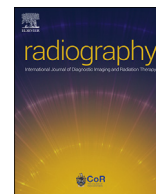




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## Burnout and occupational stress among Hungarian radiographers working in emergency and non-emergency departments during COVID-19 pandemic



David Sipos<sup>a, b, \*</sup>, Timea Jenei<sup>a</sup>, Orsolya L. Kövesdi<sup>a</sup>, Pál Novák<sup>c</sup>, Omar Freihat<sup>a</sup>, József Tollár<sup>a, b</sup>, Attila András Pandur<sup>d</sup>, Árpád Kovács<sup>a, e</sup>, Imre Repa<sup>a, b</sup>, Melinda Petóné Csima<sup>a, f</sup>

<sup>a</sup> Department of Medical Imaging, Faculty of Health Sciences, University of Pécs, Szent Imre Street 14/B, 7400 Kaposvár, Hungary

<sup>b</sup> Dr. József Baka Diagnostic, Radiation Oncology, Research and Teaching Center, "Moritz Kaposi" Teaching Hospital, Guba Sándor Street 40, 7400 Kaposvár, Hungary

<sup>c</sup> Faculty of Health Sciences, University of Pécs, Vörösmarty 4, 7621 Pécs, Hungary

<sup>d</sup> Department of Oxyology, Emergency Care, Faculty of Health Sciences, University of Pécs, Vörösmarty 4, 7621 Pécs, Hungary

<sup>e</sup> Department of Oncoradiology, Faculty of Medicine, University of Debrecen, Nagyerdei 98, 4032 Debrecen, Hungary

<sup>f</sup> Institute of Education, MATE - Hungarian University of Agriculture and Life Sciences, Guba Sándor Street 40, 7400 Kaposvár, Hungary

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### ABSTRACT

**Introduction:** The increased workload caused by the coronavirus pandemic may have had a significant impact on the mental health of radiographers. The aim of our study was to investigate burnout and occupational stress in radiographers working in emergency departments (ED) and non-emergency departments (NED).

**Methods:** Quantitative, cross-sectional, descriptive research was carried out among radiographers working in the public health sector in Hungary. Due to the cross-sectional nature of our survey, there was no overlap between the ED and NED groups. For data collection, we used simultaneously the Maslach Burnout Inventory (MBI), the Effort-Reward Imbalance questionnaire (ERI), and our self-designed questionnaire.

**Results:** We excluded incomplete questionnaires from our survey; finally, 439 responses were evaluated. Significantly higher scores for depersonalisation (DP; 8.43 (SD = 6.69) vs. 5.63 (SD = 4.21) and emotional exhaustion (EE; 25.07 (SD = 11.41) vs. 19.72 (SD = 11.72)) were observed in radiographers working in ED ( $p = 0.001$ ;  $p = 0.001$ ) when compared to NED. Male radiographers working in ED aged 20–29 and 30–39 years with experience of 1–9 years were more affected by DP ( $p \leq 0.05$ ). Worrying about one's own health had a negative effect on DP and EE ( $p \leq 0.05$ ). Having close friend with a COVID-19 infection had a negative effect on EE ( $p \leq 0.05$ ); not being infected with coronavirus, not being quarantined and relocating within the workplace had a positive effect on personal accomplishment (PA); radiographers who were 50 years or older with 20–29 years of experience were more affected by depersonalisation (DP); and those who worried about their health had significantly higher stress scores ( $p \leq 0.05$ ) in both ED and NED settings.

**Conclusion:** Male radiographers at the beginning of their careers were more affected by burnout. Employment in EDs had a negative impact on DP and EE.

**Implications for practice:** Our results support the implementation of interventions to counter the effects of occupational stress and burnout among radiographers working in ED.

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### Introduction

Health professionals come into contact with many patients in their work who have psychological, physical, and social problems, which has the potential to cause them work related stress.<sup>1–3</sup>

\* Corresponding author. Department of Medical Imaging, Faculty of Health Sciences, University of Pécs, Szent Imre street 14/B, 7400 Kaposvár, Hungary.

E-mail address: [cpt.david.sipos@gmail.com](mailto:cpt.david.sipos@gmail.com) (D. Sipos).

Occupational stress can lead to emotional exhaustion, which can be associated with low levels of personal performance and burnout.<sup>4,5</sup>

The rapid outbreak of “Coronavirus Disease 2019” (COVID -19), caused by the agent of “severe acute respiratory syndrome coronavirus 2” (SARS-CoV-2), resulted in significant restrictions worldwide. The pandemic also placed tremendous organisational and clinical pressure on healthcare systems.<sup>6</sup> Management and organisational problems were manifold worldwide, and health care workers were also under above-average stress levels.<sup>7,8</sup>

In order to make a correct diagnosis in patients with suspected/proven COVID -19 infection, medical imaging techniques were required. During the patient screening, radiographers came into close contact with the patient. Therefore, radiographers, along with other health care workers, are among the frontline workers faced with the pandemic.<sup>9</sup>

There are many causes of burnout in radiographers, which may be related to both personal situation and workplace circumstances.<sup>1–3,10,11</sup> The extent of burnout also differs between radiographers working in diagnostics and those working in oncology, both emergency and non-emergency. Working in healthcare, where life and death are at stake on a daily basis, can be emotionally and physically exhausting. Due to the constant stress, professionals may develop biophysical, psychological, and emotional reactions that may also negatively affect their mental health.<sup>10,11</sup> As COVID-19 has become a major stressor, several studies reported increased stress levels in nurses and physicians.<sup>12</sup>

The aim of our study was to investigate the burnout level and occupational stress level of radiographers working in emergency (ED) and non-emergency (NED) departments during the COVID-19 pandemic in Hungary.

