

ARAŞTIRMA / RESEARCH

Evaluation of Symptoms, Laboratory and Thorax Computerized Tomography Findings of COVID-19 Positive Healthcare Professionals: A Retrospective Study

COVID-19 Pozitif Sağlık Çalışanlarının Semptom, Laboratuvar ve Toraks Bilgisayarlı Tomografi Bulgularının Değerlendirilmesi: Retrospektif Çalışma

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Abstract

Objective: The study was carried out to examine the symptoms and laboratory and thoracic computed tomography findings of COVID-19-positive healthcare professionals in northeastern Turkey.

Material and Method: The sample of this descriptive, cross-sectional, and retrospective study consisted of 146 healthcare professionals who had positive COVID-19. Data were collected using electronic data from the hospital information management system and the personal health records of healthcare professionals.

Results: 50.6% of COVID-19-positive healthcare professionals were symptomatic, 49.4% were asymptomatic, 52.7% of nurses, midwives, and health officers, and those who were symptomatic experienced the most cough, muscle-joint pain, and fatigue. Healthcare workers had a high leukocyte, neutrophil, lymphocyte, platelet mean, C reactive protein, and D-dimer, and 24.1% had COVID-19-compatible thorax computed tomography. Symptomatic healthcare professionals had a lower median of leukocyte and a higher median of C reactive protein and procalcitonin compared to asymptomatic healthcare professionals. Healthcare professionals with COVID-19 compatible thorax computed tomography had a lower leukocyte, median, and platelet mean, lower high C reactive protein median, and higher D-dimer median.

Conclusion: The study found that half of the healthcare professionals are symptomatic, and leukocyte, neutrophil, lymphocyte, C reactive protein, and platelet values affect the development of COVID-19-compatible thoracic computed tomography. The results can be used as a knowledge base for research and by health workers and institutional authorities to implement methods to improve prevention levels.

Keywords: Health workers, SARS-CoV-2, symptoms, retrospective, Thorax CT

Öz

Amaç: Araştırma, Türkiye'nin kuzeydoğusunda COVID-19 pozitif sağlık çalışanlarının semptomlarını, laboratuvar ve toraks bilgisayarlı tomografi bulgularını incelemek amacıyla yapılmıştır.

Gereç ve Yöntem: Tanımlayıcı, kesitsel ve retrospektif tasarıma sahip bu araştırmanın örneklemini COVID-19 pozitif olan 146 sağlık profesyoneli oluşturmuştur. Veriler, hastane bilgi yönetim sisteminin elektronik verileri ve sağlık çalışanlarının kişisel sağlık kayıtları kullanılarak toplanmıştır.

Bulgular: COVID-19 pozitif sağlık çalışanlarının %52,7'si hemşire, ebe ve sağlık memuru, %50,6'sının semptomatik, %49,4'ünün asemptomatik olduğu ve semptomatik olanların en fazla öksürük, kas-eklem ağrısı ve yorgunluğu yaşadığı belirlendi. Sağlık çalışanlarının lökosit, nötrofil, lenfosit, trombosit ortalaması, C reaktif protein, D-dimer değerlerinin yüksek olduğu ve %24,1'inin COVID-19 uyumlu toraks bilgisayarlı tomografisi olduğu tespit edildi. Semptomatik sağlık çalışanlarının asemptomatik sağlık çalışanlarına kıyasla lökosit sayısı medyanının daha düşük, C reaktif protein ve prokalsitonin değerleri medyanının daha yüksek olduğu bulundu. COVID-19 uyumlu toraks bilgisayarlı tomografisi olan sağlık çalışanlarının lökosit, medyan ve trombosit değerleri ortalamasının daha düşük, C reaktif protein medyanının daha düşük ve D-dimer medyanının daha yüksek olduğu belirlendi.

Sonuç: Çalışmada sağlık çalışanlarının yarısının semptomatik olduğu ve lökosit, nötrofil, lenfosit, C reaktif protein ve trombosit değerlerinin COVID-19 uyumlu toraks bilgisayarlı tomografi gelişimini etkilediği belirlenmiştir. Sonuçlar, araştırmalar için bilgi tabanı oluşturmak, sağlık çalışanları ve kurum yetkilileri tarafından korunma düzeylerini iyileştirmeye yönelik yöntemleri uygulamak için kullanılabilir.

