RCHESTRA

Connecting European Cohorts
to Increase Common
and Effective Response to
SARS- CoV-2 Pandemic

WP5 Deliverable D5.2

Report with results of analysis of determinants of COVID-19 and their longitudinal changes among HCWs

Alma Mater Studiorum - Universita Di Bologna (UNIBO)

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Executive summary

Work Package 5 (WP5) is dedicated to collecting, standardizing, and harmonizing data related to the effects of the COVID-19 pandemic on healthcare workers (HCWs). Given their high risk of exposure to the virus, this occupational group was prone to many sequelae of infections, including psychological consequences. The purpose of this document is to describe the activities carried out under Task 5.3: Assessing the long-term effects of exposure to COVID-19, and risk of reinfection. The primary endpoint of the analysis of psychological consequences will be burnout, with mood disturbance and mindfulness as secondary outcome. This document reports the collaborative and single-center studies performed:

1. Development of an innovative psychometric tool to screen for emotional exhaustion among HCWs during public health crises.

2. Comprehensive data collection and study of the epidemiological features of occupational mental health, exploring sociodemographic and occupational factors as determinants of COVID-19, focusing on emotional exhaustion, and their longitudinal changes.

3. The publication and dissemination of research findings emphasize the importance of addressing occupational mental health among HCWs during the pandemic.

This report concludes with the results of the ongoing analysis of determinants of COVID-19 and their longitudinal changes among HCWs. To this end, we will update this report with the finalized version as soon as our detailed analysis is complete by M41(April 2024).

Rationale for expanding D5.2

During the COVID-19 pandemic, psychological consequences due to occupational stress among healthcare workers have become evident, such as occupational burnout, compassion fatigue, and change fatigue. To address emotional exhaustion among healthcare workers, we propose developing a psychometric screening tool for early detection. This proactive approach aims to identify occupational mental health indicators for emotional exhaustion before they deteriorate into more severe occupational phenomena like burnout, compassion fatigue, and change fatigue.

The selection of emotional exhaustion as a focus for research is justified by its established role as a fundamental component in various work-related psychological constructs, its theoretical significance as an antecedent to more severe psychological states, and empirical data underscoring its precedence in the sequence of psychological responses to stress in healthcare settings (1).

Core content

Introduction and context

The mental health and psychological welfare of healthcare workers during this pandemic have been strained due to increased workload, working in an unfamiliar clinical environment, insufficient availability of equipment, such as personal protective equipment, stress resulting from making difficult decisions, the agony of losing patients and colleagues, as well as the risk of contracting the virus themselves or transmitting it to their families, with numerous publications reporting on this matter (2–6). The prolonged struggles exposed healthcare workers to deteriorating mental health at work (6–9).

The ORCHESTRA project started in December 2020, and task 5.3 was designed to assess the long-term effects of exposure to COVID-19 including psychological conditions. The primary endpoint of the analysis of psychological consequences will be burnout, with mood disturbance and mindfulness as secondary outcome.

In May 2023, the World Health Organization declared an end to COVID-19 as a global health emergency (10), while emphasizing that this does not mean the disease is no longer a global threat, especially from the mental health perspective, which allows Work Package 5, Task 5.3, to explore not only occupational mental health issues such as emotional exhaustion, its sociodemographic and occupational determinants, and enable its comparison during and after COVID-19 pandemic.

Analysis

This report concentrates on the completed aspects of this work task and provides a summary of the ongoing work. The completed analysis will be shared **by M41 (April 2024)**. The report is categorized into collaborative studies and single-center studies.

Collaborative studies

This section reports the combined analysis in two main components:

1. Development of a new psychometric tool - The ORCHESTRA Emotional Exhaustion Screening Questionnaire (OEEQ) to meet the context of the public health crisis of the COVID-19 pandemic.

2. Report on data collection on the sociodemographic and occupational factors as determinants of COVID-19, focusing on emotional exhaustion, and their longitudinal changes in the Romania and Slovakia cohort, both during and after the COVID-19 pandemic.

ORCHESTRA Emotional Exhaustion Screening Questionnaire (OEEQ)

WP5.3's initial step involved the creation of a new psychometric tool - the ORCHESTRA Emotional Exhaustion Screening Questionnaire (OEEQ). This tool is designed to assist in screening and measuring emotional exhaustion among HCWs during the COVID-19 pandemic. It aims to screen for occupational burnout, change fatigue, and compassion fatigue before their manifestation in HCWs during a public health crisis, facilitating more focused interventions, as attached in **Appendix 1**.

Methods: The methods comprised a four-step approach to developing and validating the *'ORCHESTRA Emotional Exhaustion Screening Questionnaire'* for HCWs. The process began in June 2022 with a thorough literature review to identify emotional exhaustion items within existing questionnaires related to occupational burnout, compassion fatigue, and change fatigue among HCWs. Various databases were searched, and validated questionnaires published were selected for analysis. The identified items were then categorized according to Maslach et al.'s five components of emotional exhaustion: wearing out, loss of energy, depletion, debilitation, and fatigue. Following this, in July 2022, the content validity of these items was assessed by six expert panels from the ORCHESTRA research group across Spain, Slovakia, and Romania. This step was pivotal in developing a questionnaire with one question per construct in both scale and dichotomous formats. The experts, who had relevant academic and professional backgrounds, evaluated and reworded the items to ensure they were clear and applicable to HCWs, including those working in shift patterns.

