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Respiratory Symptoms and Quality of Life in First Responders to the 2021 Forest Fires in Turkey: A Cross-Sectional Sri-Based Study

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Abstract

Objective

This analytical cross-sectional study aimed to investigate respiratory complaints and their associated quality of life among fire response teams following the major forest fires that occurred in the Mediterranean and Aegean regions of Turkey in August 2021. The study utilized the Severe Respiratory Insufficiency (SRI) questionnaire, a valid tool for illuminating the effects of acute smoke exposure on respiratory health and for identifying key socio-demographic factors that affect quality of life in this at-risk population.

Material and Method

Data for this analytical cross-sectional study were collected using a convenience sampling method from 83 participants who responded to the August 2021 fires. A total of 148 individuals were invited, and 83 were included in the study. The data collection tool included demographic questions and the 49-item SRI questionnaire. Due to the non-normal data distribution, inter-group analyses were performed using the Mann-Whitney U and Kruskal-Wallis H tests, with effect sizes and 95% Confidence Intervals (95% CI) reported. The level of statistical significance was set at ($p<0.05$).

Results

Analysis revealed that participants in the 18-24 age group reported a higher quality of life compared to other age groups. Conversely, a statistically significant difference ($p < 0.05$) indicated that the 45-65 age group experienced a poorer quality of life when compared to other demographics. Alcohol consumption was found to directly impact quality of life; a significant difference ($p < 0.05$) was observed in quality of life between participants who abstained from alcohol and those who consumed alcohol once a week. Furthermore, individuals without substance addiction exhibited higher scores, indicating better quality of life, with a significant difference ($p < 0.05$) noted when compared to those with substance addiction.

Conclusion

Key factors influencing the respiratory complaints and overall quality of life among individuals directly exposed to forest fires include age, alcohol use, substance addiction, education level, and engagement in sports activities.

Keywords: Air pollution, Forest fire, Respiratory insufficiency, Quality of life

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Introduction

Air pollution stems from diverse sources, with the Industrial Revolution, technological advancements, and natural events such as fires posing significant threats to public health (1). Beyond its inflammatory impact on the respiratory tract, air pollution also disrupts various other cellular processes (2). While airway epithelial cells typically offer protection against such disruptions, elevated particulate matter concentrations in the air can induce numerous respiratory dysfunctions, even with short-term exposure (3). Forest fires exemplify this scenario, affecting residents in proximity and the personnel-including public officers, private sector employees, and volunteers—involved in firefighting efforts (4).

Forest fires are natural phenomena typically occurring during periods of high ambient temperature, often attributed to both deliberate acts and incompletely understood causes (5). These fires lead to a substantial accumulation of particulate matter in the atmosphere, exhibiting dramatic increases in both the short and long term (6). Consequently, examining forest fires and their associated damage through the lens of air pollution can facilitate the implementation of more effective preventive measures against respiratory ailments (7).

Forest fires commonly release carbon monoxide (CO), carbon dioxide (CO2), and various organic gases (8). Beyond these noxious gases, human life expectancy is further compromised by airborne particulate matter, its atmospheric persistence, and the systemic absorption of harmful chemicals, exacerbated by changing climatic conditions (9).

Airborne particulate matter constitutes the primary etiological agent for physiological dysfunctions observed during forest fires (10). Following prolonged forest fire events, these airborne particles exhibit extended atmospheric residence times, leading to damage to the epithelial cell barriers of the respiratory tract (11). Concomitantly, pre-existing chronic diseases and lifestyle factors such as alcohol and cigarette consumption exacerbate the detrimental effects of air pollution, thereby diminishing quality of life (12). Consequently, individuals residing in forest-proximate settlements and those engaged in fire suppression activities during and after forest fires are susceptible to irreversible damage to the epithelial cells lining their respiratory tracts (13).

Respiratory morbidities attributable to forest fires represent a critical public health concern warranting attention from both regional inhabitants and firefighting personnel. Accordingly, the principal objective of this study is to elucidate the physiological and sociodemographic determinants of respiratory complaints associated with forest fires. While existing literature extensively addresses air pollution from industrialization, there is a significant gap in research specifically evaluating the physiological and sociodemographic effects of large-scale, acute smoke exposure from forest fires on the quality of life of direct intervention personnel in the Turkish context. This study addresses this gap by using a validated instrument, the SRI questionnaire, to analyze the determinants of respiratory complaints in this uniquely exposed group.

Based on the detrimental health effects of air pollution observed in antecedent studies, it was hypothesized that individuals directly engaged in forest fire intervention would present with diminished quality of life scores, as quantifiably measured by the SRI questionnaire. Furthermore, key sociodemographic and lifestyle covariates, specifically age, alcohol consumption, substance dependence, educational attainment, and athletic participation, are postulated to be significantly associated with both the severity of respiratory symptomatology and the overall quality of life within this cohort of first responders.