Anahtar Kelimeler: Sağlık çalışanları, SARS-CoV-2, semptomlar, retrospektif, thorax CT

1. Introduction

The COVID-19 pandemic caused by the new severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has been a great concern for the world. The World Health Organization (WHO) reports that there were 764.474.387 confirmed cases of COVID-19 and 6.915.286 deaths until 26.04.2023. In Turkey, the number of confirmed cases of COVID-19 is 17.004.677, and there were 101.419 deaths until 26.04.2023 (1).

Health workers provide preventive, curative, and rehabilitative health services to the individual, family, and society in a planned manner. Healthcare workers are also key workers serving in healthcare environments with the potential for direct or indirect exposure to infectious agents (2). Parallel to the increase in the number of infected people during the COVID-19 epidemic, the infection rate among healthcare workers has reached a substantial level. It has been reported in different studies that COVID-19 positivity in healthcare workers was 3.46% - 28.9% in China (3), 14.5% in the United Kingdom (4), and 12.9% in one state of the USA (5). According to the update made by Amnesty International on May 24, 2021, it is stated that the total number of healthcare worker deaths was more than 17,000 (6). A meta-analysis study including 119,216 patients who were positive for COVID-19 determined that approximately 10% of the cases were healthcare workers, and their mortality rate was 0.3% (7). In Turkey, more than 140,000 (approximately 4.2% of total cases) healthcare workers were diagnosed with COVID-19, and 497 died until November 9, 2021 (8).

Healthcare workers carry an occupational risk for COVID-19 infection (9), and according to the risk category, their exposure levels to SARS-CoV-2 are considered as "very high" and "high" risk. While physicians, nurses, dentists, sample-collecting health personnel, laboratory workers, morgue workers, and emergency medical technicians are in the "very high risk" category, health workers (such as physicians, nurses, and cleaning personnel) who need to enter the patient room are in the "high risk" category (10).

Healthcare professionals at all health service stages collect upper respiratory tract samples via nasopharyngeal and oropharyngeal swabs (PT-PCR) to diagnose COVID-19. During the procedure, social distance disappears, and close contact poses a significant risk of transmission for healthcare workers (11). In addition, although body fluids other than respiratory secretions have not been associated with the transmission of COVID-19, unprotected contact with other body fluids such as urine, blood, vomit, and feces put healthcare workers at risk for COVID-19 infection (9). Again, healthcare professionals can be defenseless to COVID-19 infection due to using personal protective equipment (PPE) and the lack of sufficient knowledge on control/prevention of COVID-19 infection, working with infected patients for a long time, excessive fatigue, long working hours and weakened immune systems. Health workers are at risk of contracting COVID-19 infection due to insufficient PPE, the inability to allocate sufficient time for the training of health workers required to control the pandemic, and the inability of infection committees to adequately supervise health workers during the pandemic process (12).

COVID-19 shows symptoms ranging from asymptomatic infection to severe respiratory failure due to different viral loads and contact times among healthcare workers

(13). Typical symptoms of COVID-19 include mainly fever (87.9%), dry cough (67.7%), fatigue (38.1%) and sputum (33.4%), and shortness of breath (18.6%), myalgia/arthralgia (14.8%), sore throat (13.9%), headache (13.6%), chills (11.4%), nausea/vomiting (5%), nasal congestion (4.8%), diarrhea (3.7%), hemoptysis (0.9%), and conjunctivitis (0.9%) (14). Later, loss of smell and taste was added to these symptoms. According to Jin et al. (2020), who conducted a study with 103 healthcare workers, the most common symptoms in healthcare workers with COVID-19 positivity were fever (41.8%), muscle pain (30.1%), and fatigue/weakness (33%) (15). Again, in a study in which 906 healthcare professionals (nurses 39.2%; physicians 29.6%; assistant healthcare workers 10.6%) working in five major hospitals in Singapore and India took part in the care of COVID-19 patients between February 19 and April 17, 2020, the most frequently reported symptoms were headache (31.9%), sore throat (33.6%), anxiety (26.7%), fatigue/weakness (26.6%), and insomnia (21.0%) (16). Magnavita et al. stated that 82 of 595 healthcare workers were positive for COVID-19, respiratory symptoms were observed in 56.1% of the cases, and no symptoms were observed in 29.3% of the cases (17). A study conducted in Turkey reported that 82 healthcare workers working in the hospital were infected with COVID-19, 18% had the asymptomatic infection, 65% of those who had symptomatic had a fever, 54% had a dry cough, and 60% had COVID-19 infection compatible infiltrations in the lungs (18).

