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Spanish translation and psychometric evaluation of the healthcare professional's knowledge about radiologic protection scale

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Title: Spanish translation and psychometric evaluation of the healthcare professional's knowledge about radiologic protection scale.

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ABSTRACT

PURPOSE: To make an intercultural adaptation, and to provide a Spanish translation and psychometric evaluation of the original English version of the Healthcare Professionals Knowledge about Radiation Protection scale.

METHODS: The Spanish translation was carried out following international Guidelines for the process of cross-cultural adaptation of self-report measures. A cross-sectional design study was carried out. A hundred and thirty-eight nurses from 4 different hospitals in Barcelona (Spain) completed the Spanish version of the scale. Total score of the scale was calculated. The Pearson correlation coefficient (PCC) was used to evaluate a possible correlation between score and years of experience. A T-test for independent samples was used to evaluate significant differences between different groups. Cronbach's alpha and corrected item-total correlation coefficient and test-retest coefficient were used to determine internal consistency. The exploratory factor and parallel analysis was also calculated. All statistical tests were carried out with a level of significance α=0.05.

RESULTS: The mean scale score was poor among Spanish nurses. The PCC between total score and years of experience showed a non-significant correlation ($p>0.05$). No differences were found between nurses who work in radiation exposed units and those who work in radiation unexposed units ($p>0.05$). A Cronbach α of 0.98 was obtained for the items of the scale. The corrected item-total correlation range was 0.5-0.8. The test-retest correlation coefficient was 0.9. The exploratory analysis factor showed a single factorial structure which explained a 60.86% of the variance.

CONCLUSIONS: The new scale translated into Spanish (Sp- HPKRP) could be used to evaluate the degree of knowledge about radiological protection.

KEYWORDS: radiologic protection, healthcare professionals, nursing, training programs

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INTRODUCTION

Many treatments and diagnostic procedures in healthcare involve the use of radiological exposure. Despite the fact that its benefits and need are clear, many radiological-related risks have been described among the literature, these of which should be taken into account. Radiological-related risks affect both patients and healthcare professionals and it may lead to severe pathologies such as cancer [1–6]. Due to these health risks, the radiological use in European healthcare is covered by international regulations set by European Council [7].

The nursing staff have a crucial role in radiation use and protection, especially nurses working in radiological units [8]. Not only is radiation a part of radiological units, but also emergency units, in that an increase in the use of radiological imaging methods has been noted [9]. Therefore, nurses exposure to radiation is currently increasing among some Europe countries [6,10].

Interestingly, many studies have shown a severe lack of knowledge pertaining to this issue among healthcare professionals and specifically among nurses [11–13]. The lack of knowledge among nursing staff about radiation use and protection could lead to inadequate practice, and uncontrolled or harmful exposure for both them and patients. Thus, many studies conclude that there needs to be knowledge improvement among nursing staff [14].

It is important to evaluate the knowledge, attitudes, and behaviors about radiological protection in nursing healthcare professionals. This will determine whether or not the staff has sufficient radiation protection training for a safe working environment. Moreover, if the knowledge is not sufficient enough to identify specific deficiencies, it is crucial to develop new educational programs in order to improve knowledge about the subject. This could help eliminate pathologies derived from high radiological exposure to radiation.

Different instruments have been used to evaluate radiological protection knowledge, attitudes, and behavior among healthcare professionals. However, all of them had some limitations regarding its applicability to nursing staff [11,15,16].

Schroderus-Salo et al [17] developed and validated an English physicometric scale to assess healthcare professional knowledge about radiation protection. Their scale was the Healthcare Professionals Knowledge of Radiation Protection (HPKRP) [17].

Many authors have studied nursing and healthcare professionals' exposures to radiation, and their knowledge and behaviors. However, no studies have been found among Spanish nurses [18]. Hence, there are no Spanish validated scales or methods to evaluate this phenomenon.

Therefore, the principal purpose of this study was to perform a cross-cultural adaptation through the Spanish translation, and a psychometric evaluation of the original English version of the HPKRP scale. Secondly, this study aims to evaluate the Spanish nursing staffs knowledge about radiation protection in their corresponding practice.