**Methods**

*Design*

Quantitative, cross-sectional, descriptive research was conducted. Our online questionnaire was sent electronically by the Society of Hungarian Radiographers to the e-mail addresses of radiographers registered in the Society’s administrative system (n = 1546). The questionnaire in Hungarian was also distributed in the Society’s dedicated social media groups, and monthly reminders were sent to the target audience to respond. The questionnaire was available via both platforms from February 1, 2021, to June 1, 2021.

*Questionnaires*

The questionnaires listed below were used simultaneously and separately to assess the burnout and occupational stress of radiographers working in emergency (ED) and non-emergency departments (NED). Due to the cross-sectional nature of the survey, there was no overlap between the ED and NED groups.

*Maslach Burnout Inventory*

The 22-item questionnaire includes the dimensions of depersonalization (DP), emotional exhaustion (EE), and personal accomplishment (PA).<sup>13</sup> A 7-point Likert scale allowed the respondent to indicate how accurate the answer was for each item.<sup>9–13</sup> The scale was scored by calculating the means of the subscales. Respondents were classified into low, medium, and high burnout using the reference values described by Maslach et al.<sup>14</sup> (Table 1). Low scores for the PA dimension and high scores for the EE and DE dimensions may indicate different degrees of burnout.

**Table 1**  
Thresholds for the Maslach Burnout Inventory subscales.<sup>14</sup>

MBI subscale	Low	Medium	High
DP	≤6	7–12	≥13
EE	≤16	17–26	≥27
PA	≥39	38–32	≤31

DP – depersonalization, EE – emotional exhaustion, PA – personal accomplishment.

*Effort-reward imbalance*

The effort-reward imbalance (ERI) model<sup>15</sup> is a theoretical model of a psychosocial work environment with negative effects on health and well-being that focuses on a mismatch between high effort and low reward at work. The effort and reward dimensions assess the confounding factors that can be directly associated with work and the workplace. The third dimension of the questionnaire, over-commitment, reflects the individual characteristics of the person in the work situation. The quotient of the scales of Effort and Reward provides an indicator for measuring stress at work according to the Siegrist model. This variable, Effort Reward Imbalance, attempts to quantify the relative proportions of costs and benefits in the workday. A ratio >1 means that perceived efforts exceed perceived rewards.<sup>16</sup>

*Self-designed questionnaire*

In addition to basic demographic characteristics, our self-designed questionnaire included items on coronavirus infection in the form of multiple-choice questions. The contents of the self-designed questionnaire are described in Table 2.

*Statistical analysis*

Data processing was performed with SPSS 24.0 statistical software (IBM Corporation, Armonk, NY, USA) and Microsoft Excel 2020 (Microsoft Corporation, Redmond, WA, USA). Descriptive statistics, independent-samples t tests, analyses of variance (ANOVA), Mann–Whitney, and Kruskal–Wallis tests were used (p ≤ 0.05).

*Ethics*

Data collection was anonymous. Our study was approved by the Medical Research Council (registration number: IV/672-1/2021/EKU). In conducting the study, we followed the standards issued by the Declaration of Helsinki. Informed consent was available to

**Table 2**  
Self-designed questionnaire demographic-, work- and COVID related questions.

1. Gender: Male; Female
2. Age: 20–29; 30–39; 40–49; 50+
3. Years experienced in healthcare: 1–9; 10–19; 20–29; 30+
4. Concerns about health status: Not worried; Sometimes worried; Often worried
5. COVID-related overtime: Much more*; Bit more;** Doesn’t change; Less 6 Have you ever been tested positive for COVID? Yes; No
7. Have you ever been quarantined due COVID infection? Yes; No
8. Have you ever examined COVID confirmed patients? Yes; No
9. Have you ever examines COVID suspected patients? Yes; No
10. Have you ever been relocated within your workplace? Yes; No
11. Presence of COVID infection among close family members? (parents, grandparents) Yes; No
12. Presence of COVID infection among close friends? Yes; No
13. Presence of COVID infection among colleagues? Yes; No
14. Type of workplace: Non-Emergency department; Emergency department

\* at least 50% or more than usual \*\* more than usual, but below 50%.

each respondent before completion of the questionnaire, participation was completely voluntary. The questionnaire could be discontinued at any time without giving a reason.

