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## COVID-19 pandemic impact on the Spanish radiation protection professionals

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### Abstract

The pandemic situation originated due to the appearance of the SARS-CoV-2 virus changed many aspects of our lives and jobs. This health crisis also affected the day-to-day work of radiation protection experts, including the wide range of areas involved in this sector. This study aimed to evaluate the impact of this pandemic on the Spanish radiation protection experts. For that purpose, a Google Forms online survey was developed with 39 questions. The survey covered different aspects related to the work developed by the Spanish professionals, taking into account three different time periods along the pandemic situation. According to this survey, the appearance of COVID-19 modified the labour conditions and modalities of many Spanish radiation protection professionals, especially at the beginning of the pandemic. Most on-site activities were related to the health sector and the nuclear industry, other sectors were more flexible, and the workload increased for half of the surveyed participants. Many operational activities suffered delays due to the pandemic, whereas the one-month wearing period of passive personal dosimeters was extended in most cases during the first Spanish alarm state (15<sup>th</sup> March 2020 up to the 21<sup>st</sup> June 2020). Finally, difficulties faced in terms of the working area have been identified and may be useful for the future.

Keywords: COVID-19, radiological protection, online survey, SEPR

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### 1. Introduction

The pandemic of COVID-19 disease produced by the SARS-CoV-2 virus (WHO, 2020) has changed many aspects of our lives and jobs. Several testimonies and communications about the impact of COVID-19 in health physics have been reported in the last months (Andresz et al., 2021; Ku et al., 2020; Meades et al., 2020; Portaluri et al., 2020). In particular, the Young Generation Network of the International Radiation Protection Association (IRPA-YGN) carried out a preliminary assessment of its impact on the work of radiation protection experts, collecting the testimonies of thirty-one young professionals from different countries around the world. That study showed a significant impact on the working conditions of radiation protection experts, especially those from hospitals (Andresz et al., 2021). That first survey just focused on young professionals.

Online surveys are a common tool for analysing the impact of regulations on radiation safety (Yoshida et al. 2020), the knowledge of radiation protection among radiology professionals and students (Maharjan et al., 2020; Hasford et al., 2021; Ataalla et al., 2021), or the perspectives and opinions of young professionals in radiation protection (Andresz et al., 2019), among others. The data obtained are very important for reinforcing the radiation protection systems and the radiation safety culture.

For this reason, and due to the useful information obtained in the past with different surveys, the Youth Committee of the Spanish Society for Radiological Protection (J-SEPR), supported by the Spanish Society for Radiological Protection (SEPR) and the IRPA-YGN, launched an online survey to evaluate the impact and the consequences of this crisis in the daily job of the SEPR members, including all ages. The survey covered different time periods since the pandemic situation was declared, and focused on many aspects related to the work developed by the Spanish professionals: the possibility of teleworking, virtual or hybrid inspections / measurements / calibrations / quality controls, changes in the workload, labour productivity and main difficulties found as a consequence of the COVID-19.

This study presents the results obtained in this national online survey regarding the impact of the COVID-19 pandemic on the Spanish radiation protection (RP) professionals.

## 2. Materials and methods

The survey was implemented into Google Forms. The use of an online platform allowed promoting this survey among SEPR members by digital media, such as private and institutional social networks (Twitter, LinkedIn, or Facebook) and institutional forums, websites, and newsletters.

To encourage the participation of SEPR members, this survey was promoted by e-mail messages to members and posts in SEPR online forums.

One of the key points of all the surveys for getting a significant number of answers is the number of questions, the type of questions, and the brief time required for completing the survey. For this reason, the survey was designed with a limited number of questions (39) distributed in 5 pages, with only 4 open questions. The estimated time needed to complete it was 15 minutes.

The first page of the survey was focused on obtaining data about participants: age category (18-35 / 36-55 / >55), institution or working area, and region where their job is developed. The introduction of an e-mail address was mandatory on the first page, which allowed detecting anomalous or duplicated entries. Moreover, this point allows cross-checking some data to avoid fake entries on the survey.

To assure the privacy of participants' data, all data were managed under a non-distribution compromise, being forbidden to share the e-mail address with the rest of SEPR members. Participants consented to the detailed procedure to share their data and opinions in this survey.

The next three pages of the survey included the same ten multiple-choice questions, each page focusing on a different time period. All the questions on these three pages were related to the impact of the COVID-19 in the day-to-day labour of radiation protection professionals. The three-time periods were chosen as follows:

- From the 15<sup>th</sup> March 2020 up to the 21<sup>st</sup> June 2020: First alarm state in Spain.
- From the 21<sup>st</sup> June 2020 up to the 26<sup>th</sup> October 2020: Period between the first and the second alarm states in Spain.
- From the 26<sup>th</sup> October 2020 up to the end of the survey (5<sup>th</sup> April 2021): Second alarm state in Spain.