MATERIALS AND METHODS

Design

This study followed a cross-sectional design. Following the International guidelines [19], the HPKRP scale was translated into the Spanish language after obtaining the original author's permission. Two independent Spanish nurses translated the original English version into Spanish language. Then, a Spanish research group evaluated the translation and agreed on the preliminary Spanish version. Subsequently, an independent researcher with English as their first language performed a back-translation, and the final Sp_HPKRP version was accepted (annex 1).

A pilot study was carried out in order to determine the understanding of the new Spanish version. The study consisted of 8 Spanish nurses who concluded that there was no language difficulty in understanding the questions.

The questionnaire with the Sp-HPKRP was sent to 4 different hospitals from Barcelona, Spain. The questionnaire had some demographic data questions (age, sex, unity, hospital, official academic qualification, specific radiological protection formation, and nursing years of experience) and the Sp-HPKRP scale.

The Sp-HPKRP is a scale that evaluates the nurses' knowledge about radiological protection in the hospital. The scale is composed of 33 statements graded from 0 (no knowledge) to 10 (total knowledge).

The inclusion criteria to be included in this study were 1) to be and work as a nurse and 2) to work in one of the followings units: radiological unit, palliative unit, oncology unit, or geriatric unit.

A total of 138 nurses from four different hospitals answered the Sp-HPKRP during March 2019. All participants were informed about the study and were aware that participation was voluntary. Moreover, all of them knew that the data obtained by the survey would be kept confidential. All participants signed informed consent waivers to participate in this study. The study was approved by the Research Ethics Committee of the International University of Catalunya.

Outcome measurements

The HPKRP scale aims to evaluate the knowledge level of radiation protection among healthcare professionals who work with radiation. The total scores range from 33 to 330 points, where the highest scores mean a deeper understanding about radiation exposure and protection. Moreover, demographic data such as age, sex, years of experience and specific training on radiological protection were asked.

Statistical Analysis

Data was tabulated and analyzed using the IBM SPSS Statistics v21. All statistical tests were carried out with a level of significance α=0.05.

Kolgomorov-Smirnov test was used to determine that all Sp-HPKRP scores had normality.

Descriptive statistics were used to explain the demographic characteristics of the sample.

Floor and ceiling effects were calculated. This effect corresponds to percentage of subjects with a minimum or maximum score. Their score must not exceed 15% in either maximum or minimum cases.

Cronbach's alpha was used to determine internal consistency of the adapted Spanish scale. Moreover, the corrected item-total correlation coefficient was calculated for the total of the items.

As inferential tests, Pearson coefficient between years of experience and total Sp-HPKRP score was calculated. The determined validity of the scale was measured using the T-student for independent samples. This was used to analyze significant differences between 1) nurses with and without specific radiological protection formation, 2) sexes, and 3) nurses in radiological exposed and unexposed units. Temporal stability was measured by test-retest (two weeks follow-up) correlation coefficient.

The exploratory factor analysis was done applying the maximum likelihood method. The number of factors was analyzed following Kaiser [20] and Cattell [21] criteria and the parallel analysis proposed by Horn [22,23]. Before the factor analysis of the items, the Kaiser-Meyer-Olkin test (KMO=0.9) and the Bartlett's sphericity test ($p<0.01$) were used to determine the adequacy of the data.

RESULTS

Descriptive data

A total of 138 nurses completed the Sp-HPKRP scale with no missing data in the participants' responses. The sample consisted of 101 females (73.2%) and 37 males (26.8%). The age of the nurses ranged from 21 and over 62 with mean of 38 (SD 11.0). The years of experience ranged from 1 to 41 with mean value of 14 (SD 10.4). Ninety-four nurses (68%) worked in radiation exposure units and forty-four (32%) did not work in radiation exposure units. Regarding the specific radiation protection training among the nurses, only 21 % of the sample answered "yes" while a total of 109 nurses (79%) answered "no". All descriptive data for quantitative and qualitative variables is shown in

Table 1 and

Table 2.

Cross-Cultural adaptation

The translation and the subsequent back-translation procedure to develop the Sp-HPKRP were conducted without grammatical or linguistic controversies which guaranteed the linguistic equivalence of the scale. All 8 nurses who participated on the pilot study reported no difficulty in understanding each of the 33 items of the Scale. Moreover, they said items were clear, concise, and easy to understand.

