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Radiographers workload and workforce availability in radiology units during the COVID-19 pandemic: A cross-sectional study

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ABSTRACT

Objective: To assess the workload and available workforce of radiographers in radiology units during the first and second waves of the COVID-19 pandemic.
Materials and methods: This cross-sectional questionnaire-based study included 166 radiographers working in radiology departments of hospitals in Istanbul during the pandemic. The questionnaire covered socio-demographic and occupational characteristics, daily workload and staffing capacity, as well as COVID-19-related protective strategies.
Results: A total of 44.0 % of participants reported working 6–9 h per day, while 50.0 % reported working 10 h or more during the pandemic. Dissatisfaction with daily working hours was reported by 80.1 % of respondents, and 70.5 % indicated insufficient staff capacity. Regarding daily patient load, 63.3 % of CT, 56.6 % of MRI, and 44.6 % of X-ray radiographers reported managing 151–250 patients, while 36.7 % of CT and 20.5 % of X-ray radiographers reported seeing more than 250 patients daily. Overall, 63.3 % of radiographers stated they had knowledge in handling contaminated or hazardous materials, and 66.9 % reported experience in radiological imaging of COVID-19 patients.
Conclusion: The findings highlight the sustained high workload of radiographers during the second wave of the COVID-19 pandemic, along with widespread dissatisfaction related to working hours and staff shortages. Enhancing training on COVID-19 protocols and implementing strategies to support staff well-being are essential to ensure the health, safety, and job satisfaction of radiographers working on the front lines.

1. Introduction

Given the pivotal role of radiological assessment and reporting in supporting the diagnosis of COVID-19, radiology practice worldwide underwent extensive reorganization during the pandemic, particularly in terms of workload and practice guidelines (Elshami et al., 2021; Kanne et al., 2020; Mossa-Basha et al., 2021; Sharpe et al., 2021; Tan et al., 2020). Radiology professionals have been recognized as primary frontline staff in the COVID-19 setting (Akudjedu et al., 2021). Interventional radiologists and radiographers, in particular, faced increased risks of infection due to close patient contact and the invasive nature of many procedures (Akyurt, 2021). In response, significant operational changes were implemented to ensure continuity in radiology services during the COVID-19 pandemic (Özdemir et al., 2020; Chandy et al., 2020).

In Turkey, with the onset of the pandemic on March 10, designated pandemic hospitals were established, accompanied by institutional guidelines on COVID-19 healthcare and infection control in radiology units (Cavli et al., 2021; Republic of Turkey Ministry of Health, 2020). Consequently, imaging services were restricted to emergency radiography and computed tomography (CT), with radiographers redeployed from other units (Cavli et al., 2021; Republic of Turkey Ministry of Health, 2020).

With the healthcare system focused on COVID-19 care, radiology units saw substantial increases in thoracic imaging and emergency services due to the postponement of outpatient appointments and elective procedures during the first wave (Shi et al., 2021). This surge in demand for diagnostic imaging and the associated workload imbalance likely contributed to the overburdening of radiology practitioners (Winder et al., 2021). As standard hospital operations gradually resumed, a

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further increase in imaging volumes was expected (Shi et al., 2021).

Evaluating the changes in radiography practice brought on by the pandemic, especially in terms of imaging volume and workload, may provide essential insights for future healthcare planning and policy development (Akudjedu et al., 2021; Shi et al., 2021; Winder et al., 2021; Fleckenstein et al., 2021). Such assessment is critical in anticipating challenges related to staffing, equipment availability, infrastructure, and patient care delivery, particularly as radiology services return to pre-pandemic operation levels (Akudjedu et al., 2021; Shi et al., 2021; Winder et al., 2021; Fleckenstein et al., 2021). This study aimed to evaluate the workload of radiographers and the availability of workforce in radiology units located in Istanbul province during the first and second waves of the COVID-19 pandemic.

2. Materials and Methods

2.1. Study Population

This cross-sectional, online questionnaire-based study included 166 radiographers working in radiology units of hospitals in Istanbul during the COVID-19 pandemic. Data were collected between March 2020 and June 2021. Participation was voluntary, and informed consent was obtained electronically via a consent page offering "yes/no" options. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

According to national data from March 2014, Turkey employed 13,449 radiographers (approximately 0.17 per 1000 patients) across the Ministry of Health (MoH, 76 %), the private sector (18 %), and universities (6 %) (Republic of Turkey Ministry of Health, 2017; Republic of Turkey Ministry of Health, 2023). Among the 232 hospitals in Istanbul, those designated as pandemic hospitals by the MoH, classified as A1, and having a bed capacity of over 600 were included in this study. Of the 270 eligible radiographers working in these hospitals, 166 agreed to participate, yielding a response rate of 61 %.