Subsequently, the reliability and convergent validity of the questionnaire were tested through an online cross-sectional survey conducted from August to December 2022 at the Central University Hospital of Asturias. The survey, which included the newly developed ORCHESTRA questionnaire and the Maslach Burnout Inventory (MBI) for comparison, received ethical approval. Participation was voluntary and anonymous. The final step, accuracy testing, was focused on determining the precision of the ORCHESTRA questionnaire by using the MBI's emotional exhaustion dimension as a gold standard. Statistical analysis on sensitivity, specificity, predictive values, and ROC curve analysis were utilized to ascertain the diagnostic effectiveness of the questionnaire, thereby concluding its role as a reliable tool for measuring emotional exhaustion among HCWs.

Result: The literature review identified 15 validated questionnaires, leading to the extraction of 79 items focusing on the emotional exhaustion dimension. However, only 32 items remained after removing duplicates, and those did not fit the definition. These were further refined based on the five components of emotional exhaustion defined by Maslach et al.: wearing out, loss of energy, depletion, debilitation, and fatigue. The content validity phase involved expert review and resulted in the selecting of five items with a Content Validity Ratio (CVR) and Content Validity Index (CVI) score of 1, indicating a high level of relevance and representation for measuring emotional exhaustion.

The reliability and convergent validity of the questionnaire were tested through a survey involving 148 healthcare workers, predominantly female, with various professional backgrounds and education levels, many of whom worked in shifts. No significant differences in emotional exhaustion were observed across different demographic variables, except for low personal accomplishment amongst HCWs working in shifts and different occupations, as shown in **Appendix 2**. Notably, the ORCHESTRA questionnaire showed strong positive correlations with the Maslach Burnout Inventory's emotional exhaustion dimension, demonstrating its reliability (Cronbach's Alpha of 0.834 for the scale and 0.782 for the dichotomous version). The final step, accuracy testing, revealed that both the scale and dichotomous questionnaire versions had high sensitivity, specificity, and predictive values, confirming their effectiveness as screening tools for emotional exhaustion among healthcare workers. The ROC curve analysis further validated the accuracy of these tools in capturing the emotional exhaustion dimension.

Conclusion: This study developed and validated the ORCHESTRA Emotional Exhaustion Questionnaire to measure emotional exhaustion among healthcare workers. The questionnaire's development was grounded in a comprehensive literature review, and experts in the field evaluated its content validity. The final version of the questionnaire included five items, exhibiting a Cronbach's alpha coefficient of 0.83 for the scale and 0.78 for dichotomous responses, demonstrating favorable internal consistency, reliability, and sensitivity (90.6%) and specificity (91.6%) for the scale, and sensitivity (88.7%) and specificity (89.5%) for dichotomous responses. Findings from the pilot study demonstrated the questionnaire's clarity, relevance, and comprehensibility among participants, further supporting its validity and reliability in assessing emotional exhaustion among healthcare workers.

The detailed literature review, report, and result is available in open access publication of the British Journal of Health Psychology: https://doi.org/10.1111/bjhp.12706

Sociodemographic and Occupational Determinants of COVID-19-Related Emotional Exhaustion: Longitudinal Study in Romanian and Slovak Cohorts

Next, by using the newly developed psychometric tool –the ORCHESTRA Emotional Exhaustion Questionnaire (OEEQ), we screened emotional exhaustion among healthcare workers in Romania and Slovakia cohorts, both during and after the COVID-19 pandemic, to understand the broader implications of the pandemic on healthcare professionals. Data were collected from a cohort of 895 Romanian and 578 Slovakian healthcare workers, who provided insights into their experiences of COVID-19 exposure and associated emotional exhaustion at work, sociodemographic, and occupational information. Two surveys were done; the first was between June and September 2022 (during the COVID-19 pandemic), and the last was between June and September 2023 (after the COVID-19 pandemic). The analysis is currently ongoing and completed analysis will be update by **M41 (April 2024)**.

Notably, the study also aims to explore the potential correlations between COVID-19 exposure, the incidence of long-term COVID-19, and the resultant emotional exhaustion experienced by the HCWs, enabling the exploration of the pandemic's impact on the mental well-being of the HCWs. The sample includes a diverse range of HCWs, for profession, age, and work setting, to ensure a comprehensive understanding of the issue across different contexts. The outcomes of this study are expected to contribute knowledge on HCWs' emotional exhaustion at work during and after the COVID-19 pandemic.

Single-center studies

This section reports the analysis in three participating centers (INSP, RAPH BB, UNIOVI).

1. National Institute of Public Health (INSP), Romania

The ORCHESTRA project in INSP, Romania has a prospective cohort of over 1000 healthcare workers. The aim is to analyse the impact of the COVID-19 pandemic on their health and well-being from multiple perspectives.

The detailed description of the INSP cohort can be accessed in the Romanian Journal of Occupational Medicine: https://doi.org/10.2478/rjom-2021-0008

In line with task 5.3, INSP published the study entitled **Exhaustion in Healthcare Workers after the First Three Waves of the COVID-19 Pandemic.** It aimed to identify the factors contributing to exhaustion among frontline and second-line HCWs during the third wave of the COVID-19 pandemic.

Method: Data were collected via an anonymous questionnaire distributed through Survey Monkey to HCWs in various medical settings across Romania, using institutional email addresses from public health websites. Of the 2698 individuals who responded to the invitation, 1872 completed all survey items. The study included a diverse mix of HCWs, both those directly interacting with patients and those in administrative, research, and educational roles. A case-control approach was employed, distinguishing frontline HCWs (1311 individuals), who had contact with COVID-19 patients, from second-line HCWs (561 individuals) not involved in direct patient care. The data collection period, from May to June 2021, which coincided with the decline in COVID-19 cases after Romania's third pandemic wave.

