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Original Research

The effect of lifestyle on the course of COVID-19 infection

Pre-hospital life style and COVID-19

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Abstract

Aim: Our study's goal was to see how pre-illness lifestyle affected the course of COVID-19 infection in patients hospitalized with COVID-19.

Material and Methods: From January to May 2021, 66 patients aged 50 years and older whose PCR tests were positive for COVID-19 were studied in the pandemic service. The Pittsburgh Sleep Quality Index (PSQI), Mini Nutritional Assessment (MNA) scale, and International Short Physical Activity Questionnaire (IPAQ) were utilized to examine the impact of COVID- 19 infected individuals lifestyles such as sleep, nutrition and physical activities on the illness before the infection.

Results: According to the PSQI scale; the increases in discharged lymphocyte measurements were significant compared to the first hospitalization in the good and bad sleep group cases. A higher increase in NLR for the first hospitalization was seen in the bad sleep group compared to good sleep group. According to the MNA scale, all three groups had increased lymphocyte counts in discharge disposition in comparison to the first hospitalization. Patients at risk of malnutrition had higher increases in lymphocytes at discharge than malnourished individuals (p=0.049). Normal nutritional status had greater platelet measures than patients at risk of malnutrition (p=0.028). According to the IPAQ survey, very active cases had higher platelet measurements than minimally active cases.

Discussion: In our study on the effect of lifestyle on the course of COVID-19 infection, patients with proper nutrition, good sleep quality, and sufficient physical activity did not require treatment in the ICU. This finding revealed the importance of adopting and maintaining a healthy lifestyle.

Keywords

Pre-Hospital Lifestyle, COVID-19, Prognosis

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Introduction

The COVID-19 disease is a severe infection with varying clinical presentations that has spread globally since 2019 [1]. The COVID-19 disease is a result of the interaction between the Sars-Cov-2 virus of the coronavirus family and the host immune system. The immune response of the host depends on the age, gender, genetics, nutrition, sleep, and physical activity of the individual [2].

A healthy lifestyle is consistently associated with reduced all-cause mortality and a longer lifespan [3]. Risk of cardiovascular diseases, cancer, and all-cause mortality decrease in non-smokers, in those who are more physically active and have a balanced diet [4].

Sleep is another important period for immune function with recovering and regulating properties [5]. Sleep deprivation, disrupted sleep patterns, or poor sleep quality results in the vulnerability of the host against many infectious agents [6]. Likewise, diet and the immune system are related where an unbalanced diet disrupts the host immune response against pathogens causing susceptibility to infections [7]. Physical activity acts as an immune system modulator by contributing to the host defenses and strengthening the immune response, especially against viral diseases [1]. Proinflammatory and anti-inflammatory cytokines are released during and after physical exercise with an increase in the circulation of lymphocytes and cellular uptake of immune cells [1].

COVID-19 patients present with symptoms and findings similar to SARS and MERS with fever, nonproductive cough, dyspnea, musculoskeletal pain, malaise, low leucocyte counts, and radiological signs of pneumonia [2]. In this study, we aimed to investigate the effect of lifestyle (sleep, nutrition and physical activity) on the course of COVID-19 infection in patients admitted to the hospital with COVID-19 disease.

Material and Methods

The study was conducted on patients aged >50 years who were admitted to the pandemic wards of Fatih Sultan Mehmet Research and Training Hospital with PCR-confirmed COVID-19 infection between 31 January and 31 May 2021. Patients aged <50 years, with negative COVID-19 PCR tests, lymphatic system, or hematological diseases were excluded. The study was approved by the ethics board (E-17073117-050.06).

Age, gender, education status, duration of COVID-19 disease outside the hospital, duration of hospital stay, alcohol or tobacco habits, body mass index, comorbidities, medications, presence of lesions on thoracic CT, discharge to home, intensive care unit (ICU), or a different ward, lymphocyte count, neutrophil-lymphocyte ratio (NLR) and platelet counts at admission and at discharge were recorded.

To assess the lifestyle before the COVID-19 infection, sleep habits were evaluated with the Pittsburg Sleep Quality Index (PSQI) [8], nutritional status with Mini Nutritional Assessment (MNA) [9], and physical activity with the short International Physical Activity Questionnaire (IPAQ) [10].