3. Questionnaire

The online data collection form was created using Google Forms and distributed via email, WhatsApp, and other social media platforms. The questionnaire derived from previous studies (Abuzaid et al., 2022; Cavli et al., 2021) and included sections on four parts

a) Socio-demographic characteristics including age, gender, educational status, marital status, and monthly income), b) Occupational characteristics including hospital type, radiology subunit, and years of experience, c) Daily workload and staffing capacity, and d) COVID-19-related protective strategies (e.g., handling of hazardous substances, imaging methods for COVID-19 patients, and training participation).

4. Statistical analysis

Descriptive statistics were analyzed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp., Armonk, NY, USA). Results were expressed as percentages.

5. Results

5.1. Sociodemographic and occupational characteristics

A total of 166 radiographers participated in the study. Among them, 59 % were female, and 41.6 % were employed in state hospitals. The most commonly reported radiology subunits were X-ray (44.0 %) and CT (19.9 %) (Table 1).

Table 1
Sociodemographic and occupational characteristics.

Sociodemographic characteristics	n	%
Age (year)		
18–25	47	28.3
26–35	50	30.1
36–45	50	30.1
≥46	19	11.4
Gender		
Female	98	59.0
Male	68	41.0
Marital status		
Single	62	37.3
Married	104	62.7
Monthly income (TL)		
1500–2000	16	9.6
2001–3000	25	15.1
3001–3500	60	36.1
≥3501	65	39.2
Academic education	n	%
Medical vocational high school degree	20	12.0
Associate degree	82	49.4
Graduate degree	54	32.5
Master's degree	10	6.0
Occupational characteristics	n	%
Hospital type		
State	69	41.6
University	48	28.9
Private	30	18.1
Imaging center	19	11.4
Radiology subunit		
X-ray	73	44.0
Computerized Tomography	33	19.9
Bone densitometry	22	13.3
Magnetic resonance imaging	20	12.0
Mammography	18	10.8
Years in practice		
0–1	32	19.3 %
2–5	51	30.7 %
6–9	31	18.7 %
10–13	15	9.0 %
≥14	37	22.3 %

5.2. Daily workload and staff capacity during the pandemic by gender and hospital type

Overall, 44.0 % of participants reported working 6–9 h per day, and 50.0 % reported working 10 h or more during the pandemic. A majority (80.1 %) expressed dissatisfaction with their daily working hours. Additionally, 70.5 % considered the hospital's staffing capacity to be insufficient, and 54.8 % believed that overtime during the pandemic should be reduced or eliminated (Table 2). Radiographers in state hospitals were significantly more likely to work ≥10 h daily (72.5 %) compared to those in private (26.5 %) and university hospitals (41.7 %) ($p < 0.05$). Dissatisfaction with working hours was also more common in state hospitals (89.9 %) compared to private (73.5 %) and university hospitals (72.9 %) ($p < 0.05$) (Table 2) (Figs. 1 and 2). Gender differences were notable. A higher proportion of female radiographers reported working ≥10 h daily compared to males (63.3 % vs. 30.9 %, $p < 0.001$). Similarly, more females considered staffing capacity insufficient (81.6 % vs. 54.4 %, $p < 0.001$). Interestingly, a significantly lower percentage of females (32.7 %) than males (86.8 %) believed that overtime should be reduced or canceled ($p < 0.001$) (Table 2).

5.3. Daily workload and staff capacity by radiology subunit

Most radiographers in digital X-ray, CT, MRI, bone densitometry, and mammography reported working 6–7 h per day. MRI radiographers were more likely to report working ≥8 h daily (45.8 %) compared to those in X-ray (8.4 %), CT (12.7 %), and other subunits (0 %). Radiographers in intravenous pyelography (IVP) reported working 2–3 h daily.

Table 2
Daily workload and staff capacity during pandemic according to gender and hospital type.