The last page of the survey was dedicated to evaluating, with multiple-choice questions, the labour productivity and the workload during the pandemic, as well as the possibility of teleworking in this sector even after the pandemic situation. Furthermore, this last page included four open questions related to the main difficulties found by the professionals, and the lessons and initiatives promoted and developed by the participants and their institutions to overcome them.

The uncompleted surveys were not considered to assure the reliability of the collected data shared by participants.

This survey was opened for the participation of all the SEPR members for two weeks and a half, getting to collect data about the impact of COVID-19 in the day-to-day work of 35 radiation protection experts, which represents around 5% of the SEPR

members. The reliability of the obtained results, considering the low percentage of participants in comparison with the amount of SEPR members, is discussed in section 4.

Due to privacy issues, it has not been possible to analyze and compare the participants' working areas with that of all members of this scientific society.

### 3. Results

The characteristics of the participants in the survey in terms of working areas and age categories can be found in Figures 1 and 2, respectively.

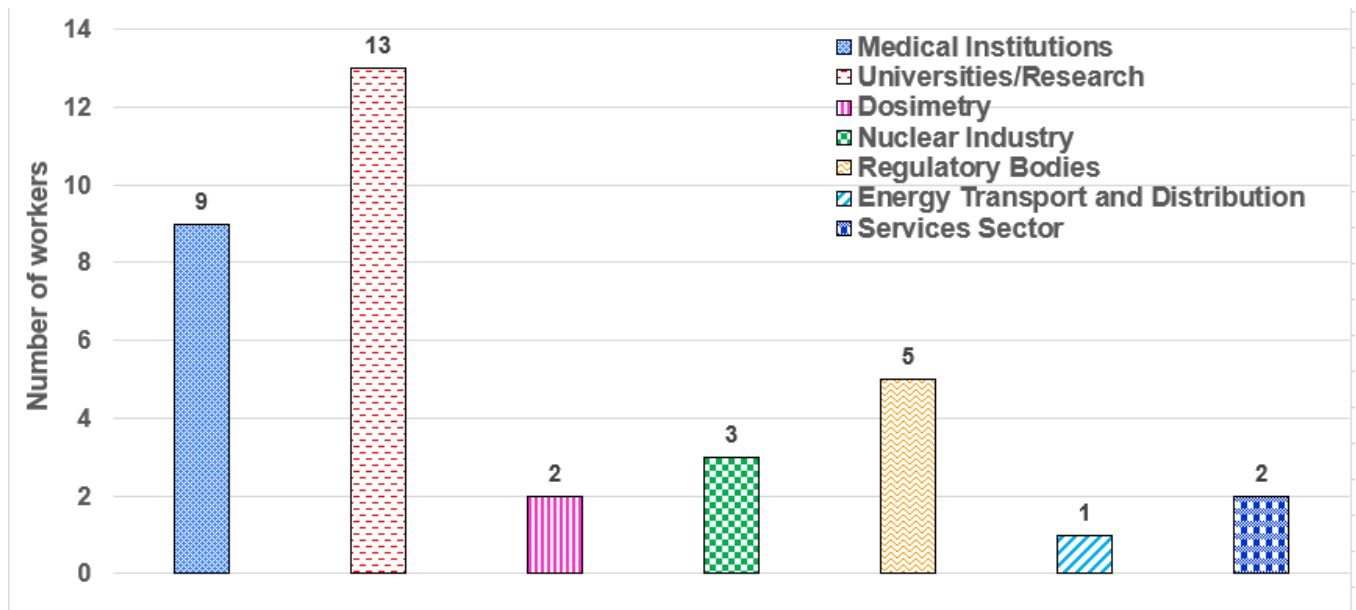


Figure 1. Working areas of the surveyed participants.

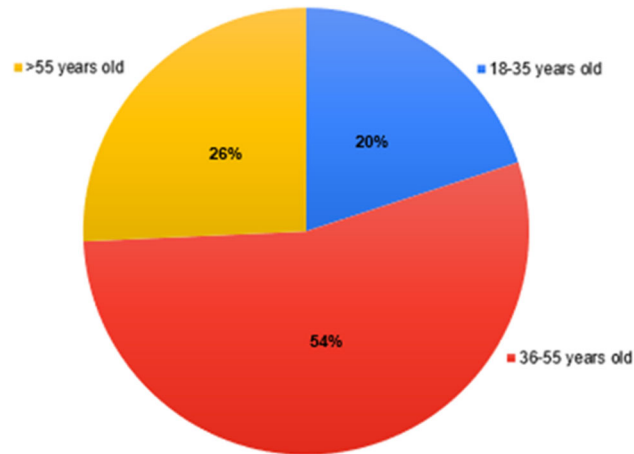


Figure 2. Percentage distribution of the age of the surveyed workers.

The answers came from eight different Spanish regions, mostly from Madrid and Cataluña, and most of the answers were from workers related to medical institutions, and research and academic areas (Fig.1). The data collected for four sectors (services sector, energy transport and distribution, nuclear industry, and dosimetry) cannot be considered fully representative; the information in these sectors may not represent all workers in those sectors.