Statistical Analysis

NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) was used for statistical analysis. Descriptive statistics were given using mean, standard deviation, median, interquartile range, frequency, percentage, minimum, and maximum values. The normal distribution of continuous variables was tested using Shapiro-Wilk's test and graphical evaluation. Groups with normal distributions were compared using the independent samples t-test and groups without normal distribution were compared using the Mann-Whitney U test, Kruskal-Wallis test, and Dunn-Bonferroni test when appropriate. Wilcoxon's signed-ranks test was applied to compare paired samples without normal distribution. The correlation of continuous variables was tested with Spearman's correlation. P<0.05 was considered statistically significant.

Results

A total of 66 patients were included in our study; 24 (36.4%) were female and 42 (63.6%) were male. The mean age of the patients was 53.53 ± 11.13 years, and the mean body mass index (BMI) was 29.29 ± 5.94. University graduates accounted for 21.5% of the patients; 19.7% were active smokers and 4.5% consumed alcohol.

The most frequent comorbidity was hypertension, seen in 50% of the patients. Of patients with comorbidities, 71.2% were on medications.The most frequent COVID-19 related symptom was malaise, followed by musculoskeletal pain in 68.2% of the patients and cough in 66.7% of the patients.

The mean duration from symptom onset to hospital admission was 7.42 ± 3.81 days, and the mean duration of hospital stay was 11.56 ± 6.22 days.

Bilateral pulmonary infiltrates were found in 84.8% of the patients on chest CT; 81.8% of the patients were discharged to home, while 4.5% required ICU care, and 13.6% were transferred to a different ward, following their COVID-19 treatment (Table 1). The PSQI, MNA, and IPAQ results are shown in Table 2.

The patients were grouped according to sleep quality and compared in terms of days of admission, along with lymphocyte count, NLR and platelet count at the time of discharge. Both groups had a significant increase in lymphocyte counts at discharge compared to the counts at admission, but the groups were not different for the change in lymphocyte counts.

The decrease in NLR from admission to discharge was significant in the poor sleep quality group, and the NLR at admission was higher in the poor sleep quality group, while the groups did not differ for the difference in NLR from admission to discharge. The platelet count at admission was not different between the groups, while they were higher in the good sleep quality group compared to the poor sleep quality group (p=0.040). At the time of discharge, the platelet count did not differ between the groups (p=0.201), but the increase in platelet counts was significant in both groups. Days of hospital stay were not different between the groups.

Patients were grouped according to the MNA scale as normal, at risk, or malnourished. Mean lymphocyte counts increased significantly in all three groups at discharge compared with their levels at admission. The groups were different in the increase in lymphocyte count (p<0.005), with the risk group being higher than the malnourished group (p=0.049). In addition, the normal and risk groups had significantly lower NLR at discharge compared to NLR values at admission. Platelet counts at admission and at discharge were different between the groups. The mean platelet count in the normal group was higher than in at risk group at admission (p=0.028) and at discharge (p=0.008). In the normal and risk groups, there was a significant increase in platelet counts at the time of discharge (p=0.001 and p=0.012), while a significant change was not observed in the malnourished group. The change in platelet counts between admission and discharge was different between the groups (p=0.024). The change in the risk group

Table 1. Baseline factors in study patients and presentation of COVID 19

		n (%)
Gender	Female	24 (36.4)
	Male	42 (63.6)
Age	Mean±Sd	63.53±11.13
	Median (Min-Max)	60.5 (50-90)
BMI	Mean±Sd	29.59±5.94
	Median (Min-Max)	28.7 (17-47.8)
Comorbidity	None	18 (27.3)
	Hypertension	33 (50.0)
	Diabetes	22 (33.3)
	COPD	10 (15.2)
	Any Cardiac	15 (22.7)
	Chronic Renal Failure	8 (12.1)
	Cerebrovascular disease	7 (10.6)
	Another	11(16,6)
Hospital stay (days)	Mean±Sd	11.56±6.22
	Median (Min-Max)	9.5 (2-32)
Chest CT Findings	(-)	2 (3.0)
	Unilateral	8 (12.1)
	Bilateral	56 (84.8)
Discharge	Home	54 (81.8)
	Another ward	9 (13.6)
	Intensive Care Unit	3 (4.5)