		Total (n = 166)		Gender				Hospital type					
				Male (n = 68)		Female (n = 98)		Private (n = 49)		University (n = 48)		State (n = 69)	
Workload during COVID-19 pandemic		n	%	n	%	n	%	n	%			n	%
Daily working hours	≤5 h	10	6.0	0	0.0	10	10.2	5	10.2	2	4.2	3	4.3
	6–9 h	73	44.0	47	69.1	26	26.5	31	63.3	26	54.2	16	23.2
	≥10 h	83	50.0	21	30.9	62	63.3[a]	13	26.5[q]	20	41.7[q]	50	72.5
Satisfaction with daily working hours	Yes	33	19.9	9	15.5	24	24.4	13	26.5[q]	13	27.1[q]	7	10.1
	No	133	80.1	59	86.8	74	75.5	36	73.5	35	72.9	62	89.9
Working overtime during pandemic should be reduced/cancelled	Yes	91	54.8	59	86.8	32	32.7[a]	25	51.0	28	58.3	38	55.1
	No	75	45.2	9	13.2	66	67.3	24	49.0	20	41.7	31	44.9
Hospital's staff capacity is sufficient	Yes	49	29.5	31	45.6	18	18.4	13	26.5	19	39.6	17	24.6
	No	117	70.5	37	54.4	80	81.6[a]	36	73.5	29	60.4	52	75.4

χ^2 test.p < 0.001 compared to males.p < 0.05 compared to state hospital.

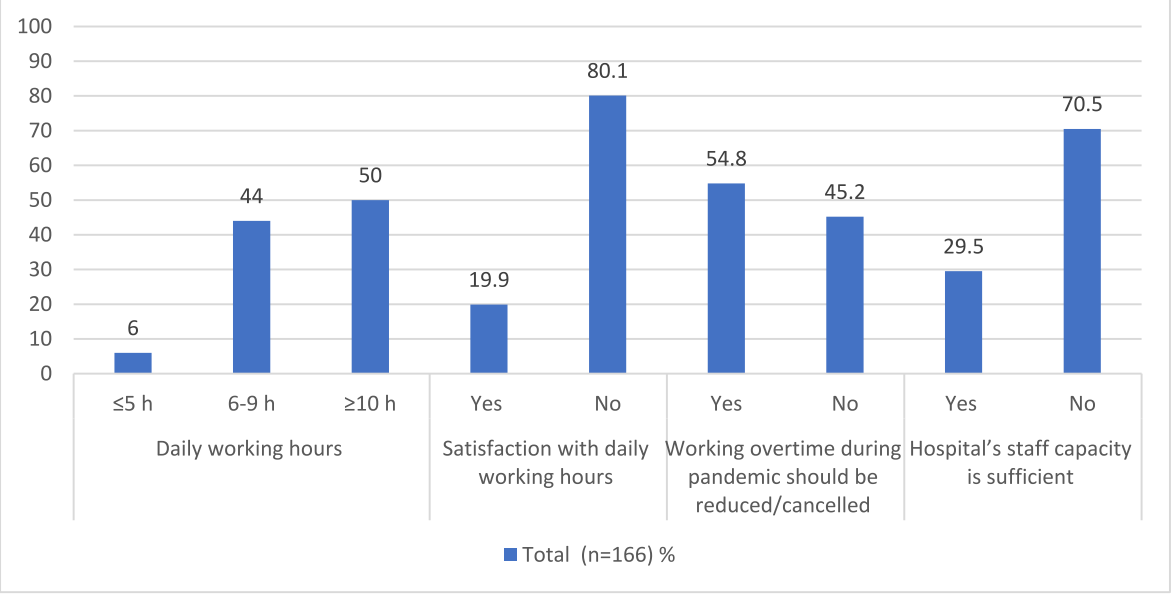

Fig. 1. Daily workload and staff capacity during pandemic according.

