# Radiation Attitudes Scale for Healthcare Staff

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**Abstract**

The aim of this study is to develop a scale that will determine whether there is a significant difference in the cognitive, affective and behavioral attitudes of healthcare staff towards radiation and its effects on the variables of the profession, gender, service year, institution and department they work. Using the radiation-emitting devices consciously by healthcare staff will fairly reduce unnecessary radiation for patients. In this context, creating a positive attitude among the healthcare staff about radiation will positively affect public health. In this study, a Likert-type scale consisting of 18 items was developed to measure the attitude of healthcare staff towards radiation. The scale prepared in line with the purpose of the study was shared on-line on the web page of the All Radiology Technicians and Technicians Association and scale data were collected from 115 volunteer participants working as healthcare staff. The validity, reliability, and factor analyses of the scale of the collected data were analyzed with the statistical program. The developed scale had four factors and the 1st factor was determined as "The Radiation Knowledge of the Practitioner"; the 2nd factor as "Radiation Sensitivity of the Practitioner"; the 3rd as "Practitioner's Sensitivity to the Patient" and the 4th as "Practitioner's Informing the Patient". It is observed that the four-factored structure of the scale explained 64.5% of the total variance and the Cronbach's Alpha coefficient applied for the reliability of the whole scale was found as 0.914.

**Keywords:** Informing the patient, radiation knowledge, radiation sensitivity, radiation attitude scale, healthcare staff, radiation-emitting devices in health.

## INTRODUCTION

Men have lived with radiation since existence. The long-lived radioactive elements existing in the environment have created a normal and naturally accepted natural radiation level in our environment (Elgazzar, 2006; Schauer & Linton, 2009). However, as a result of the nuclear bomb experiments in the early years of the 20th century and with the development of technology, the amount of radiation in the environment increased and became to threaten our health (Elgazzar, 2006).

Today, it is no longer possible to live isolated from radiation. What the radiation is, how it occurs, what the sources are, and the characteristics of the radiation produced by these sources have long been investigated (CNSC 2012). The effects of radiation on human health (Berrington et al. 2001; Mathews 2013) are cancer, skin burns, reduced natural habitability, and inherited diseases. People, who were directly exposed to radiation in Hiroshima, died, and survivors were found to have a high risk of infection (Miller 1968). Many researchers working with radiation have been exposed to the harmful effects of radiation (Elgazzar, 2006; Schauer, & Linton, 2009). Becquerel, for example, harmed himself with the radium element he carried in his pocket. Another researcher, Marie, and Pierre Curie were also exposed to severe skin burns during their research on radiation. Following these investigations, radiation harms were noticed, and the staff was warned about the necessity of taking precautions (Elgazzar 2006).

At the beginning of the 1900s, many scientific articles and publications, showing that exposure to radiation at extreme levels might cause cancer, were carried out (Berrington et al. 2001; Brown and Tones 2013; Mathews 2013; Mohan et al. 2003; Lee et al. 2004; Puri et al. 2012; Wang et al. 2002). The staff, who exposed to radiation several times during radiation studies suffered from deadly skin cancer. Many workers' organs were removed to prevent the spread of the disease, and many radiologists died of such skin cancers.

In 1927, Herman Müller revealed that radiation might cause genetic disorders as a result of his investigations on insects. Although exposure to high doses of radiation is now known to cause serious damage to the body, it has not been proved that low doses of radiation cause such effects, yet (Elgazzar 2006). Considering this case, the radiation workers' attitude towards radiation is extremely crucial. According to Elgazzar (2006), many researchers, who have been carelessly worked without considering the warnings of radiation have been exposed to lethal skin cancer and skin burns

Today, the most important studies about radiation are being carried out in the field of health. In this case, the health staff's attitudes towards radiation are very important both for the health of the employees and the patients. Applications such as Radiological Tests, PET (Positron Emission Tomography), CT (Computerized Tomography), X-ray, Angio, ECG (Electrocardiography), etc. are not applied carefully and meticulously, it may cause significant health problems for both healthcare staff and patients (Elgazzar 2006). If a professional's ignorance of the radiation issue is taken into consideration, it is obvious that the radiation will become quite dangerous (Prabhat et al. 2011). However, in addition to the harms of the radiation for human health, its benefits for health cannot be ignored. Especially, radiation is being used very much in the diagnosis and treatment phase in the field of health. This suggests that individuals must have knowledge of radiation and should consciously use radiation-emitting devices. Individuals' level of knowledge about radiation will help them develop attitudes towards radiation and use radiation more consciously.

According to Prather (2005), many physics students studying radiation have the wrong perception of radioactive decay and radioactive half-life. Although many students pass this lesson's exam and graduate, there is an incorrect scheme in their minds about the radiation issue. This case prevents students from learning about radiation (Prather 2005). According to another research conducted by teachers in Kütahya province, it was noticed that teachers did not develop a positive attitude towards the concept of radiation (Yalçın et al. 2014).