BMI: Body Mass Index CT:Computed Tomography COPD:Chronic Obstructive Pulmonary Disease

Table 2. Lifestyle Assessment

		n (%)
PSQI	Good sleep quality	35 (53.0)
	Poor sleep quality	31 (47.0)
MNA	Normal nutritional status	49 (74.2)
	At risk of malnutrition	12 (18.2)
	Malnourished	5 (7.6)
IPAQ	Inactive	34 (51.5)
	Minimally active	19 (28.8)
	Very active	13 (19.7)
International Physical Activity Questionnaire (Metabolic equivalent)	C1	34 (51.5)
	C2	1 (1.5)
	C2a	3 (4.5)
	C2b	4 (6.1)
	C2c	11 (16.7)
	C3a	6 (9.1)
	C3b	7 (10.6)
Mean±Sd		928.41±1547.63
Median (Min-Max)		186 (0-7742)

PSQI: Pittsburg Sleep Quality Index MNA: Mini Nutritional Assessment IPAQ: International Physical Activity Questionnaire C: Category C1: Inactive (600 MET-min/week): Lowest level of physical activity. Not enough activity to meet categories 2 or 3; C2: Minimally Active (601-3000 MET- min/week); C2a:3 or more days of vigorous activity for at least 20 minutes per day; C2b: 5 or more days of moderate intensity activity or walking for at least 30 minutes per day; C2c:5 or more days of walking or moderate activity achieving a minimum of 600 MET min-week; C3:Very Active (3000 MET-min/week); C3a: 3 or more days of vigorous activity accumulating a minimum of 1500 MET min-week; C3b: 7 days of a combination of moderate and vigorous activity achieving a minimum of 3000 MET min-week.

Table 3. Laboratory results at admission and discharge according to Pittsburg Sleep Quality Index (PSQI), Mini Nutritional Assessment (MNA), and International Physical Activity Questionnaire (IPAQ)

			PSQI			MNA				IPAQ			
			Good Sleep Quality (n=35)	Poor Sleep Quality (n=31)	p	Normal Nutritional Status (n=49)	At risk of Malnutrition (n=12)	Malnourished (n=5)	^{d}p	Inactive (n=34)	Minimally active (n=19)	Very active (n=13)	^{d}p
Lymphocyte Count	Admission	Mean±Sd	1.13±0.50	1.03±0.74	^{a}0.124	1.09±0.65	1.08±0.46	1.02±0.83	^{d}0.862	0.99±0.54	1.14±0.78	1.25±0.56	^{d}0.395
		Median (Min-Max)	1 (0.4-2.6)	0.9 (0.1-3.4)		0.9 (0.3-3.4)	1.1 (0.4-2)	1 (0.1-2.3)		0.9 (0.1-2.6)	0.9 (0.4-3.4)	1.2 (0.6-2.3)	
	Discharge	Mean±Sd	20.5±9.78	17.74±12.55	^{a}0.117	19.22±11.53	22.64±9.75	10.9±6.89	^{d}0.069	17.6±11.6	22.63±11.71	18.5±8.5	^{d}0.271
		Median (Min-Max)	20 (5.8-41)	12.2 (1.5-55)		16.4 (1.5-55)	20 (10.3-41.2)	7.8 (5.7-23)		14 (1.5-55)	19.3 (6.2-43)	20.2 (6.6-32)	
	^{c}p		0.001**	0.001**		0.001**	0.002**	0.043*		0.001**	0.001**	0.001**	
NLR	Admission	Mean±Sd	6.25±3.63	9.28±6.13	^{a}0.045*	7.6±5.01	6.88±3.48	10.34±9.25	^{d}0.935	9.01±6	5.98±3.39	6.66±4.11	^{d}0.207
		Median (Min-Max)	5.6 (1.7-17)	7.8 (0.7-24)		6.3 (0.7-20.8)	7.3 (1.9-11.7)	5.8 (1.4-24)		7.7 (0.9-24)	5.1 (0.7-12)	5.6 (1.7-16.7)	
	Discharge	Mean±Sd	4.94±3.72	7.85±11.16	^{a}0.192	6.54±9.18	3.81±2.13	10.1±5.09	^{d}0.057	7.65±10.73	4.5±3.49	5.45±4.06	^{d}0.291
		Median (Min-Max)	3.7 (1.3-15)	4.2 (0.6-64)		3.9 (0.6-64)	3.6 (1.3-8.4)	11(3.2-15.5)		5 (0.6-64)	3.7 (1-14.5)	3.7 (1.8-13.8)	
	^{c}p		0.077	0.018*		0.041*	0.006**	0.715		0.036*	0.070	0.442	
Platelet Count	Admission	Mean±Sd	224,03±86,56	206,16±84,14	0,15	224,57±77,63	170,75±48,42	235,8±178,29	0,025*	213,21±88,6	188,63±43,55	261,46±106,98	0,043*
		Median (Min-Max)	212 (95-559)	187 (100-546)		212 (117-559)	166 (95-266)	167 (100-546)		194 (100-546)	181 (95-266)	239 (120-559)	
	Discharge	Mean±Sd	314,97±85,14	264,9±106,05	0,040*	310,92±90,97	241,42±57,16	220,8±172,02	0,009**	262,85±97,6	297,47±100,4	357,46±60,63	0,005**
		Median (Min-Max)	305 (132-500)	260 (41-500)		312 (41-500)	248 (146-354)	156 (65-500)		259 (41-500)	298 (65-500)	380 (223-438)	
	^{c}p		0,001**	0,001**		0,001**	0,012*	0,893		0,001**	0,001**	0,001**	