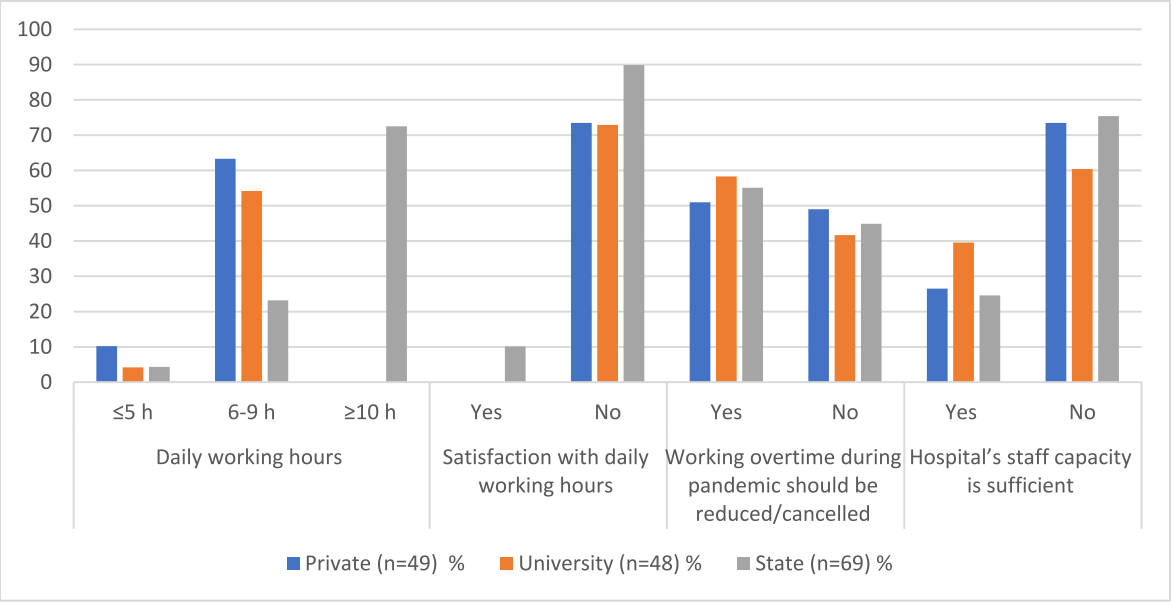

Fig. 2. Daily workload and staff capacity during pandemic according to hospital type.

Patient volume varied across subunits. Between 151 and 250 patients per day were reported by 63.3 % of CT, 56.6 % of MRI, and 44.6 % of X-ray radiographers. More than 250 patients per day were seen by 36.7 % of CT and 20.5 % of X-ray radiographers. At least 41 patients daily were reported by 56.6 % of mammography radiographers, 36 patients by 56.6 % of bone densitometry radiographers, and 31 patients by 56.6 % of IVP radiographers (Table 3). All radiographers reported attending academic congresses or educational programs for 4 days per year. A majority reported spending 1–30 min daily on private activities (80.7 %) and less than 60 min on coffee breaks (89.7 %) (Table 3).

5.4. COVID-19 and related protective strategies

In terms of preparedness, 63.3 % of participants reported having knowledge of handling contaminated or hazardous substances, and 66.9 % had experience with COVID-19-specific radiological imaging. COVID-19 training organized by the Institutional infection control committee (IICC) was confirmed by 60.2 % of radiographers, with 66.3 % indicating that they had participated in such training (Table 4).

6. Discussion

Our findings revealed a sustained increase in radiographers' workload during the pandemic, accompanied by dissatisfaction with prolonged working hours and insufficient hospital staffing. More than half of the participants reported working over 10 h daily, particularly among female radiographers and those employed in state hospitals. A systematic review of 31 articles on the radiography workforce and service delivery during the pandemic reported that COVID-19 significantly affected radiography practice in terms of training, infrastructure, technology, clinical workflow, and practitioners' mental health and well-being (Akudjedu et al., 2021). Consistent with our findings, the pandemic brought about substantial changes in working patterns and an increased perceived workload, largely driven by the surge in COVID-19 patients and the need to adhere strictly to new infection control protocols (Akudjedu et al., 2021).

In our study, X-ray, CT, and MRI radiographers were more likely to report seeing up to 250 patients daily than those in mammography, bone densitometry, or IVP. Furthermore, CT and X-ray radiographers were more likely than MRI radiographers to report seeing over 250 patients per day. These results align with pandemic-related changes in radiology practice globaly (Akudjedu et al., 2021; Abuzaid et al., 2023; Cavli et al., 2021; Winder et al., 2020; Fleckenstein et al., 2021; Mossa-Basha et al., 2020; Sim 2020; Tsou et al., 2020; Shanahan & Akudjedu, 2021). Given that chest imaging was a critical component of the triage process for COVID-19 patients (Tavare et al., 2020), increased use of chest radiography and CT was accompanied by reduced volumes in other subspecialty imaging services (Shanahan & Akudjedu, 2021; Shi et al., 2021). Our findings support this shift and confirm the widely reported increase in radiographer workload—especially for chest X-ray and CT—during the pandemic (Akudjedu et al., 2021; Shanahan & Akudjedu, 2021; Shi et al., 2021; Mossa-Basha et al., 2020).