According to a survey on electromagnetism, most of the students have created a false skeleton of knowledge in their minds (Prather 2005). A similar situation is encountered in Turkey (Sağlam and Millar 2006). When the correlation of students' responses to electromagnetism is examined, it is seen that inconsistent responses are given. This suggests that students have caused misconceptions and perceptions about this subject. Research around the world suggest that many people do not develop positive attitudes about radiation (Prabhat et al. 2011; Prather 2005; Karenoğulları 2014; Sağlam and Millar 2006; Kam 2005; Awosan et al. 2016; Abedallah et al. 2015; Awosan et al. 2016).

According to the research conducted in Hong Kong, healthcare staff think that patients should be informed about radiation; but it was noticed as a result of the research that, 76% of the healthcare staff did not inform the patient about the radiation (Prather 2005). Depending on the result of this research, that the healthcare staff should inform their patients is known; but the necessary attitude related to this topic does not occur. According to Kam (2005), unnecessary radiological tests and unnecessary drug use can be reduced if a positive attitude is made on the healthcare staff (Kam 2005). This preserves patients from exposure to unnecessary radiation.

In Egypt, in research on radiation knowledge and attitudes of doctors, a scale, which will reveal the personnel's knowledge of radiation and radiation awareness, applied for totally 120 doctors working at Suez Canal University. According to the results of the scale, it was determined that most of the doctors did not get any training about radiation protection. Also, it was found out that the doctors are less aware of the harmful effects of ionizing radiation. It was determined that even the radiologists and oncologists, who are most exposed to ionizing radiation, had low awareness levels of the subject as other branches. It was noticed that most of the doctors did not apply radiation protection methods. The reason for this, it was claimed that such measures were time-consuming and that it was not possible to apply them during the operation. Also, according to the data gathered by the questions, the lowest level of knowledge was that the applied radiological test was about how much radiation was given to the patient and the practitioner. This demonstrates that healthcare staff has low awareness of how relevant radiation can affect their health and the health of their patients. According to another research conducted in Northern Nigeria, it has been observed that healthcare staff had low awareness of the harmful effects of radiation and did not develop a positive attitude about this issue. In another survey on healthcare staff in northern Nigeria, it was revealed that even though they knew the harmful effects of radiation, they did not apply it (Awosan et al. 2016).

Research show (Jonassen et al. 2007) that thousands of personnel will be needed for new nuclear works in the next decade. The training program of radiation protection was conducted to train staff in the United States in line with this requirement. Because the harmful effects of the radiation used in the health field are too high to be underestimated. According to Abedallah (2015), although ionizing radiation is a serious health hazard, health staff's knowledge and awareness about radiation are very important to protect from danger. The training of healthcare staff is effective to make practices that are more reliable with radiological tests and gain awareness in this issue (Mojiri and Moghambeigi 2011). Conscious use of radiation-emitting devices by healthcare staff will seriously reduce unnecessary radiation for patients. In this context, providing necessary attitudes to radiation by healthcare staff will positively affect public health. There are few researches conducted to determine the attitudes of healthcare staff towards radiation in Turkey.

The aim of this study is to develop a scale that will determine whether there is a significant difference in the cognitive, affective and behavioral attitudes of healthcare staff towards radiation. With the scale, it is aimed to determine whether there is a significant difference in terms of the variables such as profession, gender, year of service, institution and department of work in their affective attitudes related to the effect of radiation on the own health of healthcare staff and the health of the patient, in their behavioral attitude to inform the patient related to the effects of radiation.

## METHOD

The quantitative research method was employed in this research.

***Research Group:*** Since each member included in the universe had an opportunity to enter the sample, a simple random sampling was applied. The sample was drawn without a selection from the created universe list. The universe of the research consisted of doctors, radiologists' nurses, and technicians working in the field of health in Turkey. So, the sampling of the study consisted of the determined group of healthcare staff. The steps followed during the development of the scale during the research consisted of 5 steps:

1. Creating the theoretical framework,

2. Format of the scale and creating item pool,

3. Applying to the expert opinion,

4. Pre-application and scale regulation,

5. Validity and reliability practices.

***Creating the Theoretical Framework:*** In the RASHS preparation, the theoretical framework for developing an attitude scale occurred in two stages. In the first stage, a Literature review on attitude and attitudes measurement was done before the articles related to attitude scale were written (Aiken and Aiken 1969; Blalock et al. 2008; Gardner 1975; Gauld and Hukins 1980; Hair et al. 2019; Myers and Fouts 1992; Navarro et al. 2016; Pearl 1973; Potvin and Hasni 2014). According to this knowledge, to create the item pool, firstly the literature review was done, the attitude scales in the literature and studies related to the attitude were investigated (Puri et al. 2012; Prabhat et al. 2011; Yalçın et al. 2018; Kam 2005; Abedallah et al. 2015; Lewis et al. 2009; Uzun and Sağlam 2006; Alport 1967; Bloom 1976; Boosherhriat et al. 2012; Briggs-Kamara et al. 2013; Günalp 2013; Keijzers 2010; Lee et al. 2004; Mojiri and Moghimbeigi 2011; O'Sullivan et al. 2010). In the literature review, the studies related to the attitudes of healthcare staff towards the radiation concept, their attitudes about the medical use of radiation, how sensitive were employees to their and patients' health were reviewed (Prabhat et al 2011; Prather 2005; Karenoğlu 2014; Sağlam and Millar 2006; Kam 2005; Awosan et al. 2016; Jonassen et al. 2007; Abedallah et al. 2015). In the second stage, considering the theoretical structure related to the attitude and topics related to this theoretical structure, a data collection tool for test purpose was prepared according to the findings gathered as a result of the literature review. The scale was applied for healthcare staff, who were having the form of education in a faculty of education, consulting the experts' opinions at a faculty of education. Scale codes were generated using the results of the data collection tool. A 5-point Likert-type scale was developed using the generated codes.