**Results**

A total of 439 radiographers completed our questionnaire (35.2% response rate), with a predominance of women (n = 354, 80.6%). We divided respondents into two groups: those working in ED (n = 260, 59.2%) and those working in NED (n = 179, 40.8%). Radiographers working in ED had “much more” work at the time of the survey (141/260; 54.2%) than radiographers working in NED (42/179; 23.4%). More COVID-19 confirmed patients (252/260; 96.9%) were seen primarily in ED than NED (139/179; 77.6%). In Hungary, it was common for hospital workers to be transferred to nursing wards because of a shortages of specialists due to coronavirus infection. More radiographers were transferred within the institution from departments involved in non-emergency patient care (34/179; 18.9%) than from departments involved in emergency patient care (22/260; 8.4%).

*A descriptive evaluation of the results of the Maslach Burnout Inventory and the effort-reward imbalance questionnaire*

Cronbach  $\alpha$  were 0.807, 0.881, and 0.858 for the dimensions DP, EE, and PA, respectively. For the dimension DP, radiographers working in emergency care had a significantly higher score (t = 4.423; p = 0.001). There were more radiographers with a high DP category from emergency care, however, it should be noted that there were almost as many radiographers with a low DP category (low DP (n = 105; 40.4% vs. n = 107; 41.2%;  $\chi^2 = 22.273$ ; p = 0.001). Regarding the scores of the EE dimension, higher mean scores were observed for radiographers working in emergency care (t = 4.773; p = 0.001). Regarding the severity of burnout, those working in emergency care are more affected by burnout ( $\chi^2 = 25.432$ ; p = 0.001). No significant difference was found in the mean scores of the PA dimension, either when looking at the mean scores (t = -1.806; p = 0.072) or in terms of the severity of burnout within the subcategories of the dimension ( $\chi^2 = 1.632$ ; p = 0.442) (Table 3).

Cronbach  $\alpha$  was 0.794, 0.790, and 0.566 for effort, reward, and overcommitment, respectively. In our analysis, we present the

occupational stress score, which is the quotient of the effort and reward scores. Effort scores did not differ significantly between radiographers working in emergency care and non-emergency department (t = 1.958; p = 0.107) (Table 3).

*Prevalence of burnout among radiographers working in non-emergency patient care*

Female radiographers had significantly lower DP (t = 4.426, p = 0.001) and EE (t = 2.658, p = 0.009) and significantly higher PA scores (t = -2.389, p = 0.018) than men.

Age and length of stay in health care significantly influenced the subscale of burnout DP (F = 4.504, p = 0.005; F = 4.180, p = 0.007). Post-hoc analysis revealed a significant increase in DP (p = 0.001) in radiographers aged 30–39 years compared to other age groups. The DP scores of radiographers working in healthcare for 1–9 and 10–19 years were significantly higher than those of radiographers with more than 20 years of experience (p = 0.001, p = 0.014).

Worrying about health status significantly affected the EE dimension of burnout (F = 3.405, p = 0.035). Post-hoc analysis showed that radiographers who were not worried about their health status had a significantly lower EE (p = 0.010).

For COVID-related overtime, the post-hoc analysis revealed significantly higher scores in the groups that worked “much more” (p = 0.001) and those that worked “less” (p = 0.005) in the PA than the radiographers from the group “bit more” and “does not change”.

The presence of coronavirus infection in the professional (t = 2.105, p = 0.037), examination of patients with confirmed infection (t = 3.011, p = 0.003), and presence of coronavirus infection among close friends (t = -2.712, p = 0.020) significantly increased the scores of DP dimension.

Examination of suspected case of coronavirus (t = 2.159, p = 0.032) and the presence of COVID-19 infection in a close circle of friends (t = -2.343, p = 0.020) also negatively influenced EE scores.

Radiographers who did not have coronavirus infection (t = -2.910, p = 0.001), were not quarantined (t = -3.670, p = 0.050), did not examine a COVID-19 positive patient (t = -3.252, p = 0.001), and coronavirus infection occurred only in their colleagues, had significantly higher PA scores (t = -2.547, p = 0.007).

**Table 3**

The mean scores of the Maslach Burnout Inventory and the Effort-Reward Imbalance Questionnaire and the proportion of burnout categories regarding radiographers working in emergency and non-emergency departments.

		Working at	
		Emergency department n (%)	Non-Emergency department n (%)
<b>Burnout dimension</b>	<b>Category</b>		
<b>Depersonalisation</b>	Low	105 (40.4)	108 (60.3)
	Moderate	48 (18.5)	34 (19.0)
	High	107 (41.2)	37 (20.7)
<b>Overall depersonalisation mean</b>		<b>8.42 (SD = 6.69)</b>	<b>5.63 (SD = 4.21)</b>
<b>Emotional Exhaustion</b>	Low	71 (27.3)	84 (46.9)
	Moderate	66 (25.4)	50 (27.9)
	High	123 (47.3)	45 (25.1)
<b>Overall emotional exhaustion mean</b>		<b>25.07 (SD = 11.41)</b>	<b>19.72 (SD = 11.72)</b>
<b>Personal Achievement</b>	Low	62 (23.8)	48 (26.8)
	Moderate	73 (28.1)	56 (31.3)
	High	125 (48.1)	75 (41.9)
<b>Overall personal achievement mean</b>		<b>32.20 (SD = 9.97)</b>	<b>33.81 (SD = 8.58)</b>
<b>Effort-Reward Imbalance</b>			
<b>Effort</b>	1.87 (SD = 1.10)	1.28 (SD = 1.03)	
<b>Reward</b>	9.36 (SD = 5.36)	6.92 (SD = 4.55)	
<b>Imbalance</b>	8.24 (SD = 2.30)	7.25 (SD = 2.40)	
<b>Stress</b>	0.37 (SD = 1.11)	0.23 (SD = 0.21)	