Despite the constant updating of COVID-19 information, there are still limited publications for COVID-19-positive healthcare workers. However, healthcare workers are more exposed to the virus than individuals in the community, exposing them to a greater risk of infection. Nevertheless, more information is needed on the occupational risk of healthcare workers to COVID-19. Healthcare workers also play a key role in the continuity of healthcare. Therefore, a detailed examination of the symptoms, laboratory and radiologic findings of healthcare workers will guide the identification of occupational risks and measures that can be taken. Therefore, this study was carried out to examine the symptoms, laboratory, and radiological findings of COVID-19-positive healthcare professionals working in a province in the Northeast of Turkey and contribute to current information and ongoing COVID-19 studies.

2. Materials and Methods

2.1. Study design

The study had a descriptive, cross-sectional, and retrospective design.

2.2. Sample

The study was conducted at Giresun between July 15 and August 28, 2020. The study population includes a total of 187 COVID-19-positive healthcare professionals [(physician, nurse, midwife, health officer, other (emergency medicine) technician, anesthesia technician, environmental health technician, pharmacy technician, laboratory technician, radiology technician, pharmacist, and hospital administrator)], who were inpatient or outpatient between March 11 April 28, 2020, at Giresun pandemic (COVID-19) clinics and intensive care units. No sample selection was made in the study, and all of the population was tried to be reached. However, the study was completed with 146 healthcare professionals since there were missing data of

41 healthcare professionals in the electronic data of the hospital information management system.

2.3. Inclusion criteria

The inclusion criteria were (a) working as a healthcare worker at a public hospital in Giresun province, (b) at least having one diagnostic laboratory-confirmed sample test positive for COVID-19 by RT-PCR (Real-time reverse transcription-polymerase chain reaction), (c) receiving inpatient or outpatient treatment in pandemic clinics and intensive care units due to COVID-19 positivity between March 11 and April 28, 2020; and (d) to be registered in the hospital information management system electronic data and patient files of the data of health workers who are positive for COVID-19.

2.4. Data collection

COVID-19 Health Worker Information Form: This form was developed by researchers by searching the relevant literature (4,22-23). The form included 35 questions. Those nine were related to socio-demographic characteristics (age, gender, education level, occupation, working year, chronic disease status, smoking status, treatment type, contact status with COVID-19 positive patients) of COVID-19 positive healthcare professionals; 12 questions were related to COVID-19 symptoms (cough, muscle-joint pain, weakness, fever, headache, sore throat, shortness of breath, chills, nausea-vomiting, diarrhea, loss of taste-smell, asymptomatic); 12 questions included laboratory findings (WBC, neutrophil, lymphocyte, platelet, CRP, D-dimer, CK, LDH, PT, troponin T, Ferritin, procalcitonin). Two questions assessed radiological findings (thorax computed) of health care professionals.

After obtaining the necessary institutional permits, the researchers filled the COVID-19 Health Worker Information Form between 15 July-28 August 2020 in state hospitals of Giresun, affiliated with the Public Hospitals Association Information Management System, by examining the patient files of healthcare professionals.

2.5. Statistical analysis

The data were analyzed with the IBM SPSS 24v package program. Descriptive statistics (mean, standard deviation, minimum-maximum, median) were calculated. The conformity of quantitative variables to normal distribution was evaluated with Kolmogorov-Smirnov and Shapiro-Wilk tests. The difference between the two groups was evaluated with the student-t and Mann-Whitney U tests. The difference between the two groups was evaluated with the Chi-square test (Pearson Chi-square, Fisher Exact Chi-square). First, simple logistic regression and then multiple logistic regression analyses used to determine the factors affecting healthcare professionals' COVID-19-compatible thoracic CT. Statistical significance was determined as $p < 0.05$.

2.6. Ethical Aspect of the Research

To carry out the study, the Ministry permission required for COVID-19 scientific research studies in Turkey is taken from the T.R. Ministry of Health (2020-04-29T12_48_42). In addition, ethics committee permission from Gümüşhane University Scientific Research and Publication Ethics Committee (Number: 2020/5 Date: 05.05.2020) and the Public Hospital (Date 14.07.2020 Number E.2114) was

obtained.

3. Results

The mean age of COVID-19-positive healthcare professionals is 38.80 ± 8.48 years, and the average working year is 12.37 ± 9.26 years. 69.1% of healthcare professionals are female, 52% are undergraduates, 52.7% are nurses, midwives, and health officers, 65.7% have a chronic disease, 81% have never smoked, 65.7% are outpatients treated, and 73.9% of them had contact with COVID-19 positive patients. 50.6% of COVID-19-positive healthcare workers are symptomatic, and 49.4% are asymptomatic. Symptomatic healthcare workers most frequently experienced cough (51.3%), muscle-joint pain (27%), and fatigue (18.9%) (Table 1).