At the end of the RASHS preparation studies, the RASHS draft form - consisting of 49 items - was created after changes and additions according to the expert opinions and suggestions. While the highest score that can be taken from the scale, developed according to the 5-point Likert-type, is 245, the lowest score is 49. 47 items in the scale are positive 2 of them are negative. The draft scale was published in the web-page of TÜMRAD-DER and all the stakeholders were given the opportunity to be included. The data gathered from the scale shared on-line were collected voluntarily with the participation of 118 healthcare staff. The data were analyzed with the statistics Programme. According to the feedback, some arrangements related to the language, expression and general structure of the scale were done. In determining the validity and reliability of the RASHS, the exploratory factor analysis, Cronbach Alpha reliability coefficient, item analysis based on correlation were calculated. The exploratory factor analysis was done for the structural validity and to decide the items that should be included in the scale. Confirmatory factor analysis was applied to verify the dimensions revealed by exploratory factor analysis and to test the validity and reliability of the measurement model. The data, reached at the end of the statistical analysis, were subjected to expert opinion in each stage. According to the statistical data and experts' suggestions, the scale consisting of 18 items in Likert-type was formed.

For the research, the decision of "conducting the research ethically" was taken by Erzincan Binali Yıldırım University, Human Research Ethics Committee on 27th April 2017, and protocol number 03/10. This prepared scale was applied considering the voluntariness to the healthcare staff participating in the 10th National Radiology Technicians Congress and Breast Radiology Symposium and to the participants by publishing online on the web page of the TÜMRAD-DER. Some of the scales were applied to the healthcare staff in different hospitals in Turkey with face-to-face interviews.

***Format of the Scale:*** 49-item "Attitude scale for radiation concept by healthcare staff "scale form was prepared after the changes and additions made in line with all opinions and suggestions as a result of the RASHS development studies. There were items, which would measure the attitudes of healthcare staff related to their knowledge about the radiation concept and the effects of radiation on the scale. There are 5 options on the scale as entirely disagree, do not agree, not decided, agree, entirely agree. While entirely disagree was scored as 5; do not agree 4; not decided 3; agree 2; entirely agree 1, inverse items on the scale scored from 1 to 5. While the highest score on the scale that could be taken was 245, the lowest score was 49. 47 items of 49 on the scale were positive and 2 of them were negative. There were two sub-dimensions on the scale as radiation information and sensitivity. The scale was published online on the TÜMRAD-DER web-page and all stakeholders were allowed to participate. The data collected from the online scale were collected based on volunteerism with the participation of 115 healthcare staff. The data obtained from the scale were analyzed by the statistics program and the final form of the scale was prepared. In the entrance part of the scale, general information about the scale was given to inform the participants that they would be filled voluntarily, their personal information would not be included, and if they wanted to give up, they could leave without saving.

***Applying to the Expert Opinion:*** Expert opinion was applied to determine whether 49 items stated in the RASHS prepared as a test form were enough to find out the healthcare staff's attitudes about the radiation concept or not. According to this case, some arrangements on the items of the scale were carried considering the opinions from the experts from the Atomic Energy Agency, educators working in the field of education in a teaching and research faculty at the Department of Nuclear Medicine and Radiology and a faculty of education.

***Pre-application and Scale Regulation:*** The RASHS was delivered to the healthcare staff in various provinces of Turkey through the internet and their participation in the scale was provided. After the handled feedbacks, arrangements were ensured related to the language, expression, and general structure of the scale.

***Validity and Reliability Studies:*** In determining the validity and reliability of the developed RASHS, the exploratory factor analysis, Cronbach's Alpha reliability coefficient, correlation-based item analysis calculations were used, and expert opinion was applied. Because one of the logical ways to test the validity of a scale is to consult an expert view. The expectation from experts is that the items in the test form should be evaluated in terms of content validity [30]. Therefore, the scale prepared through the views of the experts from the Atomic Energy Institution, the members of the teaching staff working in the field of the Nuclear Medicine and Radiology Department of an educational research hospital and the academicians working in the education faculty and arrangements were done according to these views.

To what extent the items of the scale are compatible with the theoretical framework is expressed by the structural validity. Exploratory factor analysis was performed to determine the structural validity and the items that should be found on the scale. Also, Cronbach's Alpha was calculated, and internal consistency reliability of the scale was determined. By calculating item-total correlation values, the validity of the items was calculated by revealing the level of the relationship between an item, and the total. Data and values related to the validity and reliability calculations were indicated in the findings section.

## FINDINGS

Irrelevant items in the applied scale were corrected and the analysis process was constituted with the statistical program. As a result of the analyses, the analysis was started with a total of 49 items. In the first analysis, the significance value of the items was found as low (sig.=0,001). As the Q-Q plot graph was analyzed, since the data results of the 3 people, who were applied by the scale, demonstrated large deviation from the normal distribution, the data related to those participants, who were applied to the scale, were excluded from the analysis and normal distribution was provided (sig.=0,2).