Sp-HPKRP outcomes

The total Sp-HPKRP score was calculated for all participants, and it showed a mean score of 159 points with a standard deviation of 76. The total scores ranged from 33 to 322.

Results from Kolgomorov-Smirnov test ($Z=0.79$; $p>0.05$) allowed us to accept that the data follows a normal distribution, and it justified the use of parametric tests for the inferential analysis.

The Pearson correlation coefficient between total Sp-HPKRP score and years of experience showed a non-significant correlation ($p>0.05$; $R^2=0.008$) [Figure 1].

The T-student test for independent samples between males and females showed significant differences. Males had significantly higher scores than females ($p<0.05$). Moreover, T-student test revealed significantly higher ($p<0.05$) scores in nurses with specific radiation protection formation than those who did not have specific formation. However, no significant differences were found between nurses who work in radiation exposed units and those who work in radiation unexposed units ($p>0.05$).

Floor and ceiling effects

No significant floor and ceiling effects were found. 1.4% of the participants scored 33 points and no one scored 330 points which would mean complete knowledge about radiation protection. Only 2.1% scored higher than 300 points and 5.8% scored fewer than 50 points.

Internal consistency

A Cronbach's α of 0.98 was obtained for the 33 items of the Sp-HPKRP scale. It was not affected by the removal of any item. Means and standard

deviations, corrected item–total correlation, and α if the item was removed are shown on Table 3. The corrected item–total correlation range was 0.5–0.8. The test–retest correlation coefficient measured two weeks after the first answered questionnaire was 0.9, and it revealed a good temporal stability.

Factorial validity

Although three eigenvalues were greater than one, both scree-plot visual examination and parallel analysis showed a single factorial structure. This explained 60.86% of the variance. The scree-plot is on Figure 2.

DISCUSSION

This study aimed to make a cross-cultural adaptation of the Healthcare Professional Knowledge about Radiation Protection scale to the Spanish language. The pilot study revealed a good language adaptation of the scale. It is crucial and indispensable to translate validated and useful scales in other languages in order to facilitate healthcare professionals' comprehension around the world. Thus, it could be used to assess the grade of knowledge about the topic and, if necessary, to develop and incorporate new educational strategies.

The principal finding of this study was that the Sp-HPKRP has been statistically validated from this work, with satisfactory psychometric properties similar to those obtained by Schroderus-Salo et al [17] in his original HPKRP scale version. The Sp-HPKRP had an excellent coefficient of internal consistency (α=0.98) similar to the original version.

In the original version of the scale, Schroderus-Salo et al [17] observed a factorial structure with three factors explaining 60.1%, 7.8%, and 3.5% of the variance respectively. However, although three eigenvalues were greater than one in our sample, the scree-plot visual examination revealed a one-dimensional structure. Moreover, unlike the original version, this study performed the parallel analysis and a one-dimensional structure that

explained 60.86% of the variance found. Future studies with larger sample sizes are expected to enable confirmatory factor analyses to be performed. This will deepen the current knowledge regarding the nature of the structural components of the instrument.

As expected, nurses with specific radiation protection education scored statistically higher than those without. Surprisingly, nurses who work in radiation exposed units did not score significantly higher than those who work in unexposed units. The Pearson correlation test showed a non-significant correlation. This means that the radiation protection knowledge is not a question of years of experience, but a question of specific education about the topic. Moreover, nurses who recently finished their university studies did not have better results than the nurses who had not. The nursing school curriculum should be checked and modified in order to improve this specific knowledge among Spanish nurses.

Results from this study showed a mean score of 159 points for the Sp-HPKPR among Spanish nurses. The maximum score was 330, meaning that Spanish nurses could improve their knowledge about radiation protection. No studies have been found using this scale in order to evaluate nurse's knowledge about radiation protection, therefore, the results cannot be compared to nurses from other countries. Improving radiation protection knowledge among nursing staff will increase precaution and it subsequently will prevent radiation-related damage.