The data collected about medical institutions, universities/research and regulatory bodies are not only more representative than for the rest of the sectors due to the number of participants (>5). This point is also influenced by the fact that in these areas

the labour activities and COVID-19 constraints can be considered more homogeneous, with fewer dissimilarities in labour constraints.

The age distribution of SEPR members is presented in Table 1, showing a good balance between youth and experienced professionals in the Spanish RP system, even though continuous professional promotion tasks should be assured. The comparison of the data presented in Figure 2 and Table 1 shows how young professionals have been more involved in participating in the online survey than highly experienced professionals.

Age Ranges	Percentage of SEPR members (%)
18-35	13.98
36-55	50.42
>55	35.60

Table 1. Age distribution of SEPR members in 2021.

Figure 3 shows the evolution of the percentage of workers in different working modes in the three different periods previously defined, analyzing these data per sector. In the first period of the pandemic, most on-site activities were related to the health sector (hospitals) and the nuclear industry, plus some employees of the regulatory bodies.

56% of the participants that did not work 100% on-site think that their institutions will keep on the possibility of teleworking, with more or less flexibility, after COVID-19.

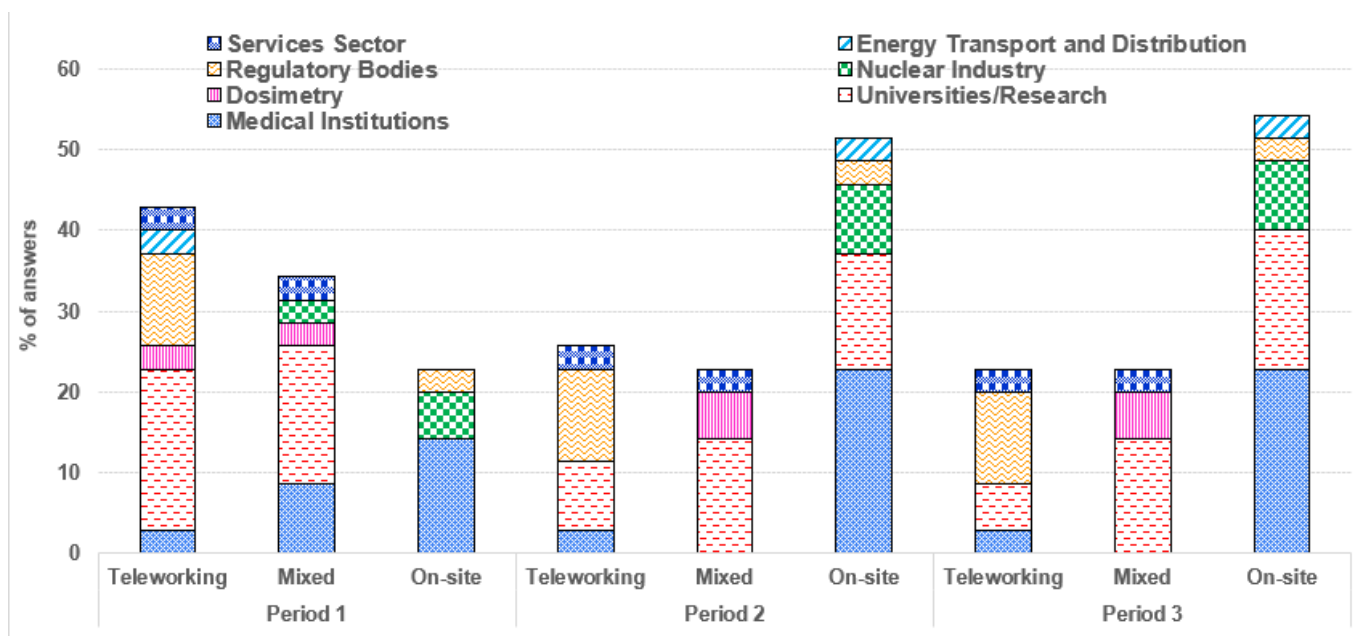


Figure 3. Percentage of workers in the different modes of work during the 3 periods of time evaluated.

All the participants indicated that their institutions promoted teleworking and/or different hygiene measures to reduce biological risks associated with COVID-19. The most common were: use of personal protective equipment (PPE), disinfection of surfaces, and increased interpersonal distance.

The workload and the labour productivity of the Spanish professionals have also been affected by the new working modes and the pandemic evolution, which postponed many radiation protection activities. Figure 4 shows the data collected in this study regarding workload and labour productivity. In Figure 4 and beyond, the group “others” includes the following sectors: energy transport and distribution, services and dosimetry, the sectors with the lowest number of workers in the survey.

