

4.2.2 One-way ANOVA test results

Table 12 shows one-way ANOVA test results. Homogeneity of variances is violated for parameter education level. For both parameters, significance values are lower than 0.05, thus it can be said that they both affect FRP level. Further investigation (Tukey's test, $P=0.033$; Tamhane test, $P=0.041$) tells that there are differences between age groups 25–34 and 40–64. On the other hand, for education level parameter, differences were observed between groups "elementary school-secondary school", "elementary school-high school" and "elementary school-university" according to Tukey's test. Tamhane test revealed that differences observed between groups "elementary school-secondary school", "elementary school-high school" and "elementary school-university".

Table 11 Independent T test results

Is FRP affected by gender?	Gender	N		Sig.	Sig. (2-tailed)
	Women	120	Equal variances assumed	0.061	0.314
	Man	777	Equal variances not assumed		0.355
Is FRP affected by flood experience? (Q1)	Flood Experience	N		Sig.	Sig. (2-tailed)
	Yes	555	Equal variances assumed	0.008	0.000
	No	341	Equal variances not assumed		0.000
Is FRP affected by the fact that the residence is under risk? (Q2)	Personal awareness	N		Sig.	Sig. (2-tailed)
	Yes	539	Equal variances assumed	0.300	0.000
	No	354	Equal variances not assumed		0.000
Is FRP affected by expected loss of life or property? (Q3)	Risk and concern perception	N		Sig.	Sig. (2-tailed)
	Yes	741	Equal variances assumed	0.910	0.000
	No	156	Equal variances not assumed		0.000
Is FRP affected by the belief that the responsibles are taking the necessary measures? (Q4)	Potential of coping proficiency	N		Sig.	Sig. (2-tailed)
	Yes	742	Equal variances assumed	0.000	0.000
	No	129	Equal variances not assumed		0.000

Table 12 One-way ANOVA results

			Sig.	ANOVA Sig.
Is FRP affected by age?	Homogeneity of variances	Based on mean	0.096	0.022
		Based on median	0.196	
		Based on median and with adjusted df	0.196	
		Based on trimmed mean	0.102	
Is FRP affected by education level?	Homogeneity of variances	Based on mean	0.001	0.000
		Based on median	0.002	
		Based on median and with adjusted df	0.002	
		Based on trimmed mean	0.002	

Comments made for the analysis made without weighting coefficients as to why these groups would differ from each other in their risk perception levels might be valid for this analysis as well.

4.2.3 Two-way ANOVA test results

Table 13 shows two-way ANOVA test results. In this test, only the combined effects of gender and age parameters were successfully tested because other two combinations, homogeneity of variances was violated. From the Table 13, it is seen that neither age and gender parameters' separate nor combined effects had any influence on FRP level of participants.

Table 13 Two-way ANOVA results

			Sig.	Tests of between-subjects effects	
Is FRP affected by a combination of education level and age?	Homogeneity of variances	Based on mean	0.005	Sig	
		Based on median	0.032	age	-
		Based on median and with adjusted df	0.032	edu_sta	-
		Based on trimmed mean	0.013	age * edu_sta	-
Is FRP affected by a combination of education level and gender?	Homogeneity of variances	Based on mean	0.002	Sig.	
		Based on median	0.005	edu_sta	-
		Based on median and with adjusted df	0.005	gender	-
		Based on trimmed mean	0.005	edu_sta*gender	-
IS FRP affected by a combination of age and gender?	Homogeneity of variances	Based on mean	0.039	Sig.	
		Based on median	0.130	gender	0.976
		Based on median and with adjusted df	0.130	age	0.080
		Based on trimmed mean	0.046	gender * age	0.710

5 Discussion

The results obtained as a result of the analyzes are compiled in the Table 14. It can be seen that use of weighting coefficients does not cause major differences in FRP scores; only difference was observed while testing the hypothesis "Is FRP affected by age?" using one-way ANOVA test. The study aimed to further investigate the results of a previous study Anılan and Yüksek (2017), in which a questionnaire consisting of four Yes/No and two open-ended questions administered to 897 participants from Eastern Black Sea Region of Turkey to determine their flood risk perceptions. Different from the previous study, SPSS software was used to examine the relationships between various factors and flood risk perception of each participant.

