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Investigation on recognition of radiation safety pictogram in the life

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Abstract: Since the accident of Fukushima Nuclear Power plant in 2011, people have been more interested in radiation safety in life. This study investigated the level of exact recognition of 6 warning pictograms enacted and utilized as per Korea Industrial Regulation in relation to medical & natural radiation safety at this time. Unless people recognize pictogram prepared for radiation safety correctly in accordance with its purpose, safety would be severely intimidated. The result of corroboratively analyzing recognition of radiation safety pictogram is as follows. First, some 63.3% of respondents negatively responded on understanding 6 pictograms related to radiation in life, showing low level of understanding. Second, the average mark of correct response on the questions asking the meaning of 6 pictograms presented in relation to radiation safety in life was 2.79 point (standard deviation 1.447 point), which was relatively low. As seen above, the level of recognition & comprehension is low, because education related to life radiation safety in the school is insufficient and the present warning pictogram established by Korea Industrial Regulation needs to be revised & supplemented. This study is meaningful in that the method of using pictogram is presented as one of diverse efforts to improve life radiation safety.

Keywords: radiation; pictogram; safety; Korea

1. Introduction

We are inadvertently exposed to radiation in daily life. Generally, radiation is composed of natural radiation which is naturally generated from all materials on the earth and artificial radiation which is artificially generated by human for specific purpose. In general, artificial radiation is relatively thoroughly managed as its danger is well known since it is regulated by Nuclear Safety Law and overall rules [5] (Lee, 2020). While natural radiation is extensively prevalent in life and thus closely exists in life, people is excessively exposed to unnecessary radiation in daily life in the pretext that the radiation is natural. As a result, their health is threatened and damaged.

Although managing & regulating natural radiation may be deemed meaningless, considerable part of radiation exposed in the air is natural radiation. Especially, life necessities which make users inadvertently exposed to radiation in life, namely, stone plate of some thermal bed, health bracelet or necklace and wallpaper or pillow [7] or people staying in subway station with high radon concentration for long time are the typical example of exposition to radiation in life. In this context, 'Radiation Safety Law' was enacted on July 25, 2011 to protect people and environment from radiation in life [6]. Notwithstanding, safety control against materials which emit natural radiation & radiation in peripheral life area is still insufficient. As a result, study by Yoon [15] who recognized danger of harmful chemical including radioactive material that is contained in life necessities used in daily life and presented the necessity of prophylactic prevention has carried on study.

However, it seems that safety control of radiation emitting materials in life is not still changed remarkably. Originally, safety is 'comfortable state where human are at ease with no anxiety over the possibility of bad result on their welfare without any intimidation of their existence' [13]. Since the catastrophe of Sewol Ho, Korea, more alert for safety,

prepared 'life-cycle safety education' propulsion plan which presented safety education requirement necessary for personal safety capability required from infants to old men in each life cycle and 7 main standard plans of school safety education composed of 25 medium classifications & 56 minor classifications in 2016 [14]. However, safety is further threatened in life and safety is more requested as life quality is heightened. Relatively, people are less sensitive to safety in whole society, showing low sense of safety [12].

Moreover, contents related to radiation safety in life are not in standard program of prepared safety education. Meanwhile, pictogram of diverse public facilities such as toilet, restaurant, subway, etc. were also established and already used in Korea as KS for national safety. Public information pictogram was defined as 'picture signal composed to deliver the message to public' [1]. In Korea Standard Information Network, pictogram in 6 categories related to facilities and 5 categories related to safety (coercive behavior, warning, prohibition, emergency · evacuation route, firefighting equipment) is prepared. As one of communication methods, pictogram is known to be effective supplemental & alternative communication method not only for those without handicap but also those with disorder in communication [9].

Thus, while safety against radiation in life is more requested above all, the character or use of pictogram related to safety prepared for radiation safety is different from that of pictogram for public facilities or event. So, management based on regulation is required & the delivery of exact meaning is more significant than originality [8].

Unless such pictogram is understood and recognized to the purpose of nation, however, national health will be damaged. Thus, we are to analyze the level of exact recognition of warning pictogram related to medical & natural radiation safety. To this end, out of warning pictogram presented in national standard information network, the present situation is to be grasped by investigating recognition of 6 pictograms related to radiation safety, improvement point is to be drawn out through statistical analysis and the necessity of radiation safety education is to be suggested.

The introduction should briefly place the study in a broad context and highlight why it is important. It should define the purpose of the work and its significance. The current state of the research field should be carefully reviewed, and key publications cited. Please highlight controversial and diverging hypotheses when necessary. Finally, briefly mention the main aim of the work and highlight the principal conclusions. As far as possible, please keep the introduction comprehensible to scientists outside your field of research. References should be numbered in order of appearance and indicated by a numeral or numerals in square brackets—e.g., [1] or [2,3], or [4–6]. See the end of the document for further details on references.