The study assessed exhaustion using a validated Romanian questionnaire. The resulting exhaustion score was the main variable in both univariate and multivariate regression models, with high-risk exhaustion identified for scores above 75% of the maximum. The Siegrist questionnaire measured effort-reward imbalance and overcommitment, and additional variables included occupational details such as job role, working hours, and patient load. Specific stress determinants considered were personal COVID-19 experiences and perceived risk management at work. Demographic factors like age, gender, marital status, and education

level were also analysed. Statistical analyses used tests like Pearson's chi-squared, Mann–Whitney, and Kruskal–Wallis, and the significance was set at a p-value less than 0.05. Data processing was conducted using STATA software.

Result: The examination of exhaustion among HCWs during the COVID-19 pandemic revealed significant differences between frontline (flHCW) and second-line (slHCW) workers. The general characteristics of the population are shown in **Appendix 4**. flHCW reported significantly more frequent longer working hours ($p = 0.0009$) and a better perception of the management of the risk for infection ($p = 0.0002$) than slHCW. The effort and overcommitment scores were higher in flHCW ($9.51 + 1.98$ vs. $8.45 + 21$, $p < 0.001$ and 16.34 ± 2.80 vs. 15.24 ± 2.94, $p < 0.001$, respectively) and the reward scores were lower (5.21 ± 1.522 vs. 5.99 ± 1.44, $p < 0.001$). The univariate analysis indicated that combining individual factors (like age, education, and overcommitment) and job characteristics (such as workload and occupation) influenced exhaustion levels. For flHCWs, the number of patients per day was directly related to exhaustion, whereas in the slHCWs, gender and age were significant factors. Occupational stressors, such as working hours, night shifts, and effort/reward imbalance, were also related to exhaustion. Additionally, personal experiences with COVID-19 and perceptions of infection risk management at the workplace significantly impacted exhaustion levels, analysis shown in **Appendix 5**.

In the multivariate analysis, high exhaustion risk among flHCW was associated mainly with overcommitment, effort/reward imbalance, and age. This risk was linked to overcommitment, effort/reward imbalance, and average daily working hours for second-line workers. Effort and overcommitment scores were higher, and reward scores were lower in frontline workers than in second-line workers. Additionally, flHCW had a greater incidence of COVID-19 infection and symptom persistence. The study also found that being diagnosed with COVID-19 increased the odds of higher exhaustion scores in frontline workers. These findings highlight the varied impact of the pandemic on different groups of healthcare workers, underscoring the importance of addressing individual and occupational factors in mitigating exhaustion and stress in healthcare settings, as shown in **Appendix 6**.

Conclusion: Through this analysis, we showed more similarities than differences between flHCW and slHCW. Even if flHCW had a higher risk of exhaustion, this risk was not negligible in slHCW. Overcommitment and the perception of effort/reward imbalance are the main determinants of exhaustion in both groups of HCW. Many workplace stressors are manageable, but lessons learned from the previous two COVID-19 waves were not enough to satisfactorily reduce the workload and emotional burden. Nevertheless, the content seemed to be better managed in the flHCW group, and the context of the work should attract more attention. For slHCW, the length of working hours was not properly adjusted, and better planning of human resources in this group is needed.

The detailed literature review, report, and result is available in open access publication of the International Journal of Environmental Research and Public Health: https://doi.org/10.3390/ijerph19148871

These results were disseminated as an oral presentation at the Conference of the Regional Public Health Center (Timisoara, Romania, 11-13 May 2023).

2. Regional Authority of Public Health Banska Bystrica (RAPH BB), Slovak Republic

The RAPH BB cohort research population consisted of HCWs from selected medical and social care facilities from the Banská Bystrica, Bratislava, Ružomberok, and Martin regions. The study involved a cohort of healthcare workers, who were surveyed across three different questionnaires to understand their psychological and psychosocial stress levels during the COVID-19 pandemic. There was no age limit for respondents.

Initially, 1072 participants responded to the first questionnaire. The second questionnaire saw a response from 766 individuals, and the third questionnaire was completed by 558 participants. Notably, 465 respondents from the original group completed all three questionnaires. An analysis of the age structure revealed that 39.5% of the respondents were over 50 years old. Consistent with trends in other countries, a significant majority of the sample comprised females, representing 85.0% of respondents. The cohort mainly included nurses, public health workers, social workers, and auxiliary healthcare personnel.

The study also recorded non-response rates for specific questions. Concerning queries about emotional state, 3%, 8%, and 8% of respondents did not answer in the first, second, and third questionnaires, respectively. As for questions about psychological and psychosocial stress, the non-response rates were 2%, 5%, and 5% for the three respective questionnaires.

During the first half of 2021, 88% of all respondents perceived an increase in psychological and psychosocial stress compared to the pre-pandemic period. By the end of 2021, this perception decreased to 58%, and further dropped to 33% at the onset of 2022, a statistically significant decrease in the perception of psychological stress was confirmed concerning gender ($p < 0.01$).

In the next step, we focused on a more detailed analysis of the following responses, conducting a thorough analysis based on profession and gender:
a) At the end of the workday, I feel exhausted;
b) I feel emotionally drained;
c) The current situation frustrates me; I feel angry;
d) I feel tired when I wake up in the morning and know that I have to go to work;
e) I am convinced that I need to quit this job.

The emotional experiences of respondents during the second wave of the pandemic (April-June 2021) were also documented. Common feelings included exhaustion at the end of the working day (reported by 551 respondents), emotional exhaustion (277 respondents), anger

and frustration with the situation (264 respondents), and tiredness upon waking up with the prospect of going to work (239 respondents).