The reliability value is an indicator of the degree to which a measuring tool gives the same result in repeated measurements. Although the items prepared for the scale are prepared by experts, it is possible to raise questions that will decrease reliability. For example, cases that have the same meaning for everyone in a particular culture can be understood differently in another culture. To prevent such misunderstandings, the scale is first subjected to reliability analysis.

One of the methods applied to test the reliability is to test the internal consistency. In determining the internal consistency of the scale Kuder & Richardson 20, 21 (KR20, 21) and Cronbach's Alpha methods are commonly applied. As our scale is a Likert-type scale the Cronbach's Alpha method is used (Cronbach's alpha coefficient differs between the values of 0 and 1). A negative value is an indication that the scale does not measure similar properties. A low alpha value indicates that the test is not homogeneous (it measures several properties together). The best value for Cronbach's alpha is that it is greater than 0.80. According to Peterson, the Cronbach Alpha coefficient is expected to be higher than 0,70 (Peterson, 1994).

***Table 1.*** *Reliability statistics table*

| Cronbach's Alpha | N of Items |
|---|---|
| .895 | 49 |

In the first analysis of reliability, the Cronbach's Alpha coefficient for the 49 items was found as 0.895. As this value was over 0.70, the internal consistency of our test was suitable. As a result of the initial reliability analysis, items with low correlations with the total item were omitted from the scale. As a result of this, 15 items were omitted from the scale as 1, 2, 4, 5, 7, 8, 10, 12, 15, 23, 24, 30, 31, 32, 37 numbered items. Item 34 (I think that a prophylaxis test should be performed against the risk of anaphylactic shock before applying the PET to the patient) is formerly accepted as a significant question for radiation information by experts. However, it was stated that this test (prophylaxis test) had never been applied in practice by individuals who applied the data collection tool during application events. So, considering these expressions of the participants in the study group, as a result of the interviews with the radiology specialists and radiology technicians of the relevant services in the hospital, it was concluded that the item should be omitted from the scale and item 34 was omitted. After omitting the items from the scale, the second reliability analysis was performed. As a result of the second reliability analysis result, the Cronbach's alpha coefficient was found as 0.914. This proved that the inner consistency of the scale was quite positive (Brendan 2014).

Another method to test the internal consistency is to consider the relationship between the items and the total. The data related to this measurement is presented in Table 2 in the reliability analysis result table according to the Alpha model.

***Table 2.*** *Reliability analysis result table according to the Alpha model*

| Item-Total Statistics | | | | |
|---|---|---|---|---|
| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
| Item 3 | 140.91 | 236.659 | .315 | .918 |
| Item 6 | 141.25 | 232.964 | .356 | .918 |
| Item 9 | 141.00 | 231.514 | .508 | .916 |
| Item 11 | 140.79 | 235.864 | .373 | .917 |
| Item 13 | 141.18 | 229.734 | .462 | .916 |

| | | | | |
|---|---|---|---|---|
| Item 14 | 141.13 | 234.561 | .323 | .918 |
| Item 16 | 140.95 | 232.628 | .484 | .916 |
| Item 17 | 141.34 | 227.127 | .544 | .915 |
| Item 18 | 141.03 | 233.972 | .365 | .917 |
| Item 19 | 141.47 | 228.828 | .521 | .915 |
| Item 20 | 141.48 | 226.342 | .533 | .915 |
| Item 21 | 141.16 | 228.641 | .563 | .915 |
| Item 22 | 141.35 | 227.652 | .627 | .914 |
| Item 25 | 141.46 | 227.782 | .544 | .915 |
| Item 26 | 141.22 | 231.580 | .450 | .916 |
| Item 27 | 140.85 | 236.382 | .326 | .918 |
| Item 28 | 141.38 | 226.617 | .529 | .915 |
| Item 29 | 141.10 | 227.783 | .567 | .915 |
| Item 33 | 141.29 | 227.381 | .542 | .915 |
| Item 35 | 141.41 | 222.839 | .658 | .913 |
| Item 36 | 141.41 | 224.532 | .631 | .914 |
| Item 38 | 141.21 | 226.963 | .601 | .914 |
| Item 39 | 140.96 | 232.241 | .542 | .915 |
| Item 40 | 141.21 | 229.323 | .487 | .916 |
| Item 41 | 141.27 | 229.009 | .474 | .916 |
| Item 42 | 141.50 | 229.423 | .423 | .917 |
| Item 43 | 141.01 | 232.640 | .547 | .916 |
| Item 44 | 141.32 | 229.824 | .446 | .916 |
| Item 45 | 140.84 | 236.839 | .359 | .917 |
| Item 46 | 140.91 | 236.352 | .323 | .918 |
| Item 47 | 140.90 | 236.378 | .377 | .917 |
| Item 48 | 141.43 | 233.148 | .324 | .918 |
| Item 49 | 141.22 | 227.148 | .543 | .915 |

The correlation of the items with the total in the scale should be above 0,5 (Field 2006). As Table 2 is analyzed, it is seen that there is not an item with a low correlation value as a result of the re-reliability test. Also, it is expected that the correlations between the expressions should also be higher than 0.3; yet above 0.4 is recommended (Mc Honey 1994; Eisen et al. 1979). As the Corrected Item Total Correlation value in the Table is analyzed, it is observed that there is no problematic item below the value 0.3.