The mean WBC of COVID-19-positive healthcare workers was $7.36 \pm 2.32 (103/mm^3)$, and it was determined that 4.4% have leukopenia, 12.6% are neutropenic, 8.9% have lymphocytopenia, 20.6% have high CRP, and 4.6% have positive D-dimer. The mean platelet count of healthcare workers was 262.26 ± 67.31 , median CK was, 12.5% had high LDH level, mean PT was 10.93 ± 1.66 , and 2.38% had critical PT. In addition, the mean of troponin T of healthcare workers was 0.005 ± 0.004 , 1.8% of them had high troponin T levels, the median of Ferritin was and the mean of procalcitonin was 0.05 ± 0.04 . Thoracic CT was performed in 79.4% of healthcare workers, and 24.1% have COVID-19-compatible CT (Table 2).

A significant difference was found between the professions of healthcare professionals and their asymptomatic and symptomatic status ($p=0.005$). The symptom rate of health workers working as nurses, midwives, and health officers were determined as 55.4%. Symptomatic healthcare workers had significantly lower median WBC ($103/mm^3$), ($p=0.025$), higher median CRP (mg/L), ($p=0.032$) high CRP level (>5 mg/L), ($p=0.007$) and higher median of procalcitonin ($p=0.011$) (Table 3).

Healthcare workers with COVID-19 compatible thorax CT had a lower significant WBC ($103/mm^3$), ($p < 0.001$); lymphocyte (%), ($p=0.016$), platelet ($103/mm^3$), ($p=0.002$) and CK (U/L), ($p=0.002$); median neutrophil (%), ($p=0.019$); neutrophil $>70\%$ (10%) ($p=0.001$), lymphocyte $<20\%$ 6 (22%) ($p=0.021$), CRP (mg/L), ($p < 0.001$) and high median CRP (>5 mg/L) 15 (55.6%) ($p < 0.001$) and higher D-dimer ($\mu g/L$), ($p=0.042$) (Table 4).

In Table 5, variables were determined with the help of simple binary logistic regression analysis for multiple logistic regression analysis. Accordingly, as thorax CT predictors in COVID-19-positive healthcare workers, "WBC ($103/mm^3$), neutrophil $>70\%$, lymphocyte (%), high CRP (>5 mg/L), CK (U/L) and platelet ($103/mm^3$)" values were found to be usable ($p < 0.05$). The 1-unit increase in WBC ($103/mm^3$), CK (U/L), and platelet ($103/mm^3$) values of COVID-19-positive healthcare workers increases the risk of COVID-19 compatible thorax CT 0.699 times (0.550-0.889), 0.982 times (0.968), respectively (-0.997), 0.988 times (0.980-0.997), and it was determined that neutrophils $>70\%$ and high CRP (>5 mg/L) increased the risk of COVID-19 compatible thorax CT by 6.639 times (2.212-19.921) and 8.182 times (3.042-22.005), respectively. One unit increase in WBC ($103/mm^3$) value of healthcare workers reduces the risk of thoracic CT compatible with COVID-19 by 0.658 times (0.458-0.892), and it was determined that it increased the risk of

COVID-19 compatible thorax CT neutrophils >70% and high CRP (>5 mg/L) by 11,054 times (2.036-60.015) and 7.212 times (2.048-25.406), respectively (Table 5).

Table 1. Descriptive Characteristics and Symptoms of COVID-19 Positive Employees (N=146)

	X±SD	Min-Max
Age (year)	38.80±8.48	22-63
Year of study	12.37±9.26	1-35
	n	%
Gender		
Male	45	30.8
Female	101	69.1
Educational level		
Literate-primary education	19	13.0
High school	24	16.4
Associate degree	13	8.90
License	76	52.0
Graduate	14	9.5
Profession		
Physician	21	14.3
Nurse, midwife, health officer	77	52.7
Other*	48	32.8
Chronic disease status		
No	96	65.7
Yes	50	34.2
Smoking status		
Never used	111	81.0
Regular every day	25	18.2
Sometimes	1	0.7
Form of treatment		
Outpatient treatment	96	65.7
Inpatient treatment	50	34.2
Contact status of a COVID-19 positive patient		
Yes	108	73.9
No	38	26.0
State of showing symptoms		
Symptomatic	74	50.6
Asymptomatic	72	49.4
Symptoms** (n=74)		
Cough	38	51.3
Muscle-joint pain	20	27.0
Fatigue	14	18.9
Fire	12	16.2
Throat ache	12	16.2
Headache	12	16.2
Shortness of breath	10	13.5
Nausea-vomiting	3	4.0
Chills-chills	3	4.0
Diarrhea	2	2.7
Taste-smell loss	1	1.3

*Emergency medical technician, anesthesia technician, environmental health technician, pharmacy technician, laboratory technician, radiology technician, pharmacist, and hospital administrators
 **Healthcare workers may express more than one symptom.