### Prevalence of stress among radiographers working in non-emergency patient care

Male radiographers had significantly higher stress scores than females ( $t = 3.140$ ,  $p = 0.002$ ). Radiographers who were often worried about their health had significantly higher stress scores ( $F = 5.962$ ,  $p = 0.003$ ). The presence of coronavirus infection in close friends negatively affected a person's stress score ( $t = 3.113$ ,  $p = 0.002$ ).

### Prevalence of burnout among radiographers working in emergency care

The scores of DP ( $t = 6.947$ ,  $p = 0.001$ ) and EE ( $t = 5.248$ ,  $p = 0.001$ ) were significantly lower for female respondents.

According to post-hoc analysis, the score of DP ( $p = 0.001$ ,  $p = 0.001$ ) was significantly higher in radiographers aged 20–29 and 30–39 years and in the group working in healthcare for 1–9 years ( $p = 0.001$ ). Further post-hoc analysis revealed that the score of EE was significantly lower in radiographers working in healthcare for 20–29 years ( $p = 0.030$ ).

Radiographers who were “not worried” and those who were “sometimes worried” about their health had significantly lower DP ( $p = 0.007$ ) and EE ( $p = 0.001$ ).

Regarding COVID-related overtime, respondents who worked “much more” and “a little more” had significantly increased DP ( $p = 0.001$ ) and EE ( $p = 0.001$ ), while their PA scores were significantly lower ( $p = 0.003$ ).

Radiographers working in emergency care who did not have coronavirus ( $t = -1.995$ ,  $p = 0.047$ ) were not subject to quarantine ( $t = -1.967$ ,  $p = 0.050$ ) and had significantly higher PA scores. Regarding PA, moving within the workplace also had a positive effect ( $t = 2.448$ ,  $p = 0.015$ ); however, this variable also resulted in significantly higher DP ( $t = 2.481$ ,  $p = 0.014$ ).

The presence of coronavirus infection in close friends had a negative effect on DP and EE scores ( $t = -4.287$ ,  $p = 0.001$ ;  $t = -2.855$ ,  $p = 0.005$ , respectively).

### Prevalence of stress in radiographers working in emergency patient care

According to post-hoc analysis, the scores of radiographers who were 50 years and older and had worked in healthcare for 20–29 years had significantly higher stress scores ( $p = 0.038$ ,  $p = 0.035$ ).

For concern about health status, respondents who frequently worried about their health status had significantly higher stress scores ( $F = 1.861$ ,  $p = 0.001$ ).

Radiographers who worked “much more” during our questionnaire had significantly higher stress scores ( $F = 4.728$ ,  $p = 0.003$ ).

All results mentioned above are reported in [Table 4](#) and [Table 5](#).

## Discussion

Although the Hungarian health care system tried to keep up with the growing demands, the health care workers were exposed to considerable emotional stress due to difficult situations and the sight of suffering patients.<sup>17</sup>

According to Foley et al., great attention should be paid to the mental health of staff to prevent the long-term negative impact of the epidemic on radiology services.<sup>18</sup> In a study by Chernoff et al., radiographers had one of the highest rates of burnout.<sup>19</sup> Radiographer burnout was primarily related to work experience, number of daily examinations,<sup>20</sup> and longer shifts.<sup>21</sup>

Pereira et al.<sup>22</sup> described 43.5% high EE, 45.5% high DP, and 59.8% low PA among Portuguese radiographers. Professionals younger than 30 years had low levels of EE, while low levels of DP were specific to those older than 50 years. Divorce, the presence of children, and 20–30 years of work experience had a negative impact on EE. They also reported that 23.3% of radiographers had high scores on two dimensions of burnout and another 78.8% had high scores on at least one dimension.<sup>22</sup>

At the time of our survey, due to a shortage of health professionals, it was common for health workers to be transferred to nursing wards to care for patients with coronavirus. In Hungary ED and NED workstations are set up separately in hospitals, and staff contact with each other has been minimised to reduce the risk of infection. The results of the current study showed that the mean scores of DP and EE were higher in radiographers working in ED than in NED. 41.2% of ED radiographers belonged to the high DP, 47.3% to the high EE, and 48.1% to the high PA.