After the reliability study, the explanatory factor analysis was performed to examine whether the original of the scale was a four-factor dimension and whether the items obtained were distributed similarly to the distribution of the scale. There are several criteria for applying factor analysis to a data set. The first is related to the sample size. The sample size is an important criterion in terms of factor analysis results being generalizable and showing a steady state.

The Kaiser-Meyer-Olkin (KMO) test to find out whether the factor analysis of the data is applicable or not and the Bartlett test to understand whether there is a meaningful difference between the variables to be analyzed or not and different from zero were applied and the findings are presented in Table 3.

***Table 3.*** *KMO and Barlett Test Table*

| | | |
|---|---|---|
| **Kaiser-Meyer-Olkin Measure of Sampling Adequacy.** | | **.806** |
| **Bartlett's Test of Sphericity** | Approx. Chi-Square | 1854.810 |
| | df | 561 |
| | Sig. | .000 |

As Table 3 is analyzed, it is seen that the KMO coefficient is 0.806. This value is expected to be equal to 0.70 or bigger than this rate (Leech et al. 2005). This finding suggests that the sample size is appropriate for factor analysis. Furthermore, it is seen from Table 3 that the Chi-square value related to the Barlett test is meaningful at the level of $p<0.05$. This finding demonstrates that the exploratory factor analysis can be applied to the scale.

Before starting the factor analysis, the correlations between the expressions should also be considered. If the correlation matrix between expressions is examined visually, if the value is not more than 0.30 or it is very low, the data set is probably not suitable for the analysis. Also, the partial correlation between variables should be considered. If there are factors that we can call real in the data set, a partial correlation in this data will be expected as low. Because variables will be expressed by a load of those variables on the factor. High partial correlation means there are no underlying factors, which invalidates our analysis. If the partial correlation is 0.7 and above, factor analysis will not give accurate results.

Communality (common variance) is the amount of variance that variable shares with other variables in the analysis. In other words, it shows whether the variables in the scale are suitable for factor analysis or not. In factor analysis, variables that have low common variance (for example below 0.50) are omitted from the analysis one by one and analyzed again, and item variances are reviewed again. Based on these data, the data obtained as a result of the analysis made over 33 items are given in Table 4.

***Table 4.*** *Commonalities Values Table*

| **Communalities** | | |
|---|---|---|
| | Initial | Extraction |
| Item 3 | 1.000 | .518 |
| Item 6 | 1.000 | .730 |
| Item 9 | 1.000 | .678 |
| Item 11 | 1.000 | .577 |
| Item 13 | 1.000 | .626 |
| Item 14 | 1.000 | .705 |
| Item 6 | 1.000 | .725 |
| Item 7 | 1.000 | .813 |
| Item 18 | 1.000 | .482 |

| | | |
|---|---|---|
| Item 19 | 1.000 | .692 |
| Item 20 | 1.000 | .746 |
| Item 21 | 1.000 | .637 |
| Item 22 | 1.000 | .701 |
| Item 25 | 1.000 | .718 |
| Item 26 | 1.000 | .781 |
| Item 27 | 1.000 | .699 |
| Item 28 | 1.000 | .548 |
| Item 29 | 1.000 | .636 |
| Item 33 | 1.000 | .747 |
| Item 35 | 1.000 | .737 |
| Item 36 | 1.000 | .678 |
| Item 38 | 1.000 | .732 |
| Item 39 | 1.000 | .585 |
| Item 40 | 1.000 | .761 |
| Item 41 | 1.000 | .616 |
| Item 42 | 1.000 | .655 |
| Item 43 | 1.000 | .717 |
| Item 44 | 1.000 | .683 |
| Item 45 | 1.000 | .448 |
| Item 46 | 1.000 | .612 |
| Item 47 | 1.000 | .719 |
| Item 48 | 1.000 | .630 |
| Item 49 | 1.000 | .719 |

As rates of explanation of the variance of the items in a common factor are analyzed in Table 4, it was observed that all substances were not problematic since their extraction values were greater than 0.30. That is, extraction means that every item above 0.30 makes a positive contribution to the scale. When Figure 1 Scree Plot chart drawn in case of factor distribution of the scale is analyzed, it is seen that the scale continues horizontally after 4th factor, and distribution of scale according to four factors was examined