Material and Method

A Working Group and Research Format

The survey instrument utilized in this study was meticulously designed to acquire data pertinent to a cross-sectional investigation, focusing on respiratory morbidities among individuals exposed to forest fire incidents. The questionnaire was administered to participants directly involved in forest fire intervention over a 45-day period. Data collection was conducted online via (https://forms.office.com/) during September and October 2021, following the acquisition of informed consent from each participant.

The dependent variable in the study was the total score obtained from the SRI questionnaire, which measures the participants' quality of life related to respiratory complaints. The independent variables consisted of sociodemographic and health factors, including age, gender, education level, professional experience, cigarette use, alcohol consumption, and substance dependence.

Cross-sectional studies provide a valuable methodology for the rapid and simultaneous collection of data in the investigation of regional disease

prevalence, additionally enabling the comparison of diverse findings. Consequently, this study adopted an analytical cross-sectional design, employing a survey-based data collection method. This approach was chosen to investigate the prevalence of respiratory complaints among public officers, private sector personnel, students, and volunteers who participated in the forest fire interventions in Antalya, Isparta, Burdur, and Muğla provinces and their surrounding areas during August 2021, and who subsequently consented to participate in the study. However, due to the cross-sectional nature of the study and the use of univariate statistical methods, the effect of potential confounding variables on the relationship between dependent and independent variables was not controlled for in these analyses.

Participant Selection Procedure

The data for this analytical cross-sectional study were acquired from individuals who had directly participated in forest fire response efforts. Prioritization was given to the inclusion of individuals who worked in shifts, possessed prior experience in forest fire intervention, and had prolonged exposure within the fire zone. Participant inclusion criteria were based on the duration of their presence in the fire zone, documented exposure to noxious gases such as sulfur dioxide (SO2) and carbon monoxide (CO) emanating from the fire, and previous engagement in forest fire suppression activities. However, a limitation of the current study is the inability to specify in detail quantitative data, such as the precise duration of exposure within the fire zone and specific gas exposure levels, which were integral to the participant selection criteria. Despite meticulous participant selection, the final sample size was limited to 83 participants out of 148 invited individuals. This limitation was primarily due to factors such as individuals declining survey participation, engagement in short-term shift work, and job transitions (Table 1).

Questions Included in the Survey

The study administered a comprehensive questionnaire comprising 63 items to the 83 participants. This instrument included demographic inquiries and questions derived from the SRI survey, encompassing domains such as respiratory complaints, physical function, symptoms and sleep, social relations, anxiety, psychological well-being, and social functionality.

Severe Respiratory Insufficiency (SRI) Survey

The study utilized questions from the SRI survey, a widely recognized instrument for assessing respiratory failure and potential respiratory complaints. Originating in Germany, the SRI is a self-administered questionnaire suitable for patients or individuals in environments conducive to respiratory complaints. This survey, which has undergone both Turkish translation and transcultural adaptation, comprises 49 items, including those pertaining to respiratory complaints. (8 items; It's hard for me to climb stairs, I get short of breath when I eat, I can go out in the evenings, I mostly feel bad, I get breathless even without physical exertion, I get headaches very often, I have many friends and acquaintances, I'm worried that my illness might get worse), physical function (6 items; I can fall asleep easily, I can easily empathize with other people, Sometimes I feel dizzy, I wake up at night with respiratory distress, I'm afraid I'll have shortness of breath at night, I have neck pain very often), symptoms

Table 1 Flow of Participants

Participant Information	Number (n)
Number of Potential Participants	250
Number of Participants Excluded Prior to Survey	102
Number of Participants Excluded Post-Survey	2
Number of Participants Invited	148
Number of Participants Who Consented to Participate	85
Number of Participants Who Declined to Participate	63
Total Included in Analysis	83

and sleep (7 items; I mostly can't leave the house, Housework is difficult for me, I often wake up at night, I can sleep through the night without interruption, I mostly feel short of breath, I feel optimistic about the future, I feel alone), social relations (6 items; I experience shortness of breath when speaking, Guests tire me out, I cough a lot, I frequently have phlegm in my airways, I avoid situations where I might feel embarrassed due to my breathing difficulties, I feel good around my friends/acquaintances), anxiety (5 items; I'm afraid of having a shortness of breath attack, I experience shortness of breath when I move, I'm anxious about the limitations caused by my illness, My relationship with my spouse has deteriorated due to my illness, I can go shopping), psychological well-being (9 items; I can do any activity/hobby I enjoy, I'm mostly restless, My relationships with friends/acquaintances are limited due to my illness, I enjoy life, I can participate in social events, I'm mostly sad, Shortness of breath bothers me in public places I'm mostly angry, I can dress and undress myself), and social functionality (8 items; I'm tired all day long, I feel isolated, I can cope with my illness, My breathing difficulties prevent me from doing my daily tasks, My family is suffering because of my illness, My relationships with other people have been cut off due to my breathing difficulties, My leisure activities are limited, Overall, I'm satisfied with my life). Responses to the SRI survey questions were compared across groups stratified by sociodemographic data, employing appropriate statistical methodologies. (14). Participants' responses to the SRI questionnaire items were assessed on a scale ranging from (-2) to (+2) points, reflecting the degree to which each statement applied to their experience. For each subgroup, responses to the SRI survey questions were scored through recording and the calculation of individual percentage values. Furthermore, the arithmetic mean of these subgroup scores was computed to derive a total score. A higher total score indicated a better quality of life, whereas a lower score signified a poorer quality of life. (15).