Between the first and second questionnaires, both doctors (p = 0.052) and nurses (p = 0.048) reported a slight decrease in the feeling of exhaustion at the end of the workday, approaching the threshold of statistical significance. In contrast, social workers experienced a statistically significant reduction in perceived exhaustion only after two years of the pandemic, evident in the responses from the second to the third questionnaire (p = 0.0045), as illustrated in **Appendix 7**.

Reflecting on their work-related emotional state, a notable number of healthcare professionals identified with the sentiment "I am tired and considering a change of job." In the first questionnaire, 55 out of 328 nurses resonated with this feeling, followed by a response from 30 out of 236 nurses in the second, and 44 out of 204 in the third. The sentiment was shared by physicians as well, with 14 out of 127 expressing this in the first questionnaire, 11 out of 85 in the second, and 7 out of 76 in the third. Social workers were not immune to this fatigue, with 13 out of 273 agreeing in the first questionnaire, and the number holding steady at 6 for both the second questionnaire from 192 and the third from 112 respondents, as shown in table 7b in Appendix 7.

Among the healthcare professionals surveyed, nurses specifically articulated a strong sentiment regarding their work situation with the statement "I am convinced that I need to quit this job." This was acknowledged by 11 out of 328 nurses in the first questionnaire, with a slight decrease to 5 out of 236 in the second questionnaire and maintaining at 5 out of 204 in the third. In contrast, none of the physicians reported feeling the need to quit their job across all three questionnaires, as shown in table 7c in Appendix 7.

These are preliminary results that will be included in pan-European analyses. The preliminary results support our adopted working hypothesis: "As the pandemic develops, stricter rules and measures are implemented, and the overall improvement in the COVID-19 situation, especially due to vaccination possibilities, the perception of psychological stress among healthcare workers will improve."

Of course, there are potential limitations to this research, especially in terms of timing during the ongoing pandemic. It is possible that respondents' subjective perceptions of stress may change over time depending on the effectiveness of measures taken by individual healthcare facilities. The questionnaire method collects data through subjective assessments of the situation during the pandemic, without considering objectivity, and investigates acute problems related to the present time.

Retrospective assessments are often biased. A smaller sample of respondents complicates generalizing the results to a broader population of healthcare workers. To confirm the above findings, further surveys and examinations on a larger sample would be necessary. Any future surveys should consider implementing structured interviews coded by expert evaluators for an

objective assessment of psychological and physical stress. WHO identified in 2021 4 main components affecting the mental well-being of healthcare workers during the pandemic: availability and distribution, health, working conditions, and social well-being.

We are now working on further systematic data collection on the psychological stress of healthcare personnel in the EU in collaboration with UNIOVI in Spain and INSP in Romania, focusing on the quality of data obtained from respondents. The goal is to develop a rapid screening tool for assessing psychological stress that can be quickly applied during a health crisis. This screening tool should also include separate modules for assessing burnout syndrome, emotional exhaustion, depersonalization, and reduced personal performance.

These results were also disseminated at the XXIX congress of occupational medicine (Pilsen, Czech Republic, 243-25 October 2023).

3. Universidad de Oviedo (UNIOVI), Spain

Amidst the COVID-19 pandemic, HCWs in Spain have encountered significant challenges leading to increased occupational burnout and deteriorating mood states, such as those related to anxiety and depression. To address these adverse psychological consequences, a study was initiated to assess the role of mindfulness as a potential mitigating factor. The primary objective of the study is to explore the impact of mindfulness practices on moderating negative mood profiles and burnout symptoms among Spanish HCWs.

For this purpose, the Five Facet Mindfulness Questionnaire (FFMQ) was employed to measure mindfulness practices. The study also utilized the Profile of Mood States (POMS) and the Maslach Burnout Inventory (MBI) to assess mood states and burnout levels, respectively, thereby establishing a comprehensive framework to analyse the potential benefits of mindfulness in this high-stress professional group.

The methodology encompassed a cross-sectional survey design, with participation from Spanish HCWs during the pandemic. The participants were required to complete the FFMQ, POMS, and MBI. Statistical analyses, including correlation and regression models, were conducted to understand the relationship between mindfulness and mental health outcomes.

The preliminary analysis of this data indicated maybe a positive correlation between higher levels of mindfulness and positive mood profiles, as well as lower burnout rates among HCWs.

The final analysis result will be shared by M41 (April 2024). These initial findings highlight the significance of mindfulness as a protective factor for mental health in HCWs. The study concludes that mindfulness-based interventions could be vital in mitigating the psychological impacts of the pandemic, suggesting that incorporating mindfulness practices into the routine of healthcare workers could be an effective strategy for enhancing their mental well-being during such unprecedented times.

Conclusions

This deliverable addresses the psychological challenges faced by HCWs during the COVID-19 pandemic. Results include the development of the ORCHESTRA Emotional Exhaustion Screening Questionnaire (OEEQ), and its determinant from sociodemographic and occupational factors during public health crises. To this end, we will update this report with the finalized version as soon as our detailed analysis is complete by M41(April 2024).

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Appendix 1: ORCHESTRA Emotional Exhaustion Screening Questionnaire.