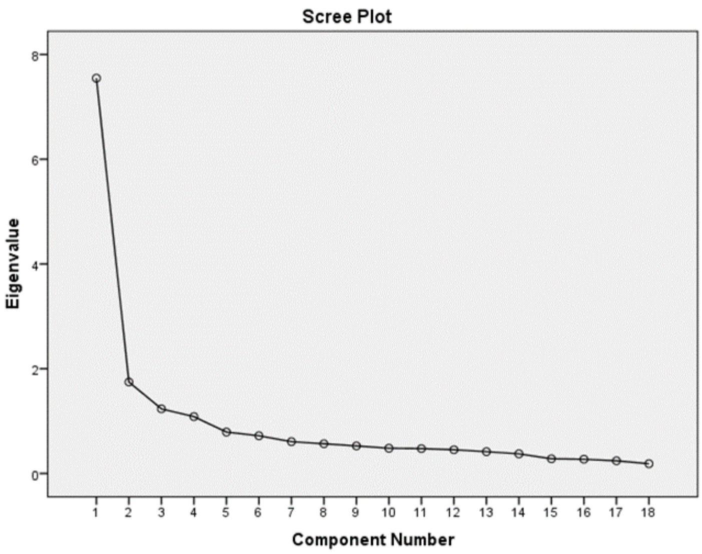


***Figure 1.*** *Slope Chart*

When the four-factor distribution structure and commonalities values of the scale were examined, two items with an item value below 0.50 were removed from the scale, and analyses were performed. As the Scree plot chart is examined for the scale consisting of the remaining 18 items, it is understood that the scale shows a four-factor structure. Factor-load analysis results for the 4-factor structure are given in Table 5.

***Table 5.*** *Total variance explained table for four-factored structure analysis*

| Component | **Initial Eigen Values** | | | **Extraction Sums of Squared Loadings** | | | **Rotation Sums of Squared Loadings** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| Factor 1 | 7.547 | 41.930 | 41.930 | 7.547 | 41.930 | 41.930 | 4.110 | 22.831 | 22.831 |
| Factor 2 | 1.746 | 9.699 | 51.630 | 1.746 | 9.699 | 51.630 | 2.746 | 15.255 | 38.085 |
| Factor 3 | 1.234 | 6.856 | 58.486 | 1.234 | 6.856 | 58.486 | 2.605 | 14.475 | 52.560 |
| Factor 4 | 1.085 | 6.029 | 64.515 | 1.085 | 6.029 | 64.515 | 2.152 | 11.955 | 64.515 |

Table 5 shows what percentage of the total variance is reflected in the data set by the factors determined. Four factors with Eigenvalues greater than 1 were determined as a result of the analysis. As Table 5 is analyzed, it is seen that the 1st factor measures the case we measure at 22.83%; 2nd factor at 15.25%; 3rd factor at 14.11%; 4th factor at 11.95%. In this survey consisting of 4 factors, it is seen that there are four factors with an Eigenvalue above 1 and the four-factor structure explains 64.5% of the total variance.

A rotated factor matrix was performed to identify and easily interpret items that have a high relationship with the factors.Factor loads show the relative importance of each item in every factor. In other words, it is a coefficient that explains the relation of the items with the factors.

As a result of the factor load analysis, which was made by considering the correlation relationship over 33 items, the items numbered 3, 6, 9, 11, 14, 18, 21, 26, 27, 28, 29, 41, 42, 45 and 48 were removed from the scale and a scale of 18 items was obtained. The rotated factor matrix is applied to understand which items will be grouped under which factor for the obtained scales. Table 6 shows which factor the variables in the 4 factors resulting from the analysis are distributed.

***Table 6.*** *Rotated Factor Matrix*

| | **Component** | | | | |
|---|---|---|---|---|---|
| | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Cronbach Alpha Level |
| 44 | .794 | | | | .885 |
| 47 | .774 | | | | |
| 46 | .771 | | | | |
| 43 | .766 | | | | |
| 40 | .651 | | | | |
| 49 | .612 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 39 | .599 | | | | |
| 13 | | .781 | | | .764 |
| 19 | | .666 | | | |
| 16 | | .655 | | | |
| 22 | | .551 | | | |
| 36 | | | .703 | | .742 |
| 33 | | | .657 | | |
| 38 | | | .621 | | |
| 25 | | | .561 | | |
| 17 | | | | .721 | .765 |
| 35 | | | | .682 | |
| 20 | | | | .554 | |

As the items distributed on the first factor were analyzed by experts, this item was called "Radiation Information of the Practitioner" (RIP) since items related to the radiation concept of the practitioner and radiological tests were collected. As the items distributed to the second factor were analyzed, this factor was named "Radiation Sensitivity of the Practitioner" (RSP) since the items measuring the sensitivity and the importance given by the practitioner in the scale were distributed. When the items distributed to the third factor were examined, this factor was named as "Practitioner's Sensitivity to the Patient" (PSP) because the items measure the sensitivity of the practitioner to the radiation to be exposed to the patient and its results. When the items distributed in the fourth factor are analyzed, all the items included in this factor are determined as "Informing Patient by Practitioner" (IPP) since the practitioner applies information related to the patient when they apply the test and the test applied, such as the amount of radiation to be exposed to the patient, and the measures to be taken after the test. Accordingly, a scale of 18 items was obtained, 7 items in the first factor, 4 items in the second factor, 4 items in the third factor, and 3 items in the fourth factor.

Confirmatory factor analysis is a multivariate technique used to test a predetermined relationship (Hair et al., 1998). Confirmatory factor analysis was performed on the four-factor structure obtained as a result of the analyses. The confirmatory factor analysis model of the Radiation Attitude Scale for Healthcare staff is given in Figure 2.