The SRI survey is applicable not only to individuals with respiratory failure or existing respiratory complaints but also to healthy individuals exposed to conditions potentially inducing such complaints. This is evidenced by its use in studies investigating potential pulmonary hypertension and subsequent quality of life in patients with Obesity-Hypoventilation Syndrome (OHS) (16). Notably, research also employs the SRI to assess potential respiratory complaints and associated quality of life following ventilator weaning. Consequently, the SRI survey serves as a valuable tool for investigating respiratory complaints and related quality of life in individuals who have experienced or been exposed to situations with the potential to cause respiratory issues, even in the absence of overt disease (17).

Statistical Analysis

Participants' responses to the sociodemographic and SRI survey questions were scored within the range of [-2, +2], and the internal consistency of the survey was assessed using Cronbach's alpha. The main findings for all quantitative variables were presented as the mean ± standard deviation, and the effect sizes were reported along with their respective 95% Confidence Intervals (95% CI).

The normality of distribution for groups stratified by sociodemographic data was determined by examining their skewness and kurtosis values. Accordingly, groups exhibiting skewness and kurtosis values outside the [-2, +2] range, indicating a non-normal distribution, were analyzed using the non-parametric Kruskal-Wallis H test. For comparisons between two non-normally distributed groups, the Mann-Whitney U test was employed. Additionally, Dunn's post-hoc test (with Bonferroni correction) was utilized to ascertain significant differences between groups in their survey responses, with the level of statistical significance accepted at $p<0.05$. However, the use of non-parametric analyses and the sample size (n=83) are not suitable for examining multiple variable interactions; therefore, the absence of multivariate regression analyses limits the ability to detail potential simultaneous interactions and causal relationships between variables.

Results

The sociodemographic characteristics of the study participants were assessed across parameters including age, gender, occupation, educational attainment, sports habits, substance addiction, and alcohol consumption. Analysis of age groups revealed that the 35-44 age bracket constituted the largest proportion of participants at 36.14%. Furthermore, 74.70% of individuals engaged in field work were male. Regarding professional distribution, public officers comprised 71.08% of the field workforce, while 36.14% of the total study participants held undergraduate degrees. Demographic analysis concerning sports, smoking, and alcohol habits indicated that 53.01% engaged in sports, 63.86% reported no smoking, and 81.93% abstained from alcohol (Table 2).

The health parameters of the study groups were assessed using survey questions pertaining to chronic diseases, COVID-19 history, and allergies.

Accordingly, 80.72% of the participants reported no chronic disease, while 33.73% had a history of COVID-19. Among groups stratified by allergy status, 81.93% reported no allergies, with allergic rhinitis being the most prevalent specific allergy, affecting 4.82% of participants (Table 3).

Table 2 Sociodemographic Distributions of the Groups Participating in the Study

Sociodemographic Parameters	Variables	n	%
Age	18-24	17	20,48
	25-34	19	22,89
	35-44	30	36,14
	45-65	17	20,48
	65+	0	0,00
Gender	Women	21	25,30
	Men	62	74,70
Jobs	Student	10	12,05
	Public officer	59	71,08
	Private sector personnel	0	0,00
	Contract employee	12	14,46
	Volunteer	2	2,41
	Unemployed	0	0,00
Education Level	Elementary school	2	2,41
	Middle school	4	4,82
	High school	19	22,89
	Associate degree	23	27,71
	Undergraduate	30	36,14
	Postgraduate	5	6,02
	Non-literate	0	0,00
Sports	(+)	44	53,01
	(-)	39	46,99
Substance addiction	Cigarette	30	36,14
	Alcohol	0	0,00
	Various Stimulants	0	0,00
	Non-User	53	63,86
Alcohol use	Non-alcoholic	68	81,93
	Once a week	13	15,66
	1-2 times a week	2	2,41
	3-4 times a week	0	0,00
	5-6 times a week	0	0,00
	Every day	0	0,00