The following statements are related to your experience in your work, please indicate what you think in relation to each of them by ticking the box that best describes your opinion using the following response:

	Never	A few times a year or less	Once a month or less	A few times a month	Once a week	Few times a week	Everyday
I feel worn out from my work.	☐	☐	☐	☐	☐	☐	☐
I feel I am overworked.	☐	☐	☐	☐	☐	☐	☐
I feel used up at the end of the workday.	☐	☐	☐	☐	☐	☐	☐
I feel like I am at the end of my capacity to cope at work.	☐	☐	☐	☐	☐	☐	☐
I feel fatigued when I get up from rest and face another day on the job.	☐	☐	☐	☐	☐	☐	☐
	NO			Yes			

Appendix 2: The result of statistical analysis of the participants participated in OEEQ pilot study from Oviedo, Spain.

Variables	ORCHESTRA EEQ (Scale)			ORCHESTRA EEQ (Dichotomous)			Maslach Burnout Inventory (MBI)								
							Emotional Exhaustion (EE)			Depersonalization (DP)			Personal Accomplishment (PA)		
	Mean	SD	P-value	Mean	SD	P-value	Mean	SD	P-value	Mean	SD	P-value	Mean	SD	P-value
Sex															
Male	12.07	8.82	0.322	2.20	1.97	0.289	20.80	14.70	0.305	9.80	8.18	0.705	37.00	7.46	0.473
Female	14.23	7.88		2.71	1.75		24.64	13.58		9.11	6.55		35.23	9.21	
Age in year															
22-30	15.57	7.72	0.687	3.04	1.75	0.633	25.35	13.17	0.926	10.09	6.46	0.880	37.09	7.14	0.768
31-40	13.80	7.31		2.73	1.74		23.83	12.43		9.40	6.23		35.50	8.56	
41-50	14.16	8.38		2.47	1.78		24.76	14.37		8.76	6.69		35.25	9.36	
51-64	13.05	8.17		2.65	1.83		23.23	14.36		9.05	7.37		34.58	10.07	
Occupation															
Nurse assistant	14.20	7.87	0.350	2.73	1.64	0.504	24.66	13.90	0.695	8.75	6.32	0.611	36.28	8.98	0.039
Watchman	10.20	5.45		1.80	1.10		20.40	10.76		11.80	5.07		35.20	7.16	
Nurse	15.19	7.98		2.87	1.85		25.56	13.71		9.96	7.27		36.12	7.83	
Physiotherapist	9.75	10.05		2.25	2.63		18.50	18.01		6.25	8.62		41.50	7.33	
Lab technician	12.35	8.23		2.26	1.96		22.00	13.40		8.52	6.56		30.35	10.94	
Education															
Undergraduate	13.52	7.86	0.345	2.57	1.71	0.396	23.76	13.58	0.579	8.86	6.30	0.463	34.74	9.67	0.252
University degree	14.80	8.16		2.82	1.89		25.05	13.97		9.70	7.35		36.50	7.86	
Shift schedules															
No	11.96	7.76	0.133	2.18	1.83	0.110	21.71	12.80	0.278	9.11	6.37	0.952	31.21	10.42	0.006

Yes	14.48	7.98		2.78	1.75		24.84	13.88		9.19	6.81		36.38	8.44

Appendix 3: The convergent validity investigating the correlation between the OEEQ and the Maslach Burnout Inventory, sensitivity, specificity, area under receiver operating characteristic curve (AUC), positive predictive value (PPV), and negative predictive value (NPV).

		EE	DP	PA	Burnout
ORCHESTRA EEQ Scale (Total score)	Spearman correlation	0.894	0.559	-0.493	0.542
	Sig.2-tailed	< 0.001	< 0.001	< 0.001	< 0.001
	N	148	148	148	148
Correlation interpretation		Strong Positive	Strong Positive	Moderate negative	Strong Positive
Reliability Statistics: Cronbach's Alpha = 0.834					

		EE	DP	PA	Burnout
ORCHESTRA EEQ Dichotomous (Total Yes)	Spearman correlation	0.856	0.491	-0.458	0.500
	Sig. 2-tailed	< 0.001	< 0.001	< 0.001	< 0.001
	N	148	148	148	148
Correlation interpretation		Strong Positive	Moderate positive	Moderate negative	Strong Positive
Reliability Statistics: Cronbach's Alpha = 0.782					

	Sensitivity	Specificity	AUC	PPV	NPV
ORCHESTRA Emotional Exhaustion Questionnaire (Scale)					
Cutoff ≤ **16**	90.6%	91.6%	0.977	85.7%	94.6%
ORCHESTRA Emotional Exhaustion Questionnaire (Dichotomous)					

	Cutoff ≤ **3**	88.7%	89.5%	0.949	82.5%	93.4%

Appendix 4: General Characteristics of the HCWs from Romania.

Characteristic N (%)	All 1872	flHCW 1311 (70.03)	slHCW 561 (29.97)	p-Value
Demographic characteristics				
Gender				0.367
Men	340 (18.16)	245 (18.69)	95 (16.93)	
Women	1532 (81.84)	1066 (81.31)	466 (83.07)	
Age (average ± SD)	48.6 ± 10.9	48.6 ± 11.1	48.8 ± 10.6	0.776 *
Age, years				0.519
20–29	128 (6.84)	89 (6.79)	39 (6.95)	
30–39	240 (12.82)	177 (13.50)	63 (11.23)	
40–49	586 (31.30)	413 (31.50)	173 (30.84)	
>50	918 (49.04)	632 (48.21)	286 (50.98)	
Marital status				0.001
Married/couple	1390 (74.25)	1002 (76.43)	388 (69.16)	
Single	482 (25.75)	309 (23.57)	173 (30.84)	
Education level				
Undergraduate	179 (9.56)	93 (7.09)	86 (15.33)	<0.001
University degree	1693 (90.44)	1218 (92.91)	475 (84.67)	
Job characteristics				
Occupation				<0.001
Doctors	1328 (70.94)	1084 (82.68)	244 (43.49)	
Nurses	248 (13.27)	152 (11.59)	96 (17.11)	
Other health professionals	168 (8.99)	64 (4.88)	104 (18.54)	
Health management and support	128 (6.85)	11 (0.84)	117 (20.86)	
Workplace				<0.001
Hospital	368 (19.66)	328 (25.02)	40 (7.14)	
Other	1504 (80.34)	983 (74.98)	520 (92.86)	