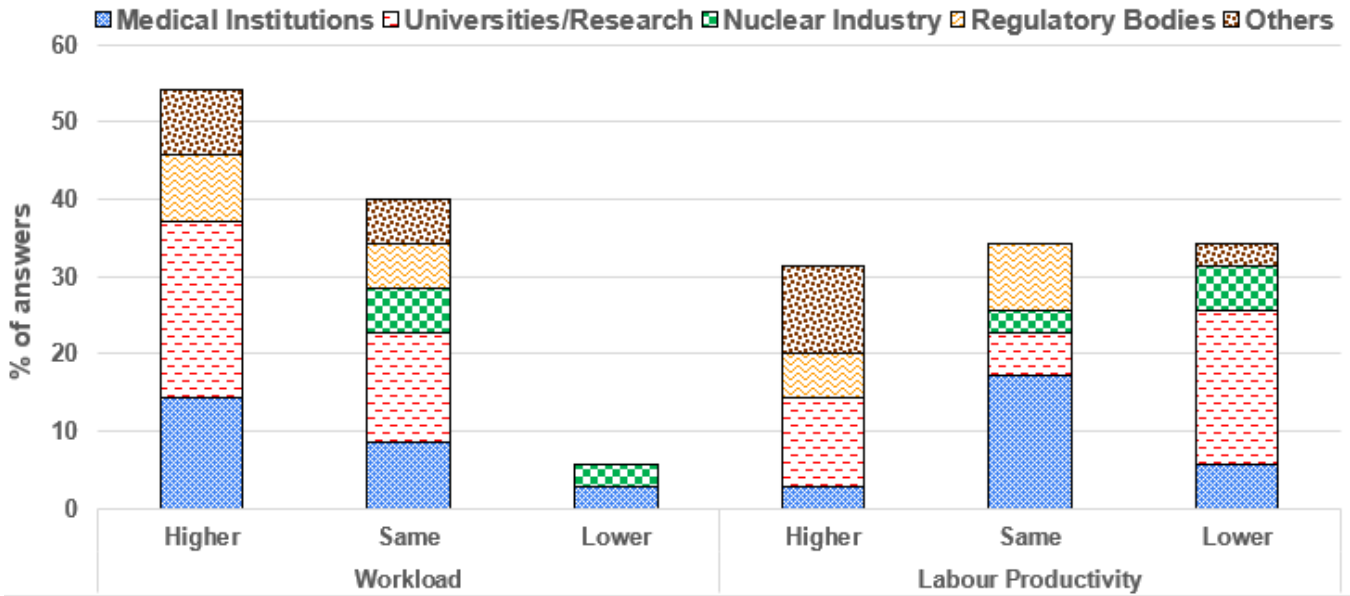


Figure 4. Workload and labour productivity perceived by the Spanish radiation protection professionals compared to the situation pre-COVID-19.

The workload increased for 54% of the surveyed participants, whereas it was the same for around 40%. On the other hand, the labour productivity varied during the surveyed periods. One of the common points found in the answers to the survey is that many operations such as quality control, calibration, commissioning, and inspections suffered delays due to the pandemic.

Another point to analyse is the impact of COVID-19 on the Spanish radiation protection system in terms of dosimetry activities and, in particular, in the temporary extension of the one-month wearing period of passive personal dosimeters used by the exposed workers. Figure 5 analyses this point for the three-time periods considered, showing that the reading period of many dosimeters was extended during the first alarm state due to the pandemic situation, impacting this fact in all the involved RP sectors.

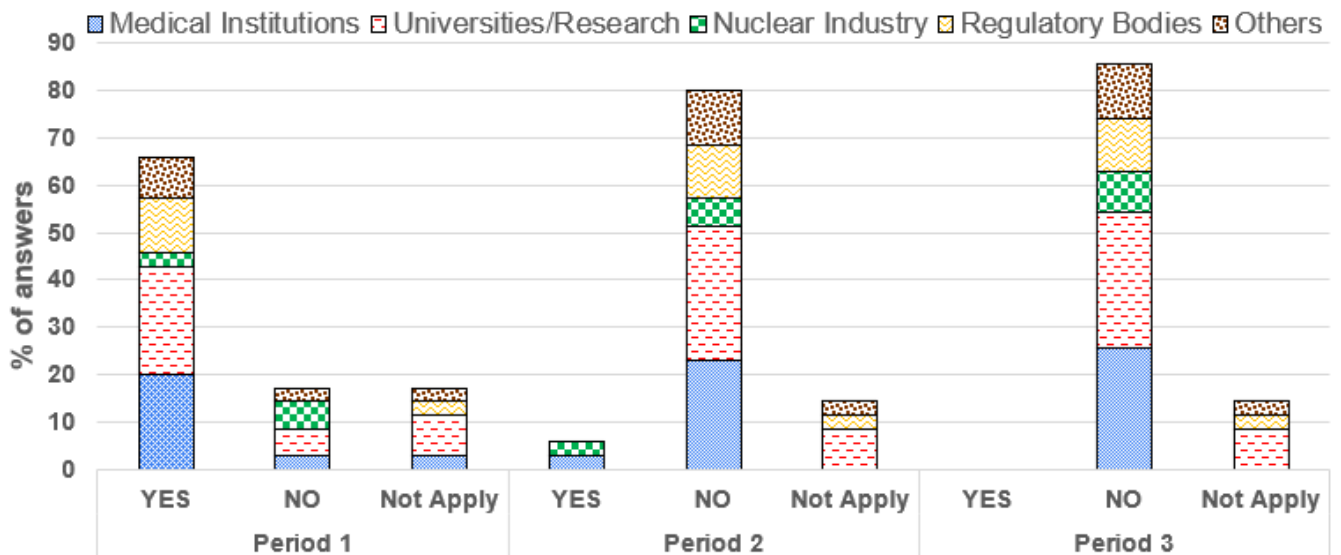


Figure 5. Extension of the wearing period of the dosimeters due to the COVID-19 impact.