According to Wu et al., frontline staff burnout was significantly lower than normal ward staff burnout (13% vs. 39%). Participants from normal wards were more concerned about infecting themselves or a family member.<sup>23</sup> It is difficult to avoid infection and contact with infected patients in healthcare settings. Pereira et al. reported that 85% of radiographers worked directly with COVID-infected patients.<sup>22</sup>

There were few radiographers in the ED who did not examine a patient with confirmed (8/260; 3,0%) or suspected (6/260; 2,3%) COVID-19 infection. The outbreak of coronavirus infection and the stay in quarantine significantly decreased the sense of PA among radiographers. Screening patients infected with coronavirus had a large impact on the DP of radiographers in NED. Screening patients with suspected coronavirus in this group had a negative impact on EE. Job relocation increased the feeling of DP and PA radiographers in the ED. The presence of coronavirus infection in a close circle of friends negatively affected DP and EE in both groups.

In contrast to the results of El Ghaziri et al.<sup>24</sup> and Woo et al.,<sup>25</sup> our own results showed an increased EE in women. According to Zhang et al.,<sup>26</sup> younger, less experienced nurses showed increased EE. The magnitude of DP was influenced by relatively “much more” work performed. It was also observed that the levels of DP and EE decreased with increasing age and working hours.<sup>26</sup> Murat et al.<sup>27</sup> studied the psychosocial factors of nurses, and high levels of overall stress and burnout were found. Regarding PA, higher time spent on health care and doubts about the quality of work could be mentioned as negative factors.<sup>27</sup>

Following our previous burnout related study among Hungarian radiographers,<sup>28</sup> age and experience significantly influenced all three burnout dimensions of radiographers. Those aged 31–35 years with 16–20 years of work experience were considered the most vulnerable group in all three burnout dimensions. As a result of our further burnout study conducted among oncology radiographers,<sup>29</sup> individual radiographers who took on-call shifts, worked more than 40 h per week, and were involved in oncology patient care also showed high levels EE.

Regarding our current study, DP scores decrease with age and time spent in health care. The score of EE for radiographers involved in emergency patient care is relatively constant across age groups, and lower for those with 20–29 years of experience. Respondents who frequently worried about their health had significantly higher scores of EE in ED. Overtime caused by the coronavirus pandemic negatively impacted radiographers' DP and EE in ED.

In the literature, the score of occupational stress for health care workers is primarily associated with overtime, isolation, lack of workplace support, and less time for meditation and relaxation.<sup>30,31</sup>



**Table 4**

The mean scores of the Maslach Burnout Inventory and the Effort-Reward Imbalance Questionnaire regarding gender, age, years experienced in helathcare, concerns about health status and COVID-related overtime.