^{a}Mann Whitney U Test; ^{b}Student t Test; ^{c}Wilcoxon Signed-Ranks Test; ^{d}Kruskal Wallis Test; ^{e}Oneway ANOVA Test; *p<0,05; **p<0,001; NLR: Neutrophil to Lymphocyte Ratio was lower than in the normal group (p=0.022). The three groups were not different for days of hospital stay.

According to the IPAQ scores, the patients were categorized as inactive, minimally active, and active groups. All three groups had significantly higher mean lymphocyte counts at discharge than at admission. The groups were different for mean platelets counts at admission (p=0.043) The active group had a significantly higher mean platelet count at admission than the minimally active group (p=0.048). The active group had a significantly higher mean platelet count at discharge than the inactive group (p=0,05). All groups had a significant increase in platelet counts at discharge. The groups did not differ for days of hospital stay. Lymphocyte count, NLR and platelet count at the time of admission and discharge are given in Table 3.

The metabolic equivalent of task (MET) scores that reflect the level of physical activity were compared with the days of hospital admission and laboratory results at admission. There was a weak but significant positive correlation between MET scores and lymphocyte percentages (r=0,282, p=0,022) and a weak but significant negative correlation between MET scores and NLR at admission (r=0.264, p=0.032).

Transfer to the ICU was necessary for 3 (4.5%) of the 66 study patients; 67% of these patients were male. One male patient expired in the ICU, while the other 2 patients survived to discharge. All of these patients were physically inactive (C1) and had poor sleep quality (PSQI: 12, 14, 10, respectively). Two of the patients were malnourished (MNA: 11, 12, respectively), and one patient was obese (BMI: 38.6 kg/m2).

Discussion

When COVID 19 patients are examined according to their lifestyles, in the good sleep quality group, the mean NLR at admission was lower and the platelet count was higher than in the poor sleep quality group. It was observed that sleep quality had an effect on platelet count and NLR. The lymphocyte count was lower in malnourished patients. Platelet counts were significantly higher in patients with normal nutritional status. Platelet counts were higher in physically active patients (>3000 MET).

Uslu et al have retrospectively studied 114 patients for their thoracic CT findings and reported typical findings in 41 (35.9%) patients, atypical findings in 3 (2.6%) patients, inconclusive findings in 18 (15.7%) patients, and no pathology in 52 (45.6%) patients. Among 62 patients with CT findings, infiltrates were bilateral in 42 (67.7%) and unilateral in 20 (32.3%) patients [11]. Among our study patients, 58 (90.6%) had bilateral lung infiltrates and 6 (9.4%) had unilateral infiltrates, while 2 patients had no COVID-19 associated findings on chest CT. A high rate of bilateral lung infiltrates was observed among our patients similar to previous reports in the literature.