Table 2. Laboratory and Thoracic CT Findings of COVID-19 Positive Health Workers on Hospital Admission

Laboratory Findings	n	%	X±SD	Min-Max
WBC* (10³/mm³) (n=134)			7.36±2.32	
WBC <4 (10³/mm³)	6	4.4		
WBC >11 (10³/mm³)	14	10.4		
Neutrophil (%) (n=134)			59.80±9.37	
Neutrophil >%70	18	13.4		
Neutrophil <%50	17	12.6		
Lymphocyte (%) (n=134)			31.01±8.61	
Lymphocyte >%40	16	11.9		
Lymphocyte <%20	12	8.9		
Platelets (10³/mm³) (n=134)			262.26±67.31	
CRP* (mg/L) (n=131)				1.44 (0.14-299.79)
High CRP (>5 mg/L)	27	20.6		
D-dimer (µg/L) (n=86)				176 (96-1755)
Positive D-Dimer (> 500 µg/L)	4	4.6		
CK* (U/L) (n=96)				85 (17-1616)
LDH* (n=96)			187.46±49.13	
High LDH	12	12.5		
PT* (n=42)			10.93±1.66	
Critical PT (>20 saniye)	1	2.3		
Troponin T (n=55)			0.005±0.004	
High Troponin T (>0.014)	1	1.8		
Ferritin (n=46)				69.07 (6.26-201.80)
High Ferritin (>400)	-			
Procalcitonin (n=37)			0.05±0.04	
High Procalcitonin (>0.5)	-			
Thorax CT **shot (n=146)				
Yes	116	79.4		
No	30	20.5		
Thorax CT result (n=116)				
Normal CT	88	75.8		
COVID-19 compatible CT	28	24.1		

* WBC: White Blood Cell (leukocyte), CRP: C-Reactive Protein, CK: Creatine Kinase, LDH: Lactate Dehydrogenase, PT: Prothrombin Time. ** Computed tomography

4. Discussion

In our study, COVID-19-positive healthcare professionals were younger, and female healthcare workers were twice as likely to be infected with COVID-19 than males. In a study conducted with healthcare professionals in Italy reported that female (72%) healthcare professionals were found to have a high level of COVID-19 positivity (19). The fact that the nurse group was mostly female was thought to affect these results. Our study's occupational group with the highest COVID-19 positivity was nurses, midwives, and health officers. Similarly, Abohamr et al., studied 108 COVID-19-positive healthcare personnel, and nurses (58.3%) were most affected by COVID-19 (20). In another study, the health

Table 3. Evaluation of Some Introductory Characteristics and Laboratory Findings of COVID-19 Positive Health Care Workers by Symptom Status (N=146)

Features/Findings	Asymptomatic (n=72)			Symptomatic (n=74)			p
	n	%	Min-Max	n	%	Min-Max	
Age (year)*			40(22-57)			41(22-63)	0.432
Gender**							
Men	26	36.1		19	25.7		0.172
Women	46	63.9		55	74.3		
Profession**							
Physician	16	22.2		5	6.8		0.005
Nurse, midwife, health officer	36	50.0		41	55.4		
Other*	20	27.8		28	37.8		
Year of study*			10.5(1-33)			12.5(1-35)	0.880
Chronic disease status**							
No	51	70.8		45	60.8		0.202
Yes	21	29.2		29	39.2		
WBC* (10³/mm³) (n=134)*			7.35(4.11-13.26)			6.66(2.71-12.43)	0.025
Neutrophil(%) (n=134)*			59.8(30.30-83.60)			58.4(42.10-87.70)	0.751
Neutrophil >%70**	6	9.8		12	16.4		0.264
Neutrophil <%50**	7	11.5		10	13.7		0.700
Lymphocyte(%) (n=134)*			31.5(8.40-56.20)			31.6(9.30-49.40)	0.835
Lymphocyte >%40**	6	9.8		10	13.7		0.492
Lymphocyte <%20**	5	8.2		7	9.6		0.779
Platelets(10³/mm³) (n=134)*			271(85-554)			252(122-440)	0.188
CRP* (mg/L) (n=131)*			1.03(0.14-50.74)			2.02(0.14-299.79)	0.032
High CRP (>5 mg/L)	6	10.2		21	29.2		0.007
D-dimer (µg/L) (n=86)*			150(96-827)			199.5(150-1755)	0.062
CK* (U/L) (n=96)*			96(17-750)			81(34-1616)	0.222
LDH* (n=96)*			184(120-528)			177(120-299)	0.716
High LDH**	5	12.5		7	12.5		1.000
PT* (n=42)*			10.7(9.90-20.40)			10.8(8.40-11.80)	0.480
Troponin T (n=55)*			0.004(0.003-0.029)			0.004(0.003-0.008)	0.956
Ferritin (n=46)*			106.6(7.98-197.10)			64.68(6.26-201.8)	0.472
Procalcitonin (n=37)*			0.03(0.02-0.05)			0.05(0.02-0.27)	0.011