Many studies have demonstrated a lack of knowledge about radiation protection among healthcare professionals [18,24,25], but no studies have been found among the Spanish population. This study demonstrated that this lack of knowledge is also found in Spanish nurses. The potential risk of this condition [3,4,26–28], requires improved knowledge. Clinical applications of this study such as educational and training programs about

specific radiation protection should at least be carried out among Spanish nurses.

CONCLUSION

The Sp-HPKRP was a valid and reliable instrument to assess the radiation protection knowledge among the population of Spanish nurses with really good psychometric properties. However, a lack of knowledge about radiation protection was noted and scores only reached half of the maximum score. New education and training programs should be carried out among Spanish nurses in order to improve this lack of knowledge and prevent radiation-associated risks.

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REFERENCES

[1] Buonanno M, de Toledo S M and Azzam E I 2011 Increased Frequency of Spontaneous Neoplastic Transformation in Progeny of Bystander Cells from Cultures Exposed to Densely Ionizing Radiation ed J Santos *PLoS One* **6** e21540

[2] Cho Y H, Kim Y J, An Y S, Woo H D, Choi S Y, Kang C M and Chung H W 2009 Micronucleus-centromere assay and DNA repair gene polymorphism in lymphocytes of industrial radiographers *Mutat. Res. Toxicol. Environ. Mutagen.* **680** 17-24

[3] Brenner D J and Hall E J 2007 Computed Tomography — An Increasing Source of Radiation Exposure *N. Engl. J. Med.* **357** 2277-84

[4] HALL E J and BRENNER D J 2008 Cancer risks from diagnostic

radiology *Br. J. Radiol.* **81** 362–78

[5] Aribal E, Mora P, Chaturvedi A K, Hertl K, Davidović J, Salama D H, Gershan V, Kadivec M, Odio C, Popli M, Kisembo H, Sabih Z, Vujnović S, Kayhan A, Delis H, Paez D and Giammarile F 2019 Improvement of early detection of breast cancer through collaborative multi-country efforts: Observational clinical study *Eur. J. Radiol.* **115** 31–8

[6] Rühm W, Azizova T V, Bouffler S D, Little M P, Shore R E, Walsh L and Woloschak G E 2016 Dose-rate effects in radiation biology and radiation protection. *Ann. ICRP* **45** 262–79

[7] European Commission 2014 Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom a *Off. J. Eur. Union* 1–73

[8] Hirvonen L, Schroderus-Salo T, Henner A, Ahonen S, Kääriäinen M, Miettunen J and Mikkonen K 2019 Nurses' knowledge of radiation protection: A cross-sectional study *Radiography* **0**

[9] Oh H Y, Kim E Y, Kim J-E, Kim Y J, Choi H-Y, Cho J, Yang H J and Ryoo E 2012 Trends of CT Use in the Pediatric Emergency Department in a Tertiary Academic Hospital of Korea during 2001–2010 *Korean J. Radiol.* **13** 771

[10] Magrini S M, Pasinetti N, Belgioia L, Triggiani L, Levis M, Ricardi U and Corvò R 2019 Applying radiation protection and safety in radiotherapy *Radiol. Med.* 1–6

[11] Yurt A, Çavuşoğlu B and Günay T 2014 Evaluation of Awareness on Radiation Protection and Knowledge About Radiological Examinations in Healthcare Professionals Who Use Ionized Radiation at Work *Malecular Imaging Radionucl. Ther.* **22** 48–53

[12] Zhou G, Wong D, Nguyen L and Mendelson R 2010 Student and intern awareness of ionising radiation exposure from common diagnostic imaging procedures *J. Med. Imaging Radiat. Oncol.* **54** 17–23

[13] Fidan F, Çetin M Ü, Kazdal C, Kılıç F and Özkaya U 2019 Behaviour and knowledge skill levels of orthopedic surgeons about radiation safety and fluoroscopy use: A survey analysis *Acta Orthop. Traumatol. Turc.*

[14] Lee W, Woo S, Seol S, Kim D, Wee J, Choi S, Jeong W, Oh S,

Kyong Y and Kim S 2016 Physician and nurse knowledge about patient radiation exposure in the emergency department *Niger. J. Clin. Pract.* **19** 502