2. Materials and Methods

2.1 Pictogram outline

As the typical form of graphic symbol, pictogram refers to picture language which transmits its meaning & concept by using the intended shape. Pictogram is the product of modern age created to remove the inconvenience to overcome diverse languages [16]. To paraphrase, *picto* means picture and *gram* means message as seen in telegram. Pictogram refers to overall signal described in picture. This pictogram is rapidly propagated and developed as consistent communication mean in modern society where faster & more exact communication is required. The portion of pictogram is increasing day by day [11]. Pictogram has 3 functions, guide (notice), order and symbol. The function of guide is arrow which basically indicates direction, direction on road sign, guide of facilities. As function that leads behavior, function of order is used in the form of diverse road sign, prohibition sign, danger sign, etc. It indicates rule or act that should be observed by people. The function of symbol is quality-related indication, mathematical mark such as addition, subtraction in math, note in music & geographical symbol indicating state & division of land [10]. Recognition of pictogram having such diverse functions is studied in several areas,

namely, Olympic pictogram trend [3], Expo pictogram design recognition [16] & familiarity of pictogram related to facilities [9].

2.2 Study object & materials collection

Referring to preceding study which investigated pictogram recognition [10], diverse ages from those under 20s' to those over 50s' were taken as object Investigation term was for 3 months from Jan 2 to Mar 31, 2020. Some 200 respondents living in Jeollabukdo (mainly in Jeonju-si) were chosen by convenience sampling and collected by self-indication method [2].

2.3 Composition of questions

Questions are composed of 2 large areas. As seen in <Figure 1>, one asks recognition of pictogram related to radiation and the other comprises questions which ask demographic and statistical matters. Demographic and statistical matters comprise questions on gender & age and comprehensibility of pictogram related to radiation, aptitude and questions asking preliminary knowledge on radiation.

★ The following figure is internationally designated warning pictogram in relation to radiation. Please choose one number out of those in the right part about its meaning.







			Sample
			① optical radiation ② laser beam ③ Biohazard ④ Radioactive material/Ionizing radiation ⑤ magnetic field ⑥ Non-ionizing radiation
P1:	P2:	P3:	
			
P4:	P5:	P6:	

Figure 1. Questions to measure recognition of pictogram related to radiation

2.4 Ethical consideration and tools for statistical analysis

To protect respondents, this study informs those willing to respond the purpose of study, confidentiality, no risk in stopping response, right to stop response at their own will and gets their consent to collect materials before collecting materials & investigation. investigation time was about 5 minutes and some money were paid to respondents as token of gratitude. Meanwhile the collected materials were input into Excel and unreliable response was ruled out through preliminary processing. Statistical analysis was done by using IBM SPSS25 [4]. The property of demographic and statistical matters was grasped by using technical & statistical analysis. For pictogram recognition related to radiation, independent sample t-test, analysis of variance & correlation, regression analysis, etc. were utilized to see whether total mark is different.

3. Results

3.1 Technical statistics

As seen in <Table 1>, out of 199 total respondents 74 male (37.2%) and 125 females (62.8%) responded. When it comes to age, those below 30s' are 75(37.7%), showing the most response and 30s' (24.6%), over 50s' (23.1%) and 40s' (14.6%). Concerning the level of understanding 6 pictograms related to life radiation presented in <Figure 1>, 63.3% responded negatively and merely 6.0% responded affirmatively. Thus, it is found that people do not easily understand pictogram relate to life radiation established and currently utilized by KS. Further, concerning the propriety, negative response is 55.8%, which is nearly 5 times of affirmative response in 11.6%. In questions asking knowledge related to radiation safety in life, the rate of choosing radon (Rn) as answer was only 42.2%, less than half, implying that the danger of radon gas was not aware.

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

Variable		Number (%)
Gender	male	74 (37.2)
	female	125 (62.8)
Age	under 29	75 (37.7)
	30 ~ 39	49 (24.6)
	40 ~ 49	29 (14.6)
	over 50	46 (23.1)
Understanding	very not so	35 (17.6)
	not so	91 (45.7)
	average	61 (30.7)
	yes	12 (6.0)
Properness	very not so	24 (12.1)
	Not so	87 (43.7)
	average	65 (32.7)
	yes	20 (10.1)
	really yes	3 (1.5)
Exposure	CO ₂	40 (20.1)
	CO	47 (23.6)
	Rn	84 (42.2)
	N	16 (8.0)
	SO	12 (6.0)

Table 1. Demographic & technical statistics on the level of comprehension and aptitude

3.2 Comparison of average

As seen in <Table 2>, the average mark of right understanding & responding to questions asking the meaning of 6 pictograms presented in <Figure 1> was 2.79 points and

standard deviation was 1.447 points. Concerning right answer rate for each pictogram, magnetic field(P6) is highest (87.9%), followed by radioactive materials(P1) in 67.3% and non-ionized radiation(P3) in 16.1%. Pictogram of magnetic field & radioactive materials was easily understood because pictogram of magnetic field was image of magnet and radioactive materials/ionized radiation could be relatively seen in medical institutions.