In Anılan and Yüksek (2017), answers "yes" given to questions to determine whether participants had had any flood experience and whether they had thought that their residence was under risk were nearly equal, as mentioned by the authors. In consistency with this, in our study it is clear that flood experience influences participants' risk perceptions. In Anılan and Yüksek (2017), it was observed that, in general, women were more conscious about flood damage mitigation measures, as they mentioned more sustainable and environmentally friendly measures while responding to the open-ended questions. It was also observed that many of the participants did not know who was responsible for taking measures, but in general women were again more conscious and also aware of their self-responsibilities. It was concluded that male participants' risk perception was lower since they had a tendency to expect less loss. However, in this study, it seems these differences were not reflected into

Table 14 Summary of statistical results

Independent T test	FRP	FRP (weight)
Is FRP affected by gender?	No	No
Is FRP affected by flood experience? (Q1)	Yes	Yes
Is FRP affected by the fact that the residence is under risk? (Q2)	Yes	Yes
Is FRP affected by expected loss of life or property? (Q3)	Yes	Yes
Is FRP affected by the belief that the responsibles are taking the necessary measures? (Q4)	Yes	Yes
One-way ANOVA, Post Hoc Test		
Is FRP affected by age?	No (not homogeneous)	Yes (homogeneous)
Is FRP affected by education level?	Yes (not homogeneous)	Yes (not homogeneous)
Two-way ANOVA, Post Hoc Test		
Is FRP affected by a combination of education level and age?	only age affects, combination does not (homogeneous)	not homogeneous
Is FRP affected by a combination of education level and gender?	not homogeneous	not homogeneous
IS FRP affected by a combination of age and gender?	no (homogeneous)	no (homogeneous)

the participants' flood risk perception levels because statistical analyses yielded no effects of gender on FRP levels.

In Anılan and Yüksek (2017), age seemed to affect awareness on possible flood mitigation measures and parties responsible for taking them. In general, younger participants seemed to be more aware of modern mitigation measures and responsible parties. In this study, only the effects on FRP level were examined and seen that age affected FRP level when the weighting coefficients used in one-way ANOVA and two-way ANOVA tests. This might arise from the different opinions of participants from different age groups on flooding. In Anılan and Yüksek (2017), it was observed that people with higher education levels mentioned more environmentally friendly solution for flood damage mitigation and were aware of their self-responsibilities more. In this study, our findings showed that education level significantly affects FRP level. This might be the result of the different opinions and awareness of people having different educational levels.

When a comparison is made between the results of Anılan and Yüksek (2017) and this study, there are some consistencies and disagreements. In both studies, flood experience affected FRP levels. In Anılan and Yüksek (2017), women were observed to be more aware of flood mitigation measures and their self-responsibilities and men had less risk perception since they had expected less losses. However, our study found no statistically significant Relationship between gender and FRP. In Anılan and Yüksek (2017), it was observed that younger people were more aware of modern mitigation measures and parties responsible for taking them. However, in this study, only the effects of age on FRP levels were examined and seen that age affected FRP levels when the weighting coefficients used in one-way ANOVA and two-way ANOVA tests. Also in both studies, education level seemed to have effects on FRP levels and awareness.

Although the fitting results of the model with the previous study of Anılan and Yüksek (2017) are encouraging, this study still has some limitations. There was a significant percentage of participants were men which might cause some uncertainty in the results. Future research should be more comprehensive. Additionally, there might be other factors which might be ignored.