High (>40 kg/m2) BMI was the second strongest predictor for admission to a hospital after advanced age in the study by Petrilli et al on 4103 COVID-19 patients [12]. The mean BMI of our study patients was 29.59, with 14.4% of the patients having a BMI > 40 kg/m2. One of the three patients who required treatment in the ICU had a BMI of 38.6 and eventually did not survive.

Zuin et al investigated the comorbidities and COVID-19 mortality in their metaanalysis, reporting that hypertension (HT) was the most frequent cardiovascular comorbidity (24.3%), followed by diabetes mellitus with 15.2% and cardiac diseases with 6.2% [13]. In our study, the most frequent comorbidity was hypertension seen in 50% of the patients.

A pilot study on 8 healthy males was conducted by Boudjeltia et al to investigate cardiovascular risks of sleep deprivation. Neutrophil and leucocyte counts were increased with sleep deprivation, which may be associated with higher cardiovascular risk due to activated inflammatory processes [14]. The relationship of poor sleep quality with the recovery of lymphopenia and ICU requirement in COVID-19 patients was investigated by Zhang et al who found higher NLR and lymphopenia that further decreased with poor sleep quality [15]. Liu et al studied the relationship between mortality and platelet counts and emphasized the importance of monitoring platelet counts for COVID-19 prognosis [16]. Platelets have effects on the innate immune system as well as T cell activation and differentiation [17]. In both our sleep quality groups, mean lymphocyte counts significantly increased at the time of discharge. The increase in lymphocyte count was higher, albeit insignificantly, in the good sleep quality group. A significant difference may have not been shown due to the low number of included patients. NLR at admission was higher and platelet count at discharge was lower in the poor sleep quality group.

Satio et al studied the effect of nutrition on immune regulation with 33 female anorexia nervosa patients and reported low lymphocyte and neutrophil counts in these patients along with increased susceptibility to infection [18]. In the study on the prevalence of malnutrition and associated factors in 182 geriatric COVID-19 patients by Li et al, the lymphocyte count at admission was lower in their malnutrition group compared to their normal nutrition group [19]. In the cross-sectional study by Kaya et al on 95 geriatric patients, patients at risk of malnutrition and with malnutrition had significantly higher NLR than patients with normal nutritional status, with a negative correlation between NLR and MNA scores [20]. In our study, the decrease in NLR at the time of discharge was significant for both patients with normal nutritional status and at risk of malnutrition, while the change in NLR was not significant in patients with malnutrition. The change in NLR did not differ between the malnutrition groups. Yoshiuchi et al have studied anorexia nervosa patients and observed a rise in thrombopoietin and thrombocyte levels shortly after recovery of liver functions with proper nutrition [21]. In our study, patients with normal nutritional status had higher platelet counts both at admission and discharge compared to patients at risk of malnutrition.

Campbell et al studied the immunological effects of exercise, reporting the benefits of a physically active lifestyle with reduced bacterial and viral infections and better overall health [22]. In a systemic review of the immune effects of physical exercise by Silveira et al, the rise in neutrophil counts after physical activity was associated with the release of neutrophils from the bone marrow upon stimulation with cortisol [23]. In the study by Furtado et al, they studied the effects of physical activity during and after COVID-19 infection, an it was found that lymphocyte and leukocyte counts were maintained at normal levels with continued physical activity [24]. In all our activity groups, there was a significant rise in lymphocyte counts at discharge. No difference could be shown between lymphocyte counts at discharge between the highly active group and the inactive group, which can be explained by the variability in the duration of COVID-19 infection prior to hospital admission and the low sample size. Hulmi et al. investigated the effects of resistance exercise and protein intake on blood leukocytes and platelets in young and old men; they found that platelet count increased rapidly after high-intensity exercises [25]. In our study, patients with high physical activity (>3000 MET) had significantly higher thrombocyte counts at admission than minimally active patients.

The limitations of our study include its single-center design, lack of a control group with healthy subjects, and its low sample size. Our findings can be confirmed by similar studies designed with larger sample sizes.

Conclusion

In our study on the effect of lifestyle on the course of COVID-19 infection, patients with proper nutrition, good sleep quality, and sufficient physical activity did not require treatment in the ICU. This finding revealed the importance of adopting and maintaining a healthy lifestyle.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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