	Non-Emergency department radiographers					Emergency department radiographers				
	n	DP	EE	PA	ERI	n	DP	EE	PA	ERI
<b>Gender</b>										
Male	38	9.39 (SD = 7.18)	24.13 (SD = 10.36)	30.89 (SD = 8.80)	0.33 (SD = 0.25)	47	14.06 (SD = 6.69)	31.68 (SD = 9.08)	32.45 (SD = 9.10)	0.24 (SD = 0.13)
Female	141	4.61 (SD = 5.53)	18.53 (SD = 11.81)	34.60 (SD = 8.38)	0.20 (SD = 0.19)	213	7.17 (SD = 6.03)	23.61 (SD = 11.37)	32.15 (SD = 10.18)	0.40 (SD = 0.39)
		<b>p = 0.001</b>	<b>p = 0.009</b>	<b>p = 0.018</b>	<b>p = 0.002</b>		<b>p = 0.001</b>	<b>p = 0.001</b>	p = 0.537	p = 0.384
<b>Age (years)</b>										
20-29	20	6.65 (SD = 7.56)	20.55 (SD = 9.67)	37.10 (SD = 7.25)	0.26 (SD = 0.27)	62	11.05 (SD = 7.13)	26.85 (SD = 11.94)	31.05 (SD = 8.89)	0.26 (SD = 0.42)
30-39	44	8.16 (SD = 6.68)	23.61 (SD = 12.73)	32.27 (SD = 8.14)	0.28 (SD = 0.22)	60	11.32 (SD = 7.26)	26.85 (SD = 11.17)	33.52 (SD = 8.32)	0.24 (SD = 0.18)
40-49	38	3.66 (SD = 3.22)	18.58 (SD = 10.96)	34.00 (SD = 7.07)	0.25 (SD = 0.17)	76	6.79 (SD = 4.66)	22.63 (SD = 9.36)	32.42 (SD = 10.86)	0.34 (SD = 0.56)
50+	77	4.48 (SD = 6.17)	17.84 (SD = 11.61)	33.74 (SD = 9.66)	0.19 (SD = 0.20)	62	4.98 (SD = 5.54)	24.55 (SD = 12.93)	31.81 (SD = 11.32)	0.66 (SD = 0.28)
		<b>p = 0.005</b>	p = 0.062	p = 0.225	p = 0.189		<b>p = 0.001</b>	p = 0.086	p = 0.574	p = 0.141
<b>Years experienced in healthcare</b>										
1-9	48	7.98 (SD = 7.10)	22.50 (SD = 9.22)	33.04 (SD = 8.73)	0.27 (SD = 0.25)	96	11.50 (SD = 7.49)	26.84 (SD = 12.39)	31.65 (SD = 9.13)	0.26 (SD = 0.36)
10-19	39	6.03 (SD = 5.76)	18.67 (SD = 14.95)	31.95 (SD = 10.04)	0.21 (SD = 0.08)	49	9.63 (SD = 5.70)	25.33 (SD = 8.14)	33.02 (SD = 7.68)	0.24 (SD = 0.15)
20-29	34	4.62 (SD = 6.06)	21.15 (SD = 11.22)	34.59 (SD = 6.28)	0.21 (SD = 0.12)	50	5.96 (SD = 5.10)	20.88 (SD = 9.97)	32.88 (SD = 11.27)	0.68 (SD = 2.36)
30+	58	4.00 (SD = 5.25)	17.29 (SD = 11.06)	35.24 (SD = 8.48)	0.22 (SD = 0.26)	65	4.85 (SD = 4.54)	25.48 (SD = 12.42)	31.88 (SD = 11.66)	0.38 (SD = 0.64)
		<b>p = 0.007</b>	p = 0.110	p = 0.251	p = 0.483		<b>p = 0.001</b>	<b>p = 0.026</b>	p = 0.821	p = 0.153
<b>Concerns about health status</b>										
not worried	24	3.63 (SD = 4.71)	14.04 (SD = 10.26)	33.96 (SD = 10.17)	0.17 (SD = 0.24)	43	8.67 (SD = 7.47)	22.74 (SD = 13.01)	33.65 (SD = 11.12)	0.21 (SD = 0.11)
sometimes worried	127	6.19 (SD = 6.52)	20.76 (SD = 12.35)	34.39 (SD = 7.28)	0.13 (SD = 0.09)	156	7.49 (SD = 6.45)	23.77 (SD = 10.52)	32.34 (SD = 10.91)	0.21 (SD = 0.13)
often worried	28	4.79 (SD = 5.60)	19.89 (SD = 8.36)	31.07 (SD = 11.86)	0.27 (SD = 0.21)	61	10.62 (SD = 6.36)	30.03 (SD = 11.12)	30.82 (SD = 8.45)	0.48 (SD = 1.43)
		p = 0.133	<b>p = 0.035</b>	p = 0.181	<b>p = 0.003</b>		<b>p = 0.007</b>	<b>p = 0.001</b>	p = 0.350	<b>p = 0.001</b>
<b>COVID-related overtime * at least 50% or more than usual ** more than usual, but below 50%</b>										
much more*	42	6.76 (SD = 7.13)	22.88 (SD = 10.24)	35.02 (SD = 9.27)	0.20 (SD = 0.15)	141	9.91 (SD = 6.65)	26.15 (SD = 11.16)	30.74 (SD = 10.00)	1.15 (SD = 3.34)
bit more**	44	5.07 (SD = 4.61)	19.07 (SD = 10.97)	31.82 (SD = 7.00)	0.23 (SD = 0.22)	64	11.41 (SD = 6.88)	27.66 (SD = 8.10)	31.67 (SD = 8.17)	0.23 (SD = 0.12)
doesn't change	35	4.03 (SD = 5.51)	20.71 (SD = 12.55)	31.40 (SD = 10.64)	0.24 (SD = 0.09)	31	5.90 (SD = 5.83)	20.68 (SD = 15.07)	36.03 (SD = 10.65)	0.23 (SD = 0.24)
less	58	6.19 (SD = 6.84)	17.33 (SD = 12.43)	35.90 (SD = 7.17)	0.24 (SD = 0.28)	24	6.71 (SD = 5.48)	17.50 (SD = 10.91)	37.21 (SD = 11.03)	0.33 (SD = 0.52)
		p = 0.209	p = 0.118	<b>p = 0.023</b>	p = 0.795		<b>p = 0.001</b>	<b>p = 0.001</b>	<b>p = 0.003</b>	<b>p = 0.003</b>

DP – depersonalization, EE – emotional exhaustion, PA – personal achievement, ERI – effort-reward imbalance – occupational stress score.

**Table 5**

The mean scores of the Maslach Burnout Inventory and the Effort-Reward Imbalance Questionnaire regarding COVID-19 infection, COVID-19 quarantine, examination of COVID-19 confirmed-, suspected patient, relocation within workplace and the presence of COVID infection among close family members-, close friends-, colleagues.