Regarding the extension of the wearing period of personal dosimeters, Figure 6 shows the evolution of on-site and hybrid inspection tasks developed by the Spanish professionals over the three-time periods.

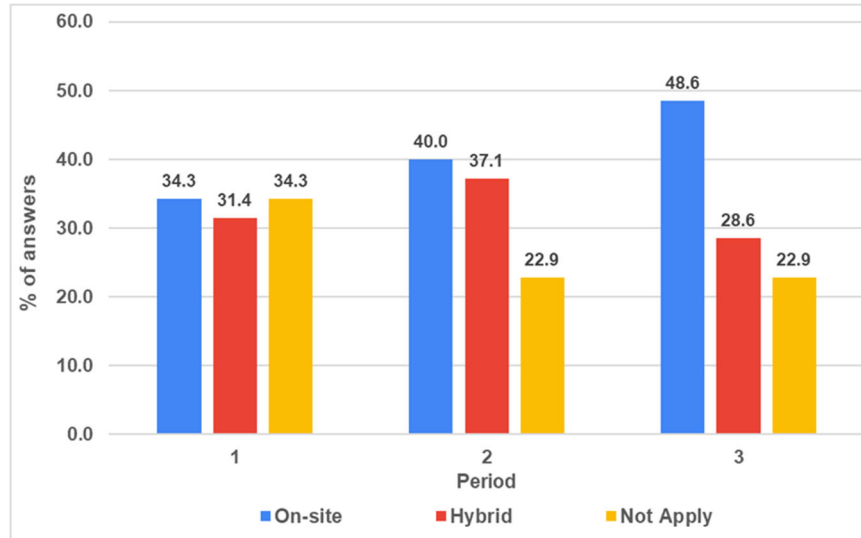


Figure 6. Implementation of hybrid inspections and tasks in the Spanish radiation protection system.

The number of inspections and tests carried out during the first period was lower than in the others. In the last two time periods, the same number of inspections were carried out. However, the most relevant information provided by Figure 6 is related to the introduction of hybrid modalities in the inspections and tests in the Spanish radiation protection system. Inspection tasks do not apply to all participants (see Fig. 6) due to the own features of each working center, such as calculation centers.

A summary of the results of the open questions referring to the main difficulties found by the professionals, as a consequence of the COVID-19, are shown in Figure 7. The main problems were related to teleworking and working issues and, to a lesser extent, with training, PPE, personal issues (like reconciling family and professional life and symptoms of anxiety), and infection risk.

The participants indicated that the reduced (and sometimes difficult) interaction between coworkers was one of the main teleworking factors that affected productivity. Another teleworking challenge is the lack or the slow adaptation of the resources and new technologies. The data presented in Figure 8, which correlates the main exposed difficulties with the professionals' working area, show that regulatory bodies employees were those more impacted by teleworking challenges.

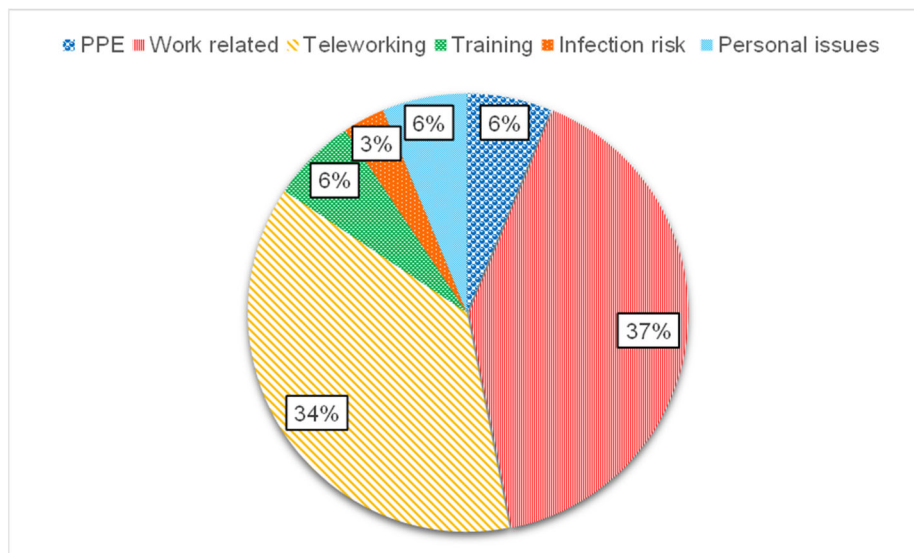


Figure 7. Difficulties found by professionals due to COVID-19.