Most participants reported spending less than 30 min per day on private activities and under 60 min on coffee breaks. While the majority reported 7-h working days, MRI radiographers were more likely to report working 8 or more hours. The second wave of the pandemic further increased imaging workloads, attributed to the resumption of postponed examinations (Bernatz et al., 2022; Boettcher et al., 2020) and the continued care of both COVID and non-COVID patients (Shi et al., 2021). A German study of 862 radiologists and radiographers showed that, although many safety measures improved from the first to the second wave, the perceived workload increased, with 84 % of inpatient and 80 % of outpatient radiographers reporting higher stress levels in the second wave compared to 72 % and 79 %, respectively, during the first (Bernatz et al., 2022). An analysis of imaging data from U.S. radiology centers revealed significant declines in abdomen, pelvis, and breast imaging during the first wave, with mammography services experiencing more than a 90 % reduction in professional work (Duszak et al., 2020). Similarly, the most affected divisions included breast, musculoskeletal, and cardiovascular imaging, likely due to their outpatient nature (Shi et al., 2021).

In a 2020 survey of 218 Australian radiographers and radiation therapists, participants reported increased procedural pressure in mobile and general radiography, CT, simulation, and linear accelerator services (Shanahan & Akudjedu, 2021). Diagnostic radiographers were more likely than radiation therapists to report altered workload patterns and potential increases in personal radiation exposure due to COVID-19-related protocols (Shanahan & Akudjedu, 2021).

A retrospective study from Germany analyzing 596,760 radiological exams during the pandemic's first wave reported a 41 % average decrease in case volume, with sonography (−53.8 %) and X-ray (−46.5 %) more affected than MRI (−42.1 %) and CT (−24.5 %).[14] Following

Table 3
Workload during COVID-19 pandemic by radiology subunits.

Workload during COVID-19 pandemic			n	%
Digital X-ray	Working hours/day	5 h	2	1.2
		6 h	33	19.9
		7 h	117	70.5
		≥8 h	14	8.4
	Number of patients/day	51–150	58	34.9
		151–250	74	44.6
		≥251	34	20.5
Computerized tomography	Working hours/day	6 h	96	57.8
		7 h	49	29.5
		≥8 h	21	12.7
	Number of patients/day	151–250	105	63.3
		≥251	61	36.7
Magnetic resonance imaging	Working hours/day	7 h	90	54.2
		≥8 h	76	45.8
	Number of patients/day	51–150	72	43.4
		151–250	94	56.6
Bone densitometry	Working hours/day	6 h	72	43.4
		7 h	94	56.6
	Number of patients/day	21–35	72	43.4
		≥36	94	56.6
Mammography	Working hours/day	6 h	72	43.4
		7 h	94	56.6
	Number of patients/day	21–40	72	43.4
		≥41	94	56.6
Intravenous pyelography (IVP)	Working hours/day	2 h	72	43.4
		3 h	94	56.6
	Number of patients/day	16–30	72	43.4
		≥31	94	56.6
Time spared for congress or academic education		4 days per year	166	100.0
Time spent on administrative tasks per day		No administrative tasks	145	87.3
		1 h	21	12.7
Time spent on private activities per day		1–30 min	134	80.7
		31–60 min	32	19.3
Time spent on coffee break per day		1–30 min	50	30.1
		31–60 min	99	59.6
		≥61 min	17	10.2

Table 4
COVID-19 and related protective strategies.

COVID-19 and related protective strategies		n	%
Knowledge on management of contaminated/dangerous substances	Yes	105	63.3
	No	61	36.7
Experience on radiological imaging methods in COVID-19 patients	Yes	111	66.9
	No	55	33.1
Presence of COVID-19 training organized by IICC	Yes	100	60.2
	No	66	39.8
Previous participation in COVID-19 training organized by IICC	Yes	110	66.3
	No	56	33.7

IICC: Institutional infection control committee.

the shutdown, exam volumes rebounded, leading to an expected workload increase of up to 22 % in some radiology departments (Fleckenstein et al., 2021). In this context, although MRI, mammography, bone densitometry, and IVP radiographers reported lower daily patient volumes than their X-ray and CT counterparts, their workloads remained substantial. This supports the notion that, after an initial decline in elective imaging, diagnostic volumes rebounded as patients returned for care delayed during earlier phases of the pandemic (Winder et al., 2021; Vingiani et al., 2020; Duszak et al., 2020).