Non-Emergency department radiographers					Emergency department radiographers				
n	DP	EE	PA	Stress	n	DP	EE	PA	Stress
<b>Have you ever been tested positive for COVID?</b>									
yes 31	7.74 (SD = 7.08)	21.94 (SD = 12.93)	28.32 (SD = 12.27)	0.19 (SD = 0.13)	43	9.56 (SD = 7.34)	24.60 (SD = 11.21)	29.44 (SD = 11.62)	0.23 (SD = 0.11)
no 148	5.18 (SD = 5.90)	19.26 (SD = 11.44)	34.96 (SD = 7.13)	0.24 (SD = 0.22)	217	8.19 (SD = 6.55)	25.16 (SD = 11.47)	32.75 (SD = 9.55)	0.40 (SD = 1.21)
	<b>p = 0.037</b>	p = 0.248	<b>p = 0.001</b>	p = 0.274		p = 0.223	p = 0.771	<b>p = 0.047</b>	p = 0.330
<b>Have you ever been quarantined due COVID infection?</b>									
yes 83	5.72 (SD = 5.31)	21.13 (SD = 10.51)	31.36 (SD = 9.51)	0.23 (SD = 0.17)	136	8.99 (SD = 6.52)	25.88 (SD = 11.57)	31.04 (SD = 10.39)	0.43 (SD = 1.46)
no 96	5.54 (SD = 6.93)	18.50 (SD = 12.59)	35.93 (SD = 7.08)	0.24 (SD = 0.23)	124	7.79 (SD = 6.84)	24.19 (SD = 11.20)	33.47 (SD = 9.39)	0.30 (SD = 0.46)
	p = 0.846	p = 0.134	<b>p = 0.050</b>	p = 0.969		p = 0.148	p = 0.234	<b>p = 0.050</b>	p = 0.370
<b>Have you ever examined COVID confirmed patient?</b>									
yes 139	6.36 (SD = 6.36)	19.82 (SD = 11.11)	32.72 (SD = 9.04)	0.23 (SD = 0.23)	252	8.40 (SD = 6.67)	25.22 (SD = 11.43)	32.15 (SD = 9.97)	0.37 (SD = 1.12)
no 40	3.08 (SD = 4.95)	19.38 (SD = 13.78)	37.60 (SD = 5.32)	0.22 (SD = 0.11)	8	9.13 (SD = 7.73)	20.38 (SD = 10.07)	33.75 (SD = 10.63)	0.41 (SD = 0.41)
	<b>p = 0.003</b>	p = 0.833	<b>p = 0.001</b>	p = 0.857		p = 0.763	p = 0.238	p = 0.656	p = 0.924
<b>Have you ever examined COVID suspected patient?</b>									
yes 162	5.88 (SD = 6.32)	20.33 (SD = 12.05)	33.54 (SD = 8.69)	0.23 (SD = 0.21)	254	8.42 (SD = 6.69)	25.20 (SD = 11.47)	32.11 (SD = 9.98)	0.37 (SD = 1.12)
no 17	3.24 (SD = 4.53)	13.94 (SD = 5.25)	36.41 (SD = 7.12)	0.21 (SD = 0.12)	6	8.33 (SD = 7.20)	19.67 (SD = 6.72)	36.17 (SD = 9.88)	0.53 (SD = 0.43)
	p = 0.096	<b>p = 0.032</b>	p = 0.190	p = 0.730		p = 0.957	p = 0.241	p = 0.326	p = 0.742
<b>Have you ever been relocated within your workplace? (for example to nursing ward)</b>									
yes 34	4.74 (SD = 3.75)	18.32 (SD = 8.12)	31.53 (SD = 8.74)	0.18 (SD = 0.21)	22	11.77 (SD = 7.54)	25.36 (SD = 8.31)	37.14 (SD = 7.03)	0.32 (SD = 0.24)
no 145	5.83 (SD = 6.65)	20.05 (SD = 12.41)	34.34 (SD = 8.49)	0.24 (SD = 0.21)	238	8.11 (SD = 6.53)	25.04 (SD = 11.66)	31.74 (SD = 10.09)	0.37 (SD = 1.16)
	p = 0.355	p = 0.323	p = 0.085	p = 0.163		<b>p = 0.014</b>	p = 0.900	p = 0.015	p = 0.834
<b>Presence of COVID infection among close family members? (parents, grandparents)</b>									
yes 66	6.44 (SD = 6.48)	21.14 (SD = 10.97)	32.67 (SD = 9.75)	0.25 (SD = 0.22)	110	8.50 (SD = 6.22)	26.44 (SD = 11.02)	32.27 (SD = 10.32)	0.51 (SD = 1.61)
no 113	5.15 (SD = 5.15)	18.89 (SD = 12.10)	34.48 (SD = 7.82)	0.22 (SD = 0.20)	150	8.36 (SD = 7.03)	24.07 (SD = 11.61)	32.15 (SD = 9.75)	0.27 (SD = 0.42)
	p = 0.181	p = 0.218	p = 0.174	p = 0.280		p = 0.868	p = 0.098	p = 0.920	p = 0.087
<b>Presence of COVID infection among close friends?</b>									
yes 81	6.99 (SD = 7.07)	21.95 (SD = 11.59)	34.80 (SD = 7.81)	0.27 (SD = 0.24)	129	10.16 (SD = 6.78)	27.08 (SD = 11.10)	31.52 (SD = 10.08)	0.24 (SD = 0.31)
no 98	4.50 (SD = 5.17)	17.88 (SD = 11.55)	32.99 (SD = 9.13)	0.17 (SD = 0.14)	131	6.71 (SD = 6.16)	23.09 (SD = 11.42)	32.87 (SD = 9.86)	0.50 (SD = 0.154)
	<b>p = 0.007</b>	<b>p = 0.020</b>	p = 0.160	<b>p = 0.002</b>		<b>p = 0.001</b>	<b>p = 0.005</b>	p = 0.276	p = 0.064
<b>Presence of COVID infection among colleagues?</b>									
yes 121	5.86 (SD = 6.50)	19.98 (SD = 11.88)	35.00 (SD = 7.85)	0.23 (SD = 0.21)	198	8.15 (SD = 6.71)	25.38 (SD = 11.44)	32.59 (SD = 9.79)	0.41 (SD = 1.27)
no 58	5.14 (SD = 5.58)	19.19 (SD = 11.45)	31.33 (SD = 9.54)	0.23 (SD = 0.20)	62	9.27 (SD = 6.61)	24.06 (SD = 11.32)	30.95 (SD = 10.54)	0.24 (SD = 0.18)
	p = 0.469	p = 0.676	<b>p = 0.007</b>	p = 0.875		p = 0.250	p = 0.428	p = 0.260	p = 0.274