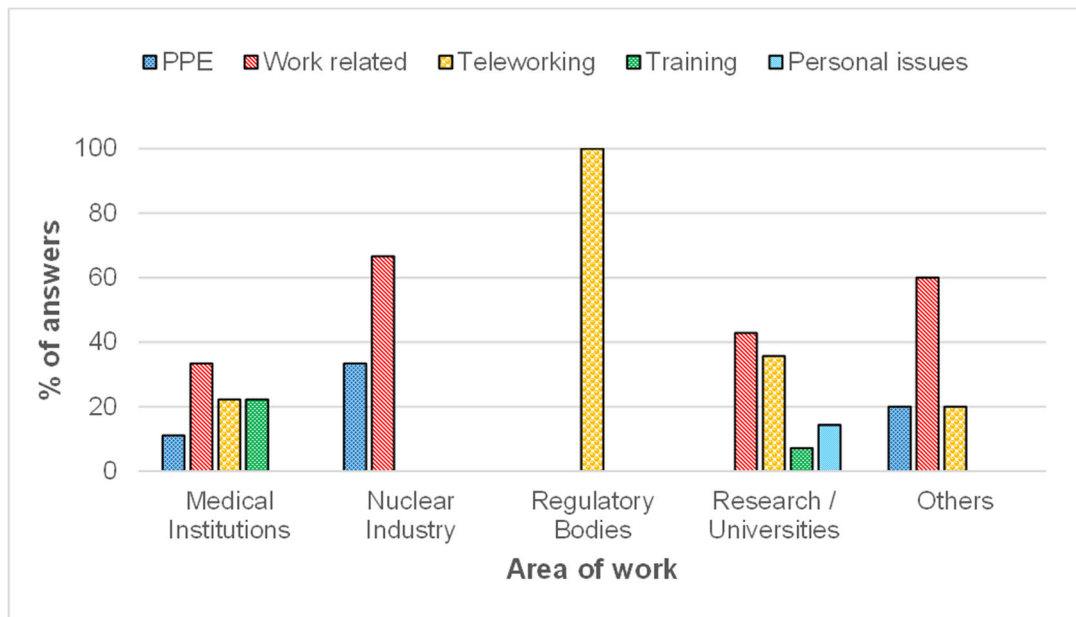


Figure 8. Correlation of work difficulties with professionals' working area.

Work-related issues stated by the surveyed professionals were related, mainly, to the procedure adaptation, work-shift, organization and labor reschedule due to lack of workers, and the difficulties to go to the workplace. Professionals from medical institutions and others (service sector, dosimetry, and energy and transport distribution) were those who communicated to have suffered these work-related difficulties (Fig. 8).

Although teleworking and work-related issues were the main difficulties faced by professionals due to COVID-19, one of the main problems that persist after the considered pandemic period is related to safety measurements such as the personal protective equipment discomfort and safety personal distance, among others. Some participants think that these issues will remain until the end of the pandemic, when people will relax mitigation actions and fears. Moreover, some professionals expressed that teleworking problems have been solved by optimizing and providing proper information technologies.

Even though teleworking and safety measures presented the main working difficulties during the COVID-19 period, these points were considered by professionals as the most common initiatives promoted by their institutions to ensure radiological protection quality levels (Fig. 9) in this pandemic situation. Workers also highlighted personal involvement as the individual initiative driven by professionals, in terms of willingness to work and the adaptation capacity to changes. These initiatives minimized the infection risk and, although some works suffered some delays or were postponed, the quality assurance levels in the radiation protection services were maintained.