[15] Dianati M, Zaheri A, Talari H R, Deris F and Rezaei S 2014 Intensive care nurses' knowledge of radiation safety and their behaviors towards portable radiological examinations. *Nurs. midwifery Stud.* **3** e23354

[16] Jones E and Mathieson K 2016 Radiation Safety among Workers in Health Services *Health Phys.* **110** S52–8

[17] Schroderus-Salo T, Hirvonen L, Henner A, Ahonen S, Kääriäinen M, Miettunen J and Mikkonen K 2019 Development and validation of a psychometric scale for assessing healthcare professionals' knowledge in radiation protection *Radiography* **25** 136–42

[18] Krille L, Hammer G P, Merzenich H and Zeeb H 2010 Systematic review on physician's knowledge about radiation doses and radiation risks of computed tomography *Eur. J. Radiol.* **76** 36–41

[19] Beaton D E, Bombardier C, Guillemin F and Ferraz M B 2000 Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine (Phila. Pa. 1976).* **25** 3186–91

[20] Kaiser H F 1960 The Application of Electronic Computers to Factor Analysis *Educ. Psychol. Meas.* **20** 141–51

[21] Cattell R B 1966 The Scree Test For The Number Of Factors *Multivariate Behav. Res.* **1** 245–76

[22] Çokluk Ö and Koçak D 2016 Using Horn's Parallel Analysis Method in Exploratory Factor Analysis for Determining the Number of Factors *Educ. Sci. Theory Pract.* **16** 537–51

[23] Timmerman M E and Lorenzo-Seva U 2011 Dimensionality assessment of ordered polytomous items with parallel analysis. *Psychol. Methods* **16** 209–20

[24] Semghouli S, Keltoum Hakam O, Choukri A, Bandyopadhyay S, Amaoui B, El Kharras A, Shaim A, Choukri A, Kumar Bandyopadhyay S and Yuan Z Physicians Knowledge of Radiation Risk in Prescribing CT Imaging in Moroccan Hospitals Geochemistry of river basins View project Physicians Knowledge of Radiation Risk in Prescribing CT Imaging in Moroccan Hospitals

[25] Winter I P, Ingledew P A and Golden D W 2019 Interprofessional Education in Radiation Oncology *J. Am. Coll. Radiol.* **16** 964–71

[26] Wong Y-S, Cheng Y-Y, Cheng T-J, Huang C-C, Yeh J-J and Guo H-R 2019 The Relationship Between Occupational Exposure to Low-dose Ionizing Radiation and Changes in Thyroid Hormones in Hospital Workers *Epidemiology* **30** S32–8

[27] Nyhan M M, Rice M, Blomberg A, Coull B A, Garshick E, Vokonas P, Schwartz J, Gold D R and Koutrakis P 2019 Associations between ambient particle radioactivity and lung function *Environ. Int.* **130** 104795

[28] Luna-Sánchez S, del Campo Balsa M T, Morán J V, Fernández I M, Checa F J S and de la Hoz R E 2019 Thyroid Function in Health Care Workers Exposed to Ionizing Radiation *Health Phys.* 1

Table 1: Descriptive data for quantitative variables

	N	Min	Max	Mean	Standard Deviation
Age	138	21	62	38.40	11.09
Years of experience	138	1	41	14.26	10.47
TotalScore of Sp_HPKRP	138	33	322	159.71	76.60