DP – depersonalization, EE – emotional exhaustion, PA – personal achievement, ERI – effort-reward imbalance – occupational stress score.

Clear communication about the infection status of patients is essential to protect health care workers and avoid unnecessary anxiety and stress.<sup>18</sup> The loss of skilled workers is a real threat. The rapidity of the pandemic made it necessary to immediately stimulate productivity and make work more attractive, otherwise it can be observed that between pandemic waves many workers have left the company and many others want to do the same.<sup>30,31</sup> Our 2017 study supports this notion.<sup>32</sup> It found that ERI was significantly higher among female radiographers and among those who rated their monthly earnings as below average, and these variables were also consistent with leaving the profession.<sup>32</sup>

In our previous articles,<sup>28,29,32</sup> the number of female respondents significantly dominated the respondent group (85.9%; 91.3% and 68%). In the present article, we also demonstrate a female dominance (80.6%), hence the stress level of male radiographers from non-emergency care can be considered as a significant predisposing factor should be treated with reservations. Radiographers who frequently worried about their health had significantly higher stress scores in both groups. Being 50 years or older with the work experience of 20–29 years, doing “Much more” work in emergency care also negatively affected sample stress scores. The presence of coronavirus among close friends negatively affected stress scores of radiographers who did not work in emergency care. Alsubaie et al. shown that the presence of infection among colleagues and friends is a significant stressor.<sup>33</sup>

**Limitations**

There are several limitations to the present study. At first, the limited sample equal to only 35.2% of the estimated total Hungarian

radiographers. Secondly, because the COVID-19 Pandemic affected the regions of Hungary in different ways, it would be interesting to have a larger sample to examine whether the associations between burnout and psychological characteristics differ according to the severity of health distress. We need to mention that low response rate, and the dominance of female gender, that may over- or underestimate the burnout and occupational stress level of the radiographers. Also the extra work caused by the Pandemic may have been prevented the time spent on the social network, and it is possible that the radiographers did not monitor the social networking sites where our questionnaire was posted.

**Conclusion**

There is agreement that the extent of burnout varies across professions and countries. It is generally believed that younger people have a higher rate of burnout.<sup>7,11,12</sup> Regarding our results young male radiographers from NED who experienced coronavirus infection at the beginning of their careers, examined patients with coronavirus, and had COVID-19 infections in their close circle of friends tended to be more affected by burnout.

In the case of radiographers working in ED, young male radiographers who are at the beginning of their careers are also more affected by the dimensions of burnout. The fear of infection, the extra work caused by the pandemic, the infection in close family members negatively affected the score of DE and EE. Relocation within the institution had a negative effect on the score of DE, but at the same time increased the feeling of PA.

Men working in NED are who experienced infection in close acquaintances experienced significantly higher occupational stress.

Exceptionally high levels of occupational stress were observed among radiographers, who frequently worried about their own health status in both groups. Radiographers with “much more” COVID-related work also experienced higher levels of stress in emergency patient care.

The results of our study will help to understand the advantages and disadvantages of coping strategies for the radiography profession. Understanding that in a crisis situation such as the current pandemic, problem-solving strategies can do more to overcome occupational stress, prevent burnout and DP of health professionals, and help personalize education for these frontline workers in the future.

## Author contributions

**David Sipos:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – Original Draft; **Timea Jenei:** Writing – Original Draft; **Orsolya Liza Kövesdi:** Writing – Original Draft; **Pál Novák:** Visualization, Writing – Review and Editing; **Omar Freihah:** Writing, Review and Editing; **József Tollár:** Review and Editing; **Attila András Pandur:** Review and Editing; **Árpád Kovács:** Writing – Review and Editing; **Imre Repa:** Writing – Review and Editing; **Melinda Petőné Csima:** Supervision, Methodology, Writing – Review and Editing.

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## Conflict of interest

All authors declare, there is no conflict of interest.

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