Given the inconsistent reductions across radiology subspecialties and the expected rebound in imaging demand, failure to fully restore baseline radiology operations may have lasting consequences (Duszak et al., 2020; Rosenkrantz et al., 2020).

According to OECD data, Turkey's per capita availability of CT and MRI scanners (13.6 and 12.2 per million, respectively) remains below the OECD average of 23.7, yet Turkey has among the highest imaging volumes (Bozer & Ağırbaş, 2016; Kiper, 2020). For example, while the number of CT scanners in the U.S. remained stable between 2012 and 2020 with a 10 % decline in usage, Turkey's CT scan volumes doubled in the same period (Bozer & Ağırbaş, 2016; Kiper, 2020).

Overutilization, particularly of chest CT, reported as an increase during the COVID-19 pandemic has emerged as a major concern. This trend may stem from insufficient clinical justification, poor adherence to optimization protocols, and a lack of exposure awareness among referrers. Promoting patient-centered imaging decisions and stricter justification protocols are essential to mitigate the risks associated with high radiation exposure.

Nearly one-third of the radiographers in our study reported limited knowledge of managing contaminated or hazardous substances, limited experience with COVID-19-specific imaging, and no exposure to formal COVID-19 training provided by the IICC. Previous studies similarly reported that radiographers received insufficient training in the early stages (Elshami, Abuzaid, McConnell, Stewart, et al., 2022; Cavli et al., 2021), which was associated with anxiety, reduced preparedness, and suboptimal safety practices (Akudjedu et al., 2021; Shanahan & Akudjedu, 2021; Tay et al., 2021).

An earlier study conducted in April 2020 across Turkish pandemic hospitals showed that 20–30 % of radiographers had no COVID-19-related training or experience. Lack of safety awareness, increased workload, and insufficient training were linked to poor emotional states and heightened fear of infection (Akyurt, 2021; Elshami, Abuzaid, McConnell, Floyd, et al., 2022). In this context, improving training may be more effective than reducing working hours alone for ensuring radiographer safety and minimizing occupational exposure.

Changes in clinical workflows to meet infection control standards have added procedural complexity and time demands, further contributing to the occupational stress already prevalent among radiographers and radiation therapists (Rivera et al., 2020; Rutter & Lovegrove, 2008; Shanahan & Akudjedu, 2021). Our findings underscore the importance of implementing well-defined, continuously updated safety policies and institutional training programs (Akyurt, 2021; ISRRT, 2020).

The persistence of limited knowledge among one-third of radiographers, combined with high workload levels, may significantly contribute to anxiety and stress (Akudjedu et al., 2021; Akyurt, 2021). This highlights the urgent need for workplace stress screening and timely implementation of effective COVID-19 support interventions to protect the psychological well-being of imaging professionals (Akyurt, 2021; Shanahan & Akudjedu, 2021).

Studies examining the global impact of the pandemic on clinical radiography recommended best practices for post-COVID service delivery. These include updated work protocols to reduce anxiety and burnout, continuous professional development, resilient supply chains, hybrid staffing models, and remote work options to enhance flexibility and ensure sustainable imaging service delivery (Akudjedu et al., 2021; Abuzaid et al., 2021; McConnell et al., 2021).

A key limitation of our study is its cross-sectional design, which restricts causal interpretation. Additionally, findings may not be generalizable across all radiology departments in Turkey. The absence of baseline data from the pre-pandemic period and reliance on self-reported perceptions rather than objective workload metrics are also limitations.

7. Conclusion

In conclusion, this study highlights a sustained increase in radiographers' workload during the second wave of the COVID-19 pandemic, accompanied by widespread dissatisfaction with extended working hours and perceived understaffing. A significant proportion of radiographers also lacked adequate training in COVID-19 imaging and infection control. To maintain the safety, health, and job satisfaction of radiographers working on the front lines, it is essential to implement targeted training initiatives, enforce infection control protocols, and adopt strategies that support staff well-being. Future large-scale studies are warranted to assess the pandemic's long-term impact on radiology practice and to inform strategic healthcare planning and resource allocation as the healthcare system transitions beyond the pandemic.

CRediT authorship contribution statement

Nuran Akyurt: Writing – original draft, Validation, Resources, Funding acquisition, Formal analysis, Conceptualization. **Wiam Elshami:** Writing – review & editing, Supervision, Conceptualization. **H.O. Tekin:** Writing – review & editing, Conceptualization.

Declaration of competing interest

The authors declare no conflict of interest.

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