Figure 1: Correlation between years of experience and total Sp_HPKRP score

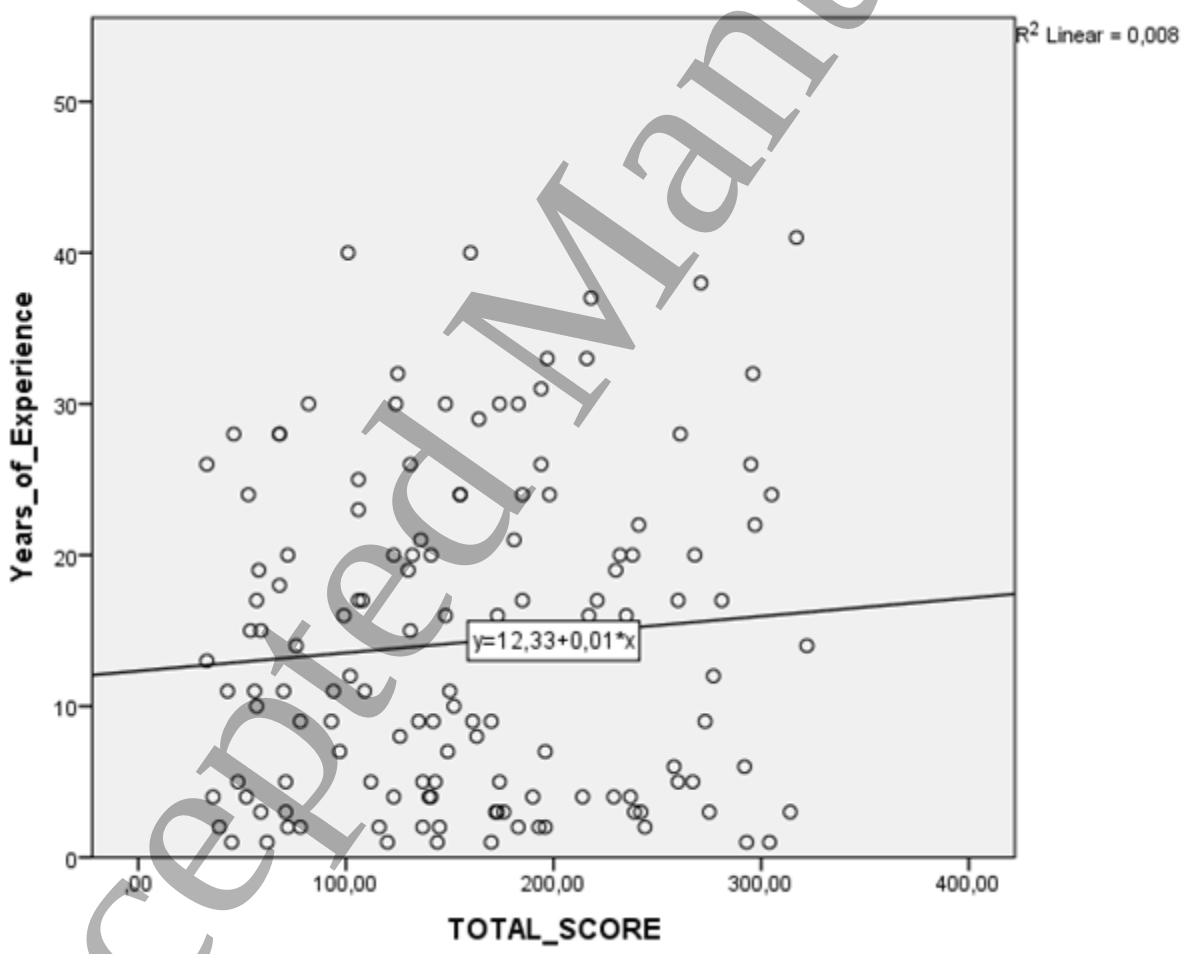

Table 2: Descriptive data for qualitative variables

		Frequency	Percentage
Specific Formation	SI	29	21.0
	NO	109	79,0
Sex	Female	101	73,2
	Male	37	26,8
Exposed Units	Exposed	94	68,1
	No Exposed	44	31,9
TOTAL	Total	138	100