Characteristic N (%)	All 1872	flHCW 1311 (70.03)	slHCW 561 (29.97)	p-Value
Job characteristics				
Tenure (years)				
<1	37 (1.98)	22 (1.68)	15 (2.67)	
1–5	229 (12.23)	160 (12.20)	69 (12.30)	0.135
6–10	163 (8.71)	125 (9.53)	38 (6.77)	
>10	1443 (77.08)	1004 (76.58)	439 (78.25)	
Number of daily working hours (hours)				
≤8	1556 (83.12)	1073 (81.85)	483 (86.10)	<0.025
>8	316 (16.88)	238 (18.15)	78 (13.9)	
Working in shifts				0.0009
No	1524 (81.415)	1047 (79.86)	477 (85.03)	
Yes	348 (18.59)	264 (20.14)	84 (14.97)	
Number of patients/day				
<5		138 (10.53)		
Between 5–15		366 (27.92)		
Over 15		807 (61.56)		
Management of risk of COVID-19 infection				0.0002
Very well	647 (34.56)	480 (36.61)	167 (29.78)	
Well	682 (36.43)	492 (37.53)	190 (33.87)	
Acceptable	429 (22.92)	269 (20.52)	160 (22.92)	
Not so well	88 (4.7)	55 (4.2)	33 (5.88)	
Very badly	26 (1.39)	15 (1.14)	11 (1.96)	
Perceived job stressors				
Reward score (average ± SD)	5.44 ± 1.54	5.21 ± 1.522	5.99 ± 1.44	<0.001 **
Effort score (average ± SD)	9.19 ± 2.04	9.51 ± 1.89	8.45 ± 2.16	<0.001 **
Personal factors				
Overcommitment score (average ± SD)	16.01 ± 2.89	16.34 ± 2.80	15.24 ± 2.94	<0.001 **
COVID-19 diagnosis				0.002
Yes	476 (25.43)	360 (27.46)	116 (20.68)	
No	1396 (74.57)	951 (72.54)	445 (79.32)	
Persistent symptoms of COVID-19				0.023
Yes	201 (46.10)	161 (49.24)	40 (36.70)	
No	235 (53.90)	166 (50.76)	69 (63.30)	
Duration of symptoms				0.138
<1 month	23 (11.44)	19 (11.80)	4 (10.00)	
1–3 months	75 (37.31)	65 (40.37)	10 (25.00)	
>3 months	103 (51.24)	77 (47.83)	26 (65.00)	

* Student's *t*-test; ** Mann–Whitney U test; Pearson's chi-squared test otherwise; flHCW: frontline healthcare workers; slHCW: second-line healthcare workers.

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Appendix 5: Univariate relation between the determinants and high exhaustion score.

Variables	Total		flHCW		slHCW	
	Coefficient (CI 95%)	p-Value	Coefficient (CI 95%)	p-Value	Coefficient (CI 95%)	p-Value
Demographics						
Age	−0.05 (−0.07−−0.03)	<0.0001	−0.06 (−0.08−−0.04)	<0.0001	−0.04 (−0.07−−0.001)	0.04
Gender						
Men	reference					
Women	0.73 (0.18–1.29)	0.010	0.61 (−0.03–1.23)	0.06	12.14 (0.14–2.21)	0.03
Level of education						
Undergraduate	reference					
University degree	1.45 (0.73–2.18)	0.00009	1.09 (0.12–2.08)	0.03	1.14 (0.07–2.22)	0.04
Marital status						
Married/couple	reference					
Single	0.005 (−0.48–0.5)	0.98	−0.52 (−1.11–0.08)	0.09	−0.58 (−1.43–0.26)	0.17
Objective job characteristics						
Occupation						
Health management and support	reference					
Doctors	2.77 (1.85–3.68)	<0.001	0.20 (−2.55–2.96)	0.884	1.95 (0.85–3.04)	0.001
Nurses	1.89 (0.84–2.95)	<0.001	−0.53 (−3.38–2.31)	0.712	1.60 (0.29–2.91)	0.017
Other health professionals	1.42 (0.31–2.53)	0.012	−0.94 (−3.91–2.03)	0.534	1.51 (0.27–2.75)	0.017
Workplace						
Other	reference					
Hospital	1.55 (1.10–2.003)	<0.0001	0.64 (−0.15–1.45)	0.11	0.57 (−0.71–1.87)	0.38
Tenure	−0.12 (−0.39–0.15)	0.4	−0.21 (−0.54–0.12)	0.21	0.32 (−0.37–1.02)	0.36
Working h/day						
≤8 h	reference					
>8 h	2.20 (1.76–3.08)	<0.0001	1.64 (0.99–2.29)	<0.0001	3.43 (2.34–4.52)	<0.0001
Night shifts						
No	reference					
Yes	1.02 (0.48–1.57)	0.0003	0.45 (−0.17–1.08)	0.16	2.22 (0.55–1.15)	0.00006
Perceived job stressors						
Effort score	1.28 (1.2–1.37)	<0.0001	1.27 (1.16–1.38)	<0.0001	1.24 (1.1–1.39)	<0.0001
Reward score	−1.20 (−1.33–1.075)	<0.0001	−1.17 (−1.33−−1.02)	<0.0001	−1.06 (−1.32−−0.80)	<0.0001
Effort/reward score	3.17 (2.91–3.44)	<0.0001	2.81 (2.51–3.11)	<0.0001	4.39 (3.73–5.03)	<0.0001
Distress (Effort/reward score > 1)	0.25 (0.21–0.28)	<0.0001	4.01 (3.53–4.48)	<0.0001	4.87 (4.07–5.05)	<0.0001
Management of the infection risk in the workplace						
Very well	reference					
Well	0.72 (0.22–1.22)	0.005	0.86 (0.29–1.44)	0.003	0.49 (−0.46–1.44)	0.309
Acceptable	2.10 (1.54–2.67)	<0.001	2.21 (1.53–2.89)	<0.001	2.52 (1.53–3.51)	<0.001
Not so well	2.71 (1.68–3.75)	<0.001	3.11 (1.84–4.38)	<0.001	2.65 (0.95–4.36)	0.002
Very badly	3.34 (1.52–5.16)	<0.001	3.81 (1.46–6.15)	0.001	3.44 (0.65–6.23)	0.016
Personal factors						
Overcommitment	1.04 (0.99–1.1)	<0.0001	1.03 (0.96–1.10)	<0.0001	1.01 (0.91–1.12)	<0.0001
HCW diagnosed with COVID-19						
No	reference					
Yes	0.95 (0.47–1.45)	0.0001	0.76	0.009	1.03 (0.07–1.99)	0.003
Persistence of symptoms	reference					
No	1.79 (0.9–2.68)					
Yes		0.00008	1.52 (0.49–2.56)	0.004	2.15 (0.42–3.88)	0.02