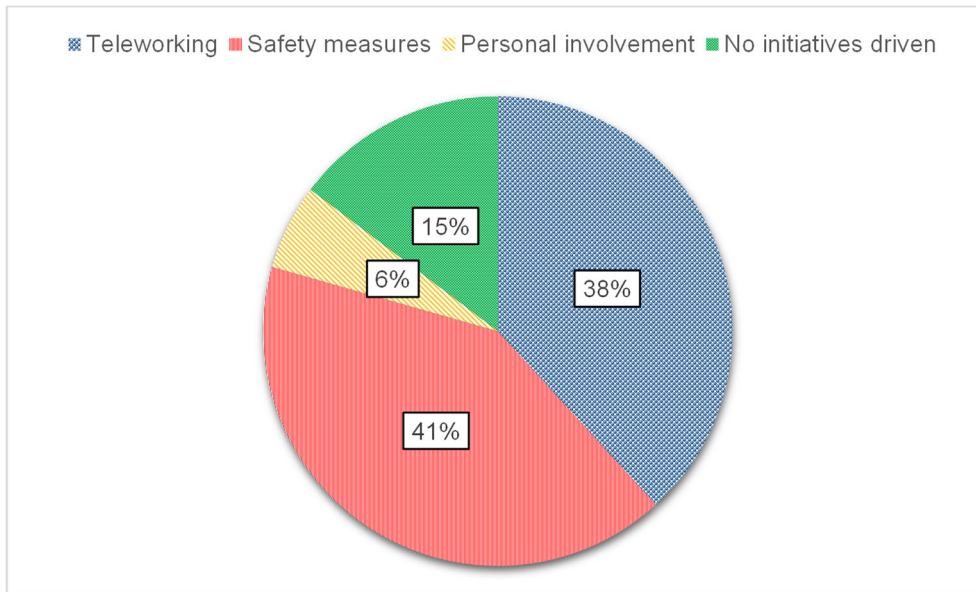


Figure 9. Initiatives promoted to ensure quality levels in the radiation protection field.

#### 4. Discussion

During the first period of the pandemic in Spain, most of those activities non-related to hospitals and the nuclear industry showed good flexibility for adapting their working modes to teleworking or mixed-modalities. However, research and routine lab works were the most affected. In fact, many of them were postponed. The stability of the number of workers in non-on-site modalities in the last two time periods suggests that these working modes might continue even after the pandemic situation (Fig. 3). Moreover, these data suggest that the services sector is the most flexible, the employees of this sector have not come back yet to work 100% on-site, although the number of participants from this area was limited.

The results of this survey demonstrate that this pandemic has accelerated the introduction of new working modes in those activities non-related to the health system and the nuclear industry in the Spanish radiation protection system.

In contrast, the health sector and the nuclear industry are the sectors of the Spanish radiation protection system with lower capacity and flexibility for changing their working modes, among other reasons, because their activities were considered essential by the Spanish Government and in most cases cannot be done from home, so the professionals of these two sectors are the most exposed to COVID-19. The workload over the Spanish professionals has been in general the same or higher than before the appearance of COVID-19, so these sectors seem not to have suffered the general activity plummet suffered by the Spanish economy.

The increment of workload reported by the 54% of the participants may be a bias to be considered in the collected data; people who have felt overworked can use this kind of surveys to alarm their employers. For this reason, the impact of these non-objective replies should be considered only as personal opinions. The points most impacted by these possible non-objective replies can be those presented in Figures 7 and 9.

The results, in terms of labour modality, suggest that, from the second period, the professionals had clear and direct instructions about how to adapt their jobs to the new situation, and many institutions will remain using teleworking as a job modality (100% or mixed) even after this pandemic.

The extension of the reading periods of the dosimeters was only important in the first period of the pandemic. In the second period, only a low percentage of nuclear industry and medical workers had an extension in the reading periods of their dosimeters. The data shown in Figure 5, in combination with data from Figure 3, are not alarming from the radiation protection point of view. The reason is that most of the extensions took place in the first period of the pandemic, when most Spanish RP professionals were teleworking or reduced their on-site activity. In the particular case of health workers, many procedures were postponed. Even though the number of chest X-ray images was increased, this is expected to have a small impact on the absorbed doses to the exposed workers or, in any case, the possible increase has been measured by their personal dosimeters.

Teleworking started as one of the main institutional initiatives to ensure radiological protection quality levels in Spain during the COVID-19 crisis. However, once the starting technical and adaptation problems have been solved, many workers of certain RP sectors are in favour of the continuity of this labour modality, which presents some important personal advantages.



Nowadays teleworking follows presenting some technological difficulties that need to be overcome, for instance with proper training. Nevertheless, it is considered a good working mode by professionals and fits well with some working areas, such as regulatory bodies. It also introduced some advantages, such as the possibility of balancing up family and work life and paperless solutions, which are positively assessed by workers.

The number of answers from dosimetry centers is low, but seems to point out that these centers have been working in mixed modalities during these periods. Hence, the work developed by these centers has been continuous and the new modalities have not harmed the dosimetry control of radiation protection professionals. In the last period, the participants did not report any delay in the reading of dosimeters.

Other essential problems found during this pandemic situation by the Spanish radiation protection professionals were related to work-related issues, which were especially relevant in the services and medical sectors.

This survey may be an example for other national or international societies, following the proposal promoted by the IRPA-YGN, for the implementation of this kind of studies about the impact of COVID-19 in the radiation protection professionals in different countries. The same survey could be launched by other youth committees of RP societies, comparing the radiation protection systems of different countries and their difficulties in this period, sharing lessons learned to face in a better way future extreme situations.

The weakest point of this survey has been the low percentage of responses in comparison to the target audience (5% of SEPR members). However, the global results of the survey can be considered partially representative, with a sufficient range of reliability. This is because the pandemic situation impacted in a very similar way in the whole Spanish territory, and in the different labour areas considered in this work (labour constraints were similar for the same sector in the whole territory; discrimination by essential and non-essential activities). Therefore, the data collected in the survey and presented in this work can be considered fairly reliable and representative, especially for medical institutions, universities/research and regulatory bodies.