	N	min.	max.	mean	s.d.
score	199	0	6	2.79	1.447

Table 2. Mark of rating the level of understanding

	P1	P2	P3	P4	P5	P6
Rate of right answer	67.3	51.3	16.1	30.7	29.1	87.9

Table 3. Rate of right answer for each pictogram (%)

Implementing independent t-test to see whether there is statistically significant difference in the mark of right answer for each gender, it is found that the difference in mark between male & female is statistically significant in the level of 5% as seen in <Table 4>, while Levene's equal variance was not satisfied ($p=0.044$). Namely, male's mark of right answer is found to be significantly higher than that of female.

Gender	Mean	s.d.	t	p-value
male	3.22	1.616	3.056	0.003 < 0.05
female	2.54	1.280		

Table 4. Comparison of average of score in gender

Age	Group 1	Group 2	F	p-value
over 50	2.41		2.297	0.079
40 ~ 49	2.59			
30 ~ 39	2.84			
under 29		3.07		

Table 5. Difference on the score of right answer in each age

Analysis of variance was carried on seeing whether there is significantly difference on the score of right answer in each age, the result is in <Table 5>. Although it is not statistically significant in statistical level of 5%, Duncan's post-hoc analysis showed no difference between 20s' group and group over 50s'.

3.3 Correlation analysis & regression analysis

Correlation analysis was carried on seeing score of right response to question on the meaning of 6 pictograms presented in <Figure 1> and whether there is statistically significant correlation between the level of understanding & properness on these pictograms. As seen in <Table6>, there was statistically significant relation at significant level of 5% between score & properness. Namely, it is found that the respondents who correctly knew the meaning of pictogram properly judged. Further Pearson's correlation coefficient between understanding & properness was 0.577, which was relatively high, implying that higher understanding is evaluated to higher properness.

Simple linear regression analysis was carried on constructing statistical model which can predict properness by using the level of understanding, thereby acquiring <Table 7>. As p-value is $0.000 < 0.05$, model is statistically significant in the significant level of 5% and explanation power is found to be 0.333.

	Score	Understanding	Properness
score	-	0.126 (0.077)	0.164 (0.021 < 0.05)
understanding		-	0.577 (0.000 < 0.05)
properness			-

Table 6. Pearson's correlation coefficient (significant level=0.05)

	B	p-value	R-square
constant	1.041	0.000	0.333
understanding	0.627		

Table 7. Regression analysis

4. Conclusions

Existing before being peacefully used by human, radiation has been in our life from time immemorial. In addition to medical radiation receiving in the process of treatment, human receive natural radiation from soil, air, food, cosmos, etc. in daily life. Like this, radiation is one of energies we always contact in environment of daily life. If exposed to such radiation, we are biologically affected depending on the level of exposure, namely, change, damage, harm, etc. Thus, Nuclear Safety Law or Radiation Safety Control Law was enacted to protect our safety and health from radiation. Since people are unaware of radiation, however, warning phrase or figure was developed for safety. This study carried on corroborative analysis on the level of understanding pictogram, the picture language which is related to radiation safety in life and which is enacted and utilized as KS. As a result, the following fact was found.

First, some 63.3% of respondents negatively responded on understanding 6 pictograms related to radiation in life, showing low level of understanding and an affirmative response was merely 6.0%. Further, negative response on evaluation of properness was 55.8%, which was nearly 5 times higher than that of affirmative response (11.6%).

Second, the rate of selecting radon (Rn) as correct answer in the question on knowledge related to radiation safety in life was 42.2%, implying that the level of knowledge on the danger of radon gas is not high.

Third, the average mark of correct response on the questions asking the meaning of 6 pictograms presented in relation to radiation safety in life was 2.79 points (standard deviation 1.447 point), which was relatively low. Further, the rate of correct response was higher in case that pictograms were easily drawn for inference or they were relatively frequently exposed. However, the rate of correct response was low in case of laser beam, biological danger, non-ionized radiation. This result may be due to lack of school education or information in life related to radiation safety. This can be confirmed in the fact that contents related to radiation safety was not sufficiently included in school education or daily information related to radiation safety.

Fourth, concerning the comparison of average of score of right answer in each gender, the score of males was higher than that of female. As significant level was 5%, the difference was statistically significant. Correlation coefficient between level of understanding and properness on finally presented pictogram is 0.577, which is relatively high, implying that the higher level of understanding is, so is the level of properness.

Based on these points, it is found that the pictogram utilized in relation to radiation safety in life is less recognized, although higher safety is required. Thus, we are to present improvement program for future.

First, it is required to enhance the education related to life radiation safety in the school education site above all. To this end, the contents related to radiation safety should be necessarily included in standard program of safety education.

Second, in relation to life radiation safety, the present warning pictogram established by KS should be revised and supplemented so that warning can be enhanced. Further, if written message meaning pictogram is presented, the level of understanding could be much higher. This study is meaningful in that it grasps the present situation of life radiation safety and it utilizes pictogram out of diverse methods to improve radiation safety.

This section is mandatory.

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