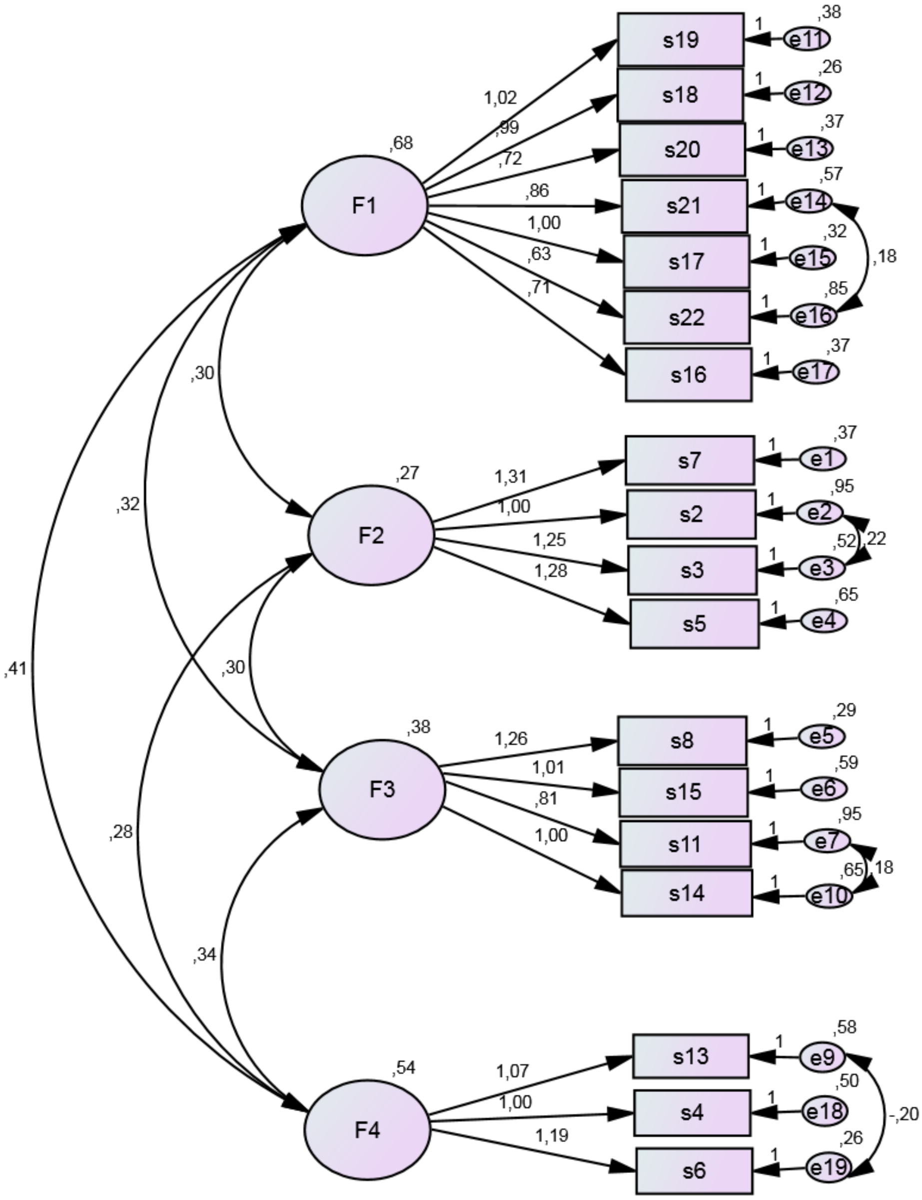


***Figure 2.*** *Confirmatory factor analysis model of radiation attitude scale for healthcare staff*

The pattern chart of the scale is given in Figure 2. When the correlation between the RIP (F1), RSP (F2), PSP (F3) and IPP (F4) subscales of the Radiation Attitude Scale for Healthcare Staff is examined, it is seen that it was actualized at 0.30 between RIP and RSP sub-factors, 0.32 between RIP and PSP factors, 0.41 between RIP and IPP factors, 0.30 between RSP and PSP factors, 0.34 between PSP and IPP factors, and at 0.28 between RSP and IPP factors. According to Bagozzi (1981a), for each dimension to exist alone in a structure, the dimensions must have a moderate correlation with each other (Bagozzi (1981a). Accordingly, the sub-dimensions of the Radiation Attitude Scale for Healthcare Staff, it is seen that the correlation level between RIP, RSP, PSP, IPP sub-factors fulfils this requirement. The sub-dimensions of the scale have a moderate correlation. Factor loads related to the items are shown on one-way arrows from the dimensions of the scale to the scale items.

The fit indices calculated as a result of the confirmatory factor analysis within the framework of the validity studies of the Radiation Attitude Scale for Healthcare Professionals are given in Table 4.