flHCW: frontline healthcare workers; slHCW: second-line healthcare workers.

Appendix 6: Multivariate analysis between the determinants and high exhaustion score.

6a: Regression models of correlation between the risk factors and exhaustion score in flHCW.

Variables	Model 1		Model 2		Model 3		Model 4		Model 5	
	Beta Coef.	p	Beta Coef.	p	Beta Coef.	p	Beta Coef.	p	Beta Coef.	p
Demographics										
Age	−0.144	<0.0001	−0.178	<0.001	−0.169	<0.001	−0.190	<0.001	−0.189	<0.001
Level of education	0.074	0.007	0.048	0.198	0.040	0.234	0.041	0.146	0.059	0.006
Objective job characteristics										
Occupation			−0.085	0.003	−0.04	0.12	−0.026	0.23	0.009	0.84
Working h/day			0.160	<0.001	0.098	<0.001	0.043	0.048	0.043	0.046
Number of patients/day										
<5			reference							
5–15			0.007	0.874	−0.0009	0.982	0.003	0.933	0.003	0.919
>15			0.117	0.008	0.046	0.245	−0.005	0.888	−0.005	0.891
Perceived job stressors										
Effort/reward score					0.422	<0.001	0.207	<0.001	0.207	<0.001
Management of the risk of infection in the workplace					0.113	<0.001	0.092	<0.001	0.091	<0.001
Personal factors										
Overcommitment score							0.532	<0.001	0.531	<0.001
Personal history of COVID-19									0.013	0.519

flHCW: frontline healthcare workers.

6b. Relation between the variables and high exhaustion score in flHCW

Variable	Unstandardized Coefficients	Standard Error	Beta	t	p *
Age	−0.00566	0.00089	−0.15207	−6.39373	<0.0001
Score of overcommitment	0.05210	0.00388	0.35508	13.42087	<0.0001
Effort/reward score	0.12807	0.01439	0.23497	8.90018	<0.0001
Intercept	−0.54038				

* Regression analysis adjusted for occupation, number or working hours/day, number of patients/day, personal history of COVID-19 and management of the risk of infection; flHCW: frontline healthcare workers.

6c. Regression models of the correlation between the risk factors and exhaustion score in slHCW.

Variables	Model 1		Model 2		Model 3		Model 4		Model 5	
	Beta Coef.	p	Beta Coef.	p	Beta Coef.	p	Beta Coef.	p	Beta Coef.	p
Demographics										
Age	−0.086	0.04	−0.008	0.048	-0.077	0.038	−0.122	<0.001	−0.1123	<0.001
Gender	0.100	0.02	0.082	0.042	0.075	0.039	0.009	0.777	0.009	0.771
Level of education	0.082	0.05	0.072	0.068	0.042	0.251	0.001	0.733	0.010	0.745
Objective job characteristics										
Occupation			−0.124	0.004	−088	0.023	−0.100	0.002	−0.101	0.002
Working h/day			0.246	<0.001	0.158	<0.001	0.064	0.057	0.065	0.053
Night shifts			0.054	0.22	−0.0006	0.880	−0.0004	0.988	0.00006	0.999
Perceived job stressors										
Effort/reward score					0.411	<0.001	0.199	<0.001	0.199	<0.001
Management of the risk of infection in the workplace					−0.067	0.08	−0.067	0.04	−0.067	0.04
Personal factors										
Overcommitment score							0.521	<0.001	0.523	<0.001
Personal history of COVID-19									0.012	0.701

slHCW: second-line healthcare workers.

6d. Relation between the variables and high exhaustion score in slHCW.