* Mann-Whitney U test was used. ** Chi-square test was used. † WBC: White Blood Cell (leukocyte), CRP: C-Reactive Protein, CK: Creatin Kinase, LDH: Lactate Dehydrogenase, PT: Prothrombin Time

personnel most affected by COVID-19 were determined as physicians (11%), nurses with 7%, and paramedics with 6% (21). This may result from nurses spending more time with patients due to their many roles, such as personal care, treatment, and diagnostic procedures. The fact that our study's contact rate with COVID-19-positive patients was 73.9% also supports this result. Another study conducted in Central Italy determined that approximately half of COVID-19-positive healthcare workers were in contact (22). A study conducted with 2149 healthcare workers in Sweden reported that 1764 (85%) healthcare workers had patient contact, and 962 (46%) had COVID-19 patient contact. In the contact group, the highest contact was in the nurse group with 636 (36%), followed by physicians with 439 (25%), assistant nurses with 428 (24%), and other health personnel with 254 (14.5%) (23). In our study, the rate of regular smoking (18.2%) of COVID-19-positive healthcare workers every day is found to be considerably lower than the smoking rate (60.2%) found in COVID-19-positive

healthcare workers in the study of Abohamr et al. In this study, 34.2% of COVID-19-positive healthcare workers have a chronic disease. The study of Abohamr et al. states that COVID-19 affects healthcare workers with chronic diseases at a higher rate (20).

Half (50.6%) of COVID-19-positive healthcare workers were symptomatic in our study, while nearly half (49.4%) were asymptomatic. Regarding the occupations, the COVID-19 course is more symptomatic (55.4%) among nurses, midwives, and health officers. Those who were symptomatic primarily experienced the symptoms of cough, musculoskeletal pain, and malaise. Supporting our findings, a study conducted with healthcare professionals in Denmark specified that 53.5% of COVID-19 positive healthcare professionals were found to be symptomatic (24). Approximately one-third (29.3%) of COVID-19-positive healthcare workers have never shown symptoms (17). Again, 15 studies that analyzed the symptoms and

Table 4. Evaluation of Some Descriptive Characteristics and Laboratory Findings of COVID-19 Positive Health Workers According to Thorax CT Findings (N=116)

Features/Findings	Normal Thorax CT (n=88)			COVID-19 Compatible Thorax CT (n=28)			p
	n	%	X±SS	n	%	X±SS	
Age (year)[†]			38.3±8.5			40.0±9.1	0.392
			Min-Max			Min-Max	
Gender[†]							
Men	28	31.8		4	14.3		0.071
Women	60	68.2		24	85.7		
Smoking status							
No	68	81.0		20	80		1.000
Yes	16	19.0		5	20		
Year of study[§]			9.5(1-33)			11.5(1-35)	0.196
Chronic disease status[†]							
No	60	68.2		17	60.7		0.466
Yes	28	31.8		11	39.3		
WBC (10³/mm³) (n=134)[§]			7.4(2.7-12.4)			5.5(3.3-13.2)	<0.001
Neutrophil(%) (n=134)[§]			58.2(30.3-87.7)			62.8(46.5-83.6)	0.019
Neutrophil >%70 [†]	7	8.1		10	37		0.001
Neutrophil <%50 [‡]	11	12.8		3	11.1		1.000
Lymphocyte(%) (n=134)[§]			32.9(9.3-56.2)			29(8.4-43.3)	0.016
Lymphocyte >%40 [†]	10	11.6		3	11.1		1.000
Lymphocyte <%20 [†]	5	5.8		6	22.2		0.021
Platelets (10³/mm³) (n=134)[§]			258.5(85-554)			228(155-298)	0.002
CRP (mg/L) (n=130)[§]			1.1(0.1-299.7)			6.1(0.1-50.7)	<0.001
High CRP(>5 mg/L) [†]	11	13.3		15	55.6		<0.001
D-dimer (µg/L) (n=86)[§]			167(150-1755)			229(150-550)	0.042
CK (U/L) (n=96)[§]			94(33-1616)			62.5(17-167)	0.002
LDH (n=96)[§]			176.5(120-299)			186.5(128-239)	0.343
PT (n=42)[§]			10.6(8.4-12.6)			10.6(9.5-11.8)	0.685
Troponin T (n=55)[§]			0.00(0.00-0.00)			0.00(0.00-0.02)	0.889
Ferritin (n=46)[§]			92.3(6.2-201.8)			61.1(10.3-148.7)	0.456
Procalcitonin (n=37)[§]			0.0(0.0-0.2)			0.0(0.0-0.1)	0.684