***Table 7.*** *The table of fit indices calculated as a result of confirmatory factor analysis within the framework of validity studies of Radiation Attitude Scale for Healthcare Staff*

| Fit Indices | Good fit | Acceptable Fit | Advised Model |
|---|---|---|---|
| RMSEA | *0<RMSEA<0.05* | 0,05≤RMSEA≤0.10 | 0.076 |
| NFI | 0.95≤NFI≤1 | 0.80≤NFI≤0.95 | 0.863 |
| CFI | 0.97≤CFI≤1 | 0.85≤CFI≤0.97 | 0.916 |
| IFI | 0.95≤IFI≤0.85 | 0.85≤IFI≤0.95 | 0.918 |
| TLI | 0.90≤TLI≤0.85 | 0.85≤TLI≤0.9 | 0.917 |
| AGFI | | | 0.840 |
| χ2/df | 0<χ2/df<3 | | 293.130/125=2.345 |

The χ2 value is the value that tests the statistical suitability of the model and the sample analyzed in the confirmatory factor analysis (Schumacker and Lomax 2004). This value tests whether the population's covariance matrix is equal to the covariance matrix applied in the model. However, since the χ2 value is sensitive to the sample size and will be reached high χ2 values in multi-element samples, it is more appropriate to use χ2 / df value corrected with the degree of freedom (df) (Bagozzi 1981b). The χ2 / df value reached in this study was found as 2,345. This result indicates that the model is statistically significant (Bagozzi 1981b). Also, according to the consistency goodness index given in Table 7, the TLI value is in the border of good (Root Mean Square Error of Approximation= RMSEA) RMSEA, NFI, the Comparative Fit Index, CFI, and IFI values are near the limits of acceptable fit. This indicates that the dimensions obtained as a result of the explanatory factor analysis for the study were confirmed as a result of the confirmatory factor analysis.

## RESULTS AND DISCUSSION

In this study, an attitude scale was developed to determine the attitudes of the healthcare staff in Turkeys including doctors, radiologist, technicians, and nurses related to the radiation concept considering the variables of the profession, gender, year of service, institution, and branches, and the findings gathered from the developed scale were analyzed. The scale will determine whether the radiation used in the field of health is used consciously, whether the employees take into account the effects of radiation on human health, and how they have an attitude towards taking precautions against the radiation that they and the patients will be exposed to. This scale provides the opportunity to analyze healthcare staff's attitudes towards radiation in terms of emotion, thought, and behavior dimension.

In this scale obtained, the scale consisted of a total of 18 items including 7 items in the first factor, 4 items in the second factor, 4 items in the third factor, and 3 items in the fourth factor. In a similar study, a scale with 4 factors and 25 questions was developed to measure the attitudes of nurses working in the emergency medical department in Japan towards radiation (Noto et al. 2014). Four factors consisting of 25 items were determined as "confidence in knowledge and skills", "psychological resistance", "responsibility as a medical expert" and "interest in radiation emergency medicine". The attitudes and attitudes measured by the factors coincide with the scale we have created.

The data obtained as a result of the RASHS prepared to determine the attitude of the staff will be analyzed, whether positive attitude about the radiation concept has been developed, if not, it will contribute to the identification of the source of the problem and the solution. As Jonassen et al. (2007) suggest in their study, especially in the field of medicine, increasing nuclear and radiological studies create a need for conscious health personnel today. The positive attitude of the staff in the field of nuclear medicine and radiology is of great importance for both the society and the health of the staff themselves. It is expected that the scale developed in this study will contribute to the healthcare staff's professional life to behave more sensitively to the harmful effects of radiation. In the study conducted by Kam (2005), it is suggested that if a positive attitude can be formed on healthcare staff regarding radiation, unnecessary radiological tests and unnecessary drug use can be reduced. As a result of the study (Kam 2005). Rahman et al. (2008) on cardiologists, it is emphasized that there are alarming deficiencies in the knowledge and practice of the use of radiation in medicine by cardiologists. On the basis of these deficiencies, it is argued that the lack of formal radiation education was the biggest factor. In addition, it was found in the study that, depending on the year of service in the field of cardiology, the rate of correct answers by the more experienced workers about the use of radiation and the effects of radiation was higher than the rate of answers by less experienced workers (Rahman et al. 2008). According to another study carried with the healthcare staff in Hong Kong, the staff think that patients should be informed about radiation; however, it was noticed that 76 % of them had not informed the patient about the radiation (Prather 2005). Several researches conducted abroad suggest that healthcare staff were largely unable to develop a positive attitude about the negative effects of radiation on both their own and patient health (Kam 2005; Güdük 2018; Rahman et al. 2008; Balsak 2014). In some studies, it was found that there was a lack of knowledge among medical students, doctors, paramedics, and dentists about their understanding of ionizing radiation or the use of equipment involved in the process (Shiralkar et al. 2003; Finestone et al. 2003; Correia et al. 2005; Soye and Paterson 2008).

In the study by Jonassen et al. (2007), training programs were arranged to train radiation protection personnel, provided suggestions such as in-service training and awareness-raising works (brochures, information booklets, direction signs, etc.) to raise the awareness of the staff.

## Ethical Statement

For the research, the decision of "conducting the research ethically" was taken by Erzincan Binali Yıldırım University, Human Research Ethics Committee dated 27.04.2017 and protocol number 03/10.

## Consent Statement

For the research done, Erzincan Binali Yıldırım University, for the decision of the Human Research Ethics Committee dated 27.04.2017 and numbered 03/10 protocol, LIGHTED CONSENT FORM was approved for each individual participating in the research.

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