6 Conclusions

In this study, results of a previous study (Anılan and Yüksek 2017) were used, a different method was adopted to interpret the results. In their study, a questionnaire was administered to over 1000 participants from Eastern Black Sea Region of Turkey, to investigate their flood risk perception and knowledge level. The questionnaire consisted of six questions, four of them being Yes/No questions and the rest of them being open-ended. Using the responds, some conclusions were drawn but no statistical method was used to interpret the responds. It was aimed to perform some statistical tests using SPSS software to adopt a different approach and further investigate the questionnaire results.

In Anılan and Yüksek (2017) a Likert Scale was not employed, for this reasons data had to be converted to scaled data in order for it to be used for statistical analyses. An approach based on Liu and Li (2015) and Liu et al. (2018) was taken as basis for this purpose. Demographic factors such as age, gender and education level were also considered since they are known to affect risk perception and awareness of people greatly. Same statistical analyses were performed both with and without weight coefficients to allow for a comparison of results between them as well.

When weight coefficients were not used; independent sample t-test was performed to see whether FRP changed with gender, flood experience, risk of the residence, expectations of life and property loss and belief in responsible parties; it was seen that only gender had no effects on FRP, all the other parameters significantly affected FRP levels of the participants. It can be argued that people who had had flood experience could felt themselves under more risk. It was also expected for residence risk to have an effect on FRP since people in risky zones would naturally feel themselves under higher risk. It can also be said that when people think that the responsible parties are fulfilling their roles properly, they tend to feel safe and have a lower risk perception. One-way ANOVA tests were performed to investigate the effects of age and education level on risk perception. It was seen that age did not have any effects on FRP, while education level did. To see how FRP differed between different subgroups of education level parameter, Tukey's test was performed. It was observed that the differences were between "elementary school-university" and "high school-university". Tamhane Test was also applied and showed that there were differences between groups "elementary school-secondary school", "elementary school-university" and "high school-university". Two-way ANOVA tests were used to examine the combined effects of education level and age, education level and gender, and age and gender. Since for the combination of education level and gender, the homogeneity of variances was violated, these results could not be interpreted. The other combinations did not have effects on FRP levels.

When weighting coefficients were used; independent t-test results showed that except gender, all other parameters had effects on FRP levels. This was in consistency with the results of the same tests when weighting coefficients were not used. When one-way ANOVA was performed, it was seen that both age and education level affected FRP levels. Tukey's test suggested that the differences caused by education level were between groups "elementary school-secondary school", "elementary school-high school" and "elementary school-university". Tamhane Test results were in agreement with these. When two-way ANOVA was performed, only in the case where the combined effects of gender and age the homogeneity of variances was not violated. Thus effects of only this combination could be examined and it was seen that both separate and combined effects of these parameters had any influence on FRP levels of the participants. As a results, it can be said that among the cases where the homogeneity of variances was not violated, the only difference between the results of the tests where the weighting coefficients were used and not used, was the effects age on FRP. Normally age did not have any effect on FRP, but when weighting coefficients were used, it was seen that age affected FRP levels of participants.

In particular, this article has the potential for wider readership and to make contributions to hazards professionals, GIS professionals, and those working on perception of risk among a variety of hazard domains. It would be more complete research if sensitivity analysis or similar were performed to see if any of the variables offered interaction or if the variables selected were significant in overall prediction. Based on the results of this study, training programs should be carried out in order to increase the flood risk awareness of the people of the region. There was a significant percentage for whom this was not accessible that majority of respondents were men. Policy makers should work on equalize participant gender. In addition, surveys and their statistical analysis could also be done periodically to determine the level of awareness and preparedness of the population.

In this study, which was conducted with reference to the survey results compiled by Anılan and Yüksek (2017), it was aimed to obtain in-depth examinations based on numerous statistical studies mentioned in the literature. The results demonstrated vast parallelism with previous studies. Overall, the findings of the study are at a level that can give insight and be useful in terms of flood management.

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Data availability Data and models that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

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