* Student-t test was used in independent groups. † Chi-square test was used. ‡ Fisher exact chi-square test was used. § Mann-Whitney U test was used. || WBC: White Blood Cell (leukocyte), CRP: C-Reactive Protein, CK: Creatin Kinase, LDH:Lactate Dehydrogenase, PT: Prothrombin Time

signs of healthcare workers concerning COVID-19 infection reported that symptomatic healthcare workers showed higher COVID-19 compliance (25). Like our study findings, previous studies confirmed that cough, muscle-joint pain, weakness, fever, headache, sore throat, and shortness of breath were among the most common symptoms in people with COVID-19 positivity (20).

Although there was heterogeneity in the parameters obtained in our study, the mean leukocyte value was 7.36±2.32. In contrast, the median leukocyte medians of healthcare workers with symptomatic and COVID-19 compatible thorax CT were significantly lower. Interestingly, the rates of neutropenia, lymphocytopenia, neutrophilia, and lymphocytosis are high in symptomatic healthcare workers. As the cause of neutropenia and lymphocytopenia, it is thought that COVID-19, like the SARS-CoV virus, leads to the depletion of T lymphocytes, especially on CD4 and CD8 cells occurs following viral invasion as a result of bone marrow suppression or peripheral destruction in the early stages of infection. The increase in neutrophil and lymphocyte values has been

evaluated because of increased sensitivity to secondary bacterial infections in severe COVID-19 (26). However, in similar studies, the rate of healthcare workers with low leukocyte levels is higher (27). The low incidence of thrombocytopenia in COVID-19 is explained by the increase in the severity of the disease and the triggering of irregular proinflammatory cytokine storms such as IL-1β and IL-6 (24). In our study results, a decrease was observed in the median platelet of symptomatic healthcare workers, and a significant decrease was found in patients with COVID-19-compatible thorax CT. CRP, one of the earliest biomarkers of the inflammatory process, is highly sensitive to increased inflammation and tissue damage. For this reason, it is very important to follow COVID-19 closely so that severe COVID-19 results can be prevented (28). In our study, although an increase in D-dimer medians was observed in symptomatic healthcare workers compared to asymptomatic ones, this increase is not significant. However, D-dimer medians were significantly increased in healthcare workers with COVID-19-compatible thoracic CT. This is consistent with the literature, and D-dimer increases in COVID-19, especially in severe diseases.

Table 5. Factors Affecting COVID-19 Positive Health Workers' COVID-19 Compatible Thorax CT (Simple Binary and Multiple Logistic Regression)

Variable	Odds Ratio	95% Confidence Interval	p
Gender	2.790	0.887-8.840	0.079
Age	1.023	0.973-1.075	0.369
Chronic disease status	1.387	0.574-3.347	0.467
WBC* (10 ³ /mm ³)	0.699	0.550-0.889	0.003
Neutrophil >%70	6.639	2.212-19.921	0.001
Neutrophil <%50	0.852	0.219-3.310	0.817
Lymphocyte (%)	0.929	0.881-0.979	0.006
Lymphocyte >%40	0.950	0.242-3.736	0.941
High CRP* (>5 mg/L)	8.182	3.042-22.005	<0.001
PT*	0.886	0.372-2.109	0.785
D-dimer (µg/L)	1.000	0.998-1.003	0.774
CK* (U/L)	0.982	0.968-0.997	0.019
Platelets (10 ³ /mm ³)	0.988	0.980-0.997	0.007
Ferritin	0.993	0.982-1.004	0.190
LDH*	1.003	0.990-1.017	0.637
Variable	Odds Ratio	95% Confidence Interval	p
Still	1.89	-	0.512
WBC*	0.658	0.458-0.892	0.007
Neutrophil >%70	11.054	2.036-60.015	0.005
High CRP* (> 5 mg/L)	7.212	2.048-25.406	0.002