Variable	Unstandardized Coefficients	Standard Error	Beta	t	p *
Average working hours/day	0.04226	0.01500	0.10789	2.81773	0.00501
Score of overcommitment	0.04084	0.00488	0.34874	8.35956	<0.0001
Effort/reward score	0.12349	0.02719	0.18794	4.54216	<0.0001
Intercept	−0.72794				

* Regression analysis adjusted for gender, occupation and nightshift; slHCW: second-line healthcare workers.

6e. Comparison of the exhaustion scores in frontline healthcare workers and in the control group by occupation.

	flHCW		slHCW		p *
	Average + SD	Median	Average + SD	Median	
Doctors	15.023 ± 4.64	15	13.63 ± 4.72	13	0.00002
Nurses	14.28 ± 4.82	14	13.28 ± 5.23	13	0.06
Other health professionals	13.88 ± 3.75	14	13.19 ± 4.37	13	0.20
Health management and support	14.82 ± 6.54	15	11.68 ± 4.16	11	0.11

* Mann–Whitney U test; flHCW: frontline healthcare workers; slHCW: second-line healthcare workers.

f. Relation between the high exhaustion scores and the diagnosis of COVID-19 of the HCW in the frontline and the second-line healthcare workers.

	OR (CI 95%)	p *
flHCW group		
COVID-19—exhaustion score > 75% of the maximum score	1.36 (1.027–1.82)	0.03
Persistence of symptoms—exhaustion score > 75% of the maximum score	1.41 (0.87–2.31)	0.16
Duration of symptoms—exhaustion score > 75% of the maximum score	1.13 (0.69–1.85)	0.62
slHCW group		
COVID-19—exhaustion score > 75% of the maximum score	1.41 (0.81–2.47)	0.21
Persistence of symptoms—exhaustion score > 75% of the maximum score	2.52 (0.94–6.77)	0.06
Duration of symptoms—exhaustion score > 75% of the maximum score	1.88 (0.54–6.47)	0.31

* Logistic regression; flHCW: frontline healthcare workers; slHCW: second-line healthcare workers.

Appendix 7: Illustrated results of analysis from Slovakian cohorts

7a. The graph illustrates a notable trend in the subjective perception of exhaustion among healthcare professionals in Slovakia.

At the end of the workday, I feel exhausted
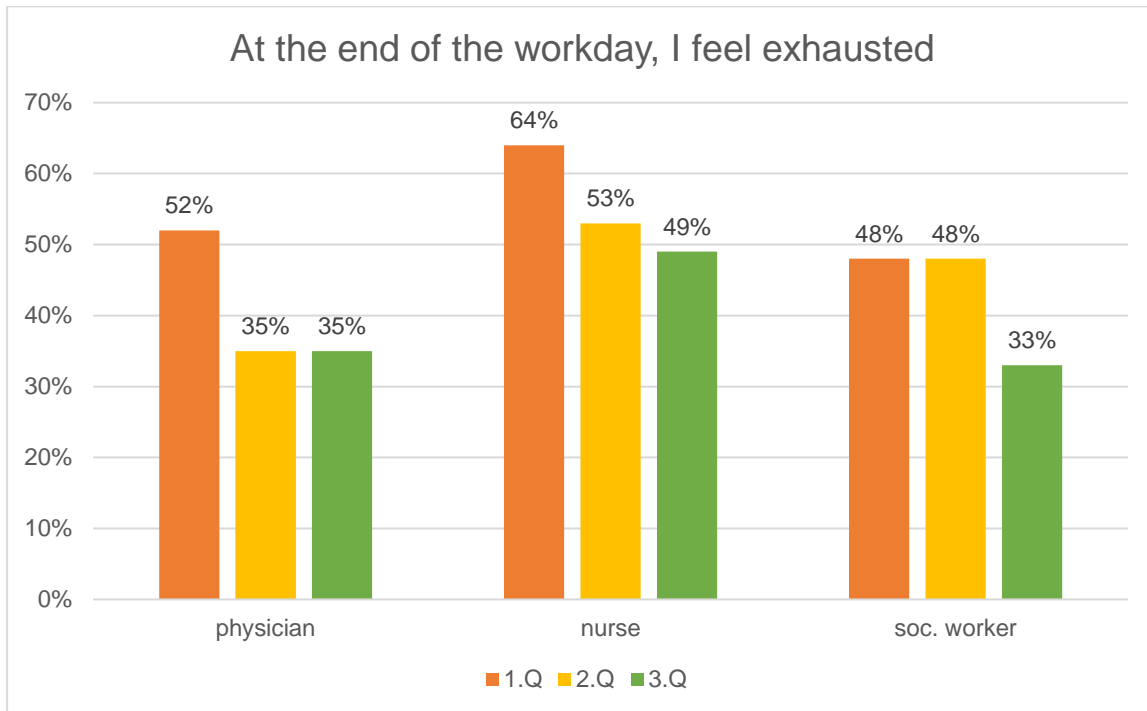
1.Q: First Questionnaire survey
2.Q: Second Questionnaire survey
3.Q: Third Questionnaire survey

7b. The table shows notable number of healthcare professionals identified with the sentiment "I am tired and considering a change of job." In Slovakia.

Respondent	Nurses		Doctors		Social Workers	
	Total Number	Yes	Total Number	Yes	Total Number	Yes
1.	328	55	127	14	273	13
2.	236	30	85	11	192	6
3.	204	44	76	7	112	6

7c. The table shows notable number of healthcare professionals identified with the sentiment " I am convinced that I need to quit this job." In Slovakia.

Respondent	Nurses		Doctors	
	Total number	Yes	Total number	Yes
1.	328	11	127	0
2.	236	5	85	0
3.	204	5	76	0