Moreover, in this kind of social and labour studies about the activities of technical/scientific society members is usual to find quite limited percentages of participation. This point should be considered by RP societies interested in launching similar surveys, considering this issue in the survey conceptual design phase.

In the future, these data could also be shared and compared with the impact of COVID-19 in other related areas, such as medical physics or nuclear engineering services.

## **5. Conclusions**

The appearance of COVID-19 has modified deeply the labour conditions and working modalities of the Spanish radiation protection professionals. The impact of COVID-19 on daily RP labour was much more significant at the beginning of the pandemic (first period), and new labour modalities were implemented in all the sectors involved in the Spanish radiation protection system, except in the nuclear industry and the health sector. These two sectors need to be in close contact with either the nuclear power plants or the patients, so teleworking is difficult to apply due to specific constraints, such as the need of: radiological diagnosis of patients with COVID-19, radiotherapy treatment for cancer patients, operation of nuclear power plants or maintenance activities of nuclear power plants (monitoring, surveillance, inspection, testing, assessment, calibration, overhaul repair or replacement of components). This sort of activities cannot be done by teleworking, needing the permanent presence of workers.

The one-month wearing period of passive personal dosimeters was also extended in most cases during the first alarm state (15<sup>th</sup> March 2020 up to the 21<sup>st</sup> June 2020). The main difficulties faced by radiation protection workers were mainly related to teleworking and safety measures. However, this survey has shown how the Spanish system has great flexibility and adaptation capacity, which has allowed to assure all the critical services even in the worst moments of the pandemic, except for some routine quality controls, calibrations, commissioning, and inspections, which were postponed.

### **Conflict of Interest**

The authors declare that they have no conflict of interest.

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### **Ethical approval**

Ethical approval was not required.

## Informed consent

This article does not contain any studies involving human subjects.

## Authors contributions

*R. García-Baonza: Writing original draft, Investigation, Visualization, Conceptualization*

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*Cristian Candela-Juan: Investigation, Methodology, Conceptualization, Writing-Reviewing and Editing*

*Sarao Rozas: Conceptualization, Supervision, Writing-Reviewing and Editing*

*Anna Camp: Conceptualization, Methodology, Writing-Reviewing and Editing*

*Joana Martínez: Writing original draft, Visualization and Writing-Reviewing and Editing*

*Sylvain Andresz: Writing-Reviewing and Editing*

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## References

- Andresz, S., Bryant, P., Heaps, J., Beaumont, T., Vecchiola, S., Caldeira Ideias, P. (2019) Young professionals in radiation protection: Challenges and perspectives - Outcomes of an international survey, *Radioprotection* 54, 35–40.
- Andresz, S., Kabrt, F., Sáez-Muñoz, M., Nusrat, O., Papp, C. (2021) Impacts of the Covid-19 on the IRPA young generation activities in radiation protection: Testimonies and experience feedback, *Radioprotection* 56, 193–197.
- Ataalla, N., Yousef, A.M. (2021) Healthcare professionals' knowledge of the doses and risks for radiological investigations performed during pregnancy, *Radioprotection* 56 (1), 37-42.
- Hasford, F., Sackey, T.A., Inkoom, S., Sosu, E.K., Hammond, E.N.B., Awua, A.K., Pokoo-Aikins, M., Dery, T.B., Teye, S., Issahaku, S., Eduful, E.K., Boadu, M. (2021) Knowledge levels on applications of radiation in medicine among medical practitioners in Ghana, *Radioprotection* 56 (2), 117-125.
- Instituto Nacional de Estadística (2020) Pirámide de la población empadronada en España [Online]. Available: <https://www.ine.es/covid/piramides.htm>. [Accessed: 13-Apr-2021]
- Ku, M., Morgan, T., Malbon, A., Bartram, T., Cavanagh, J., Halvorsen, B. (2020) Provision of a consistent national approach to radiation therapy workforce protection measures in Australia during the COVID-19 pandemic, *Aust. Heal. Rev.* 44, 535–539.
- Maharjan, S., Parajuli, K., Sah, S., Poudel, U. (2020) Knowledge of radiation protection among radiology professionals and students: A medical college-based study, *Eur. J. Radiol. Open* 7, 100287.
- Meades, R., Gnanasegaran, G., McCool, D. (2020) Radionuclide therapy services in an era of COVID-19: The radiation protection challenges, opportunities and considerations, *Nucl. Med. Commun.*
- Portaluri, M., Bambace, S., Tramacere, F., Errico, A., Carbone, S., Portaluri, T. (2020) Staff and Patient Protection in Radiation Oncology Departments During Coronavirus Disease 2019 (COVID-19) Pandemic, *Adv. Radiat. Oncol.* 5, 628–630.
- WHO (2020) WHO Director-General's opening remarks at the media briefing on COVID19 – March 2020.
- Yoshida Y, Yoshida Y. 2020. Medical staff perceptions of risk communication needs for the public and comparison with the needs expressed by the public. *Radioprotection* 55(3), 199–206.