* WBC: White Blood Cell (leukocyte), CRP: C-Reactive Protein, PT: Protrombin Time, CK: Creatin Kinase, LDH: Lactate Dehydrogenase

Therefore, the D-dimer value is important in managing and following up with patients with COVID-19 (29). The increase in inflammatory markers with COVID-19 is reminiscent of the increases in markers in other infections. Although procalcitonin does not exhibit a specific profile for COVID-19, increased procalcitonin levels result from secondary bacterial infections. In our study, the medians of procalcitonin in healthcare workers with a symptomatic course showed a significant increase compared to the asymptomatic group. This situation suggests that individuals may have a secondary infection (30).

Although there is no diagnostic test, radiological examinations such as thorax CT in COVID-19 patients can help diagnose and follow up. The presence of thorax CT findings in the lung varies according to the stage of the disease. While there is no thoracic CT finding in most patients in the symptomatic period, thoracic findings compatible with COVID-19 are more common in the stage where the symptoms progress (31). Our study detected COVID-19-compatible thoracic CT in only 24.1% of healthcare workers (79.4%) who underwent thoracic CT. This can be explained by thorax CT being normal in the early stages of the disease (32).

The high neutrophil leukocyte ratio is due to increased neutrophil count and/or decreased lymphocyte count. Differences in neutrophil and lymphocyte parameters have been associated with poor prognosis and hospitalization in many studies (33). In a meta-analysis, a moderate increase in leukocyte count, increase in neutrophil count, and decrease in lymphocyte count were observed as

COVID-19 infection intensified, and it was thought that the increase in neutrophils was responsible for the increase in leukocyte count. It is stated that the most common laboratory findings at the time of diagnosis of COVID-19 are elevated CRP (58.3%), elevated LDH (57%), and lymphopenia (43.1%) (34). In addition, high CRP, prolonged PT, and elevated creatinine phosphokinase were reported as poor prognostic factors, and these laboratory findings were associated with poor clinical course and mortality (35). In our study, thorax CT predictors of COVID-19-positive healthcare workers were found as WBC (103/mm³), neutrophil >70%, lymphocyte (%), high CRP (>5 mg/L), CK (U/L), and platelet (103/mm³).

5. Conclusion

About half of the COVID-19-positive healthcare workers show symptoms. WBC, neutrophil, lymphocyte, thrombocyte, CRP, D-dimer, and procalcitonin values affect healthcare workers with symptoms and COVID-19-compatible thorax CT. Therefore, close monitoring of COVID-19 symptoms and laboratory values is recommended for early diagnosis and effective treatment of the inflammatory process in healthcare professionals. This study was carried out to contribute to current information and records regarding COVID-19 by examining the symptoms and laboratory and radiological findings of COVID-19-positive healthcare workers.

6. Contribution to the Field

This study was carried out to contribute to current information and records regarding COVID-19 by examining the symptoms and laboratory and radiological findings of COVID-19-positive healthcare workers. At the same time, routine screening of common symptoms, laboratory and radiological findings, detection of occupational risks, prevention of infections in healthcare workers, providing a safe working environment, reducing morbidity and mortality, reducing transmission, and maintaining the health system are of great importance.

Limitations

An important limitation of this study is that missing electronic data of the Hospital Information Management System and the patient files.

Ethical Aspect of the Research

To carry out the study, the Ministry permission required for COVID-19 scientific research studies in Turkey is taken from the T.R. Ministry of Health (2020-04-29T12_48_42). In addition, ethics committee permission from Gümüşhane University Scientific Research and Publication Ethics Committee (Number: 2020/5 Date: 05.05.2020) and the Public Hospital (Date 14.07.2020 Number E.2114) was obtained.

Conflict of Interest

This article did not receive any financial fund. There is no conflict of interest regarding any person and/or institution.

Authorship Contribution

Concept: SH, EA, ZA, AK, ÇK; **Design:** EA, AK; **Supervision:** EA, ZA; **Funding:** None; **Materials:** None; **Data Collection/Processing:** EA; **Analysis/Interpretation:** EA, ZA, AK;

Literature Review: SH, EA, ZA, AK, ÇK; **Manuscript Writing:** SH, EA, ZA, AK, ÇK; **Critical Review:** SH.

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