Figure 2: Scree Plot

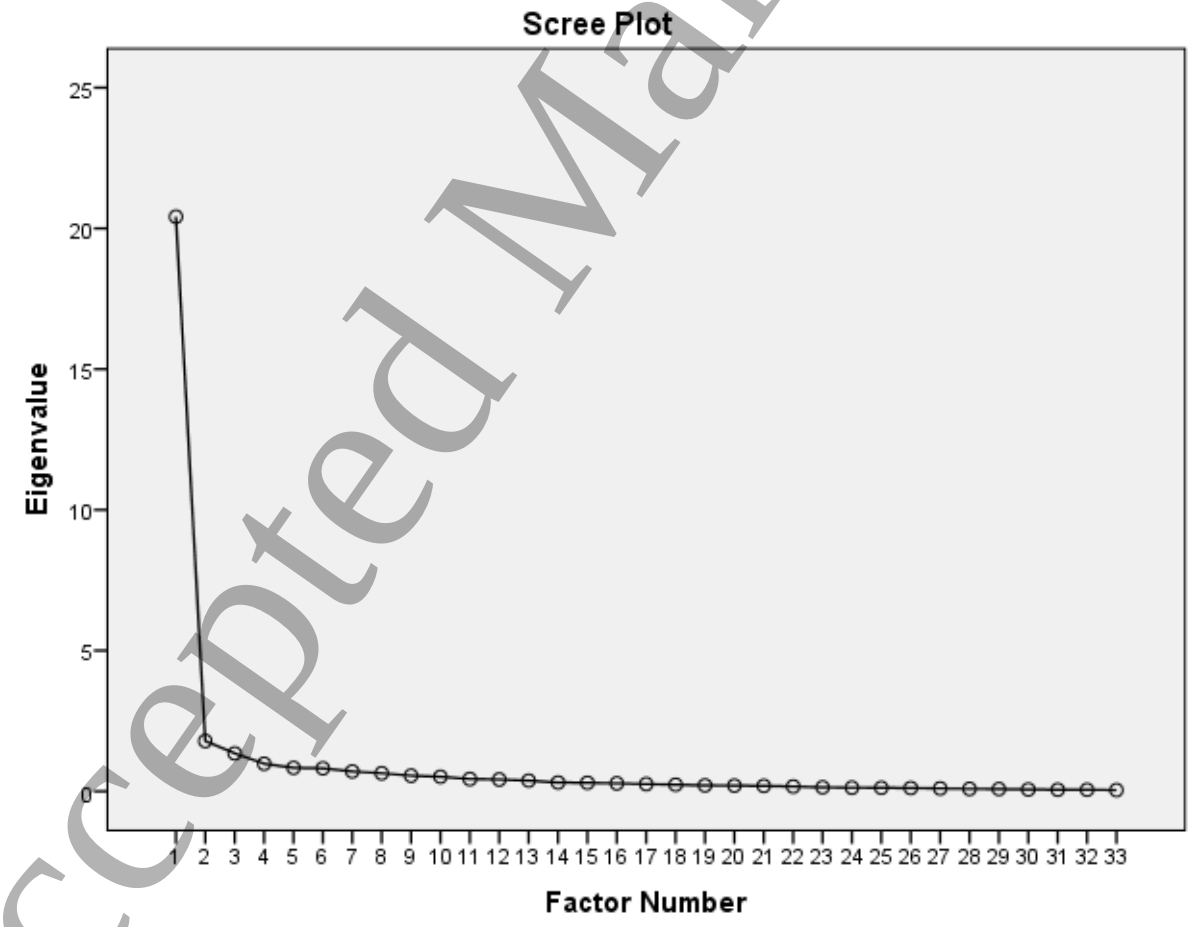

Table 3: Sp_HPKRP score distribution and internal consistency by 1–33 questions

	Mean	Standard Deviation	Corrected item-total correlation	α if the item is removed
GC1	4,43	3,030	,791	,979
GC2	4,31	3,006	,790	,979
GC3	4,19	3,015	,804	,979
GC4	4,64	2,758	,824	,979
GC5	5,24	2,919	,788	,979
GC6	4,28	2,731	,781	,979
GC7	4,10	2,753	,752	,980
GC8	6,93	2,568	,544	,980
GC9	3,98	2,893	,733	,980
GC10	5,57	3,146	,712	,980
GC11	6,38	2,640	,742	,980
GC12	3,88	2,945	,844	,979
GC13	6,12	2,878	,790	,979
GC14	5,45	3,078	,815	,979
GC15	6,45	2,977	,645	,980
GC16	3,33	2,506	,816	,979
GC17	4,95	3,433	,566	,981
GC18	5,09	3,108	,728	,980
GC19	5,46	3,211	,737	,980
GC20	4,94	3,006	,837	,979
GC21	4,80	3,032	,800	,979
GC22	3,28	2,996	,727	,980
GC23	4,80	3,003	,810	,979
GC24	4,71	3,140	,804	,979

GC25	5,36	3,108	,803	,979
GC26	6,28	2,871	,803	,979
GC27	6,12	3,071	,770	,980
GC28	4,59	3,143	,768	,980
GC29	3,49	2,883	,806	,979
GC30	3,63	2,769	,813	,979
GC31	3,97	2,972	,802	,979
GC32	4,46	3,028	,775	,979
GC33	4,47	3,151	,832	,979

"GC1-33"→different questions of the questionnaire.

ANNEX 1

Traducción y validación española de una escala psicométrica para evaluar los conocimientos de los profesionales sanitarios en materia de protección radiológica (HPKRP).

Datos básicos

Edad: _____ años.

Sexo: mujer / hombre

Unidad y centro en el que trabajo: _____

Grado de formación académica oficial: _____

Formación específica de protección radiológica: _____

Años de experiencia laboral en enfermería: _____ años.

Escala HPKRP

Las siguientes cuestiones se refieren a tu grado de conocimiento sobre las radiaciones y protección radiológica. Te pedimos que en cada una de ellas indiques con una X tu grado de conocimiento sobre la cuestión del 1 al 10, siendo 1 desconocimiento total y 10 conocimiento total. Intenta responder a todas las cuestiones. Gracias.

1 desconocimiento total **10 conocimiento total**

1	2	3	4	5	6	7	8	9	10

Grado de conocimiento	1	2	3	4	5	6	7	8	9	10
1. Conozco cómo se produce la radiación ionizante.										
2. Conozco las diferencias entre la radiación ionizante y la radiación no ionizante.										
3. Conozco las diferencias entre la radiación electromagnética y la radiación ionizante										
4. Conozco las características y propiedades físicas de los rayos X.										
5. Conozco cómo se producen los efectos nocivos de la radiación médica.										

6. Puedo describir los efectos determinados de una cierta dosis de radiación.										
7. Puedo describir los efectos fortuitos de una cierta dosis de radiación.										
8. Conozco los motivos que justifican las exploraciones radiológicas.										
9. Conozco las fórmulas y las medidas de las exploraciones radiológicas.										
10. Entiendo el significado del principio *"Tan Bajo Como Sea Razonablemente Posible"* en las exploraciones radiológicas.										
11. Conozco los principios fundamentales de la protección frente a la radiación.										
12. He recibido suficiente formación sobre el uso de la radiación en las exploraciones radiológicas.										
13. Conozco cómo usar adecuadamente el equipo de protección personal.										
14. Conozco cómo usar adecuadamente el equipo de protección radiológica para los pacientes.										
15. Presto atención al resto del personal mientras trabajamos en un área controlada usando radiación.										
16. Conozco como registrar toda la información esencial en cuanto al uso de radiación.										
17. Soy consciente de que la información con respecto a la dosis de radiación recibida por los pacientes debe constar en su historia clínica.										
18. Conozco los protocolos relativos a las profesionales embarazadas que trabajan en unidades con radiación.										
19. Procuro aplicar protocolos de seguridad con respecto a la dosis de radiación y el uso de radiación en mi trabajo diario.										
20. Entiendo los factores que afectan a la dosis de radiación de un paciente.										
21. Conozco las diferencias entre pacientes adultos y niños/adolescentes en las exploraciones radiológicas.										
22. Entiendo el significado de la ley del cuadrado inverso en la protección contra las radiaciones.										
23. Soy capaz de evaluar mis actuaciones de forma crítica y completa mientras trabajo con radiación.										
24. Estoy informado/a de las medidas de seguridad radiológicas de mi trabajo.										
25. Entiendo el significado de la cultura de seguridad radiológica.										
26. Conozco el significado de señales de advertencia con respecto a la seguridad radiológica.										
27. Soy capaz de identificar las señales de advertencia relativas a la seguridad radiológica mientras trabajo en un área controlada.										
28. Conozco el protocolo de revisiones de la salud de personal trabajador de áreas radiológicas.										
29. Conozco cómo se clasifican los trabajadores radiológicos.										
30. Conozco cómo informar sobre eventos adversos o atípicos en el uso de la radiación.										
31. Conozco las situaciones en las que se debe notificar un evento adverso.										

32. Conozco los procedimientos para monitorizar la exposición a la radiación de los trabajadores.										
33. Entiendo el principio de limitación de dosis en la protección radiológica.										