Table 3 Distributions of Health Information of the Groups Participating in the Study

Health Related Parameters	Variables	n	%
Chronic Diseases	Other	8	9,64
	Asthma	2	2,41
	COPD	1	1,20
	Diabetes	0	0,00
	Hypertension	5	6,02
	No Chronic Disease	67	80,72
Covid-19	Yes	28	33,73
	No	55	66,27
Allergy	Other	4	4,82
	Asthma	1	1,20
	Allergic Rhinitis	4	4,82
	Atopic Dermatitis	0	0,00
	Urticaria	3	3,61
	Drug Allergy	3	3,61
	Food Allergy	0	0,00
	Venom Allergy	0	0,00
	Anaphylaxis	0	0,00
	No Allergy	68	81,93

Given the non-normal distribution of the data obtained from the groups, Interquartile Range (IQR) values were calculated (Table 4).

Groups and SRI Scores

Analysis of the SRI and standard deviation (SD) data, presented as percentages of quality of life, revealed a significant inverse correlation between increasing average age and quality of life within age groups exposed to forest fires (Table 5).

A significant association was observed between alcohol consumption and quality of life within the groups stratified by self-reported alcohol use (Table 6).

Additional findings from the study pertained to SRI scores in relation to educational attainment. Specifically, individuals with undergraduate and graduate education who participated in forest fire suppression exhibited a favorable quality of life, as indicated by their SRI scores (Table 7).

The SRI scores for women exposed to forest fires in the field were relatively higher compared to men; however, the overall quality of life for both genders was assessed as poor. Furthermore, the sports group exhibited lower SRI scores than the non-sports group. Regarding substance addiction (smoking), the non-addiction group demonstrated higher SRI scores. Conversely, both groups with and without a history of COVID-19 showed lower SRI scores compared to other demographic stratifications. These findings suggest that participation in sports and the absence of substance addiction significantly influence quality of life by impacting SRI scores (Table 8).

Analysis revealed that the 18-24 age group demonstrated a superior quality of life compared to both the 25-34 and 45-65 age groups, as indicated by their SRI scores. Additionally, the 25-34 and 35-44 age groups exhibited a better quality of life than the 45-65 age group. Participants reporting alcohol consumption 1-2 times per week showed a better quality of life than those who abstained from alcohol. Furthermore, the

Table 4 IQR Analysis by Group

Groups	Q1 - 25th Percentile	Q3 - 75th Percentile	Interquartile Range (IQR)
Age Group 18-24	30.96	81.70	50.73
Age Group 25-34	38.96	80.35	41.39
Age Group 35-44	42.31	74.94	32.63
Age Group 45-65	31.94	71.49	39.55
Non-Alcholic Group	43.23	73.07	29.84
Alcohol Using Once a Week Group	57.55	76.99	19.44
Alcohol Using 1-2 Times a Week Group	54.86	50.76	-4.09
Elementary School Group	9.45	88.57	79.11
Middle School Group	27.27	87.67	60.40
High School Group	29.04	83.19	54.15
Associate School Group	37.43	76.71	39.28
Undergraduate School Group	38.90	76.07	37.17
Postgraduate School Group	32.49	84.89	52.39
Women Group	36.94	76.58	39.64
Men Group	45,52	80,12	34,60
Sport (+) Group	39.73	79.85	40.11
Spor (-) Group	32.49	75.56	43.07
Substance Addiction (+) Group	32,03	71,36	39,32
Substance Addiction (-) Group	38,97	79,20	40,22
COVID-19 (+) Group	46,34	79,57	33,22
COVID-19 (-) Group	32,49	73,06	40,56

Table 5 Age Groups and SRI Scores

Groups	SRI (%) ± SD, (CI_{95})	n	Cronbach's alpha
Age Group 18-24	60.57±6.84, (47,10-73,00)	17	0,76
Age Group 25-34	38.68±12.64, (44,00-69,90)	19	0,78
Age Group 35-44	49.28±7.79, (48,20-65,60)	30	0,73
Age Group 45-65	27.70±12.30, (33,90-61,00)	17	0,72

Table 6 Alcohol Groups and SRI Scores

Groups	SRI (%) ± SD, (CI_{95})	n	Cronbach's alpha
Non-Alcoholic Group	44,42±6,03, (48,60-60,70)	68	0,81
Consumed Alcohol Once a Week Group	61,46±6.52, (49,80-73,20)	13	0,74
Consumed Alcohol 1-2 Times a Week Group	52,82±5.17, (0,78-105,00)	2	0,72

Table 7 Education Level Groups and SRI Scores

Groups	SRI (%) ± SD, (CI_{95})	n	Cronbach's alpha
Group Elementary School	31,75±23.72, (25,30-112,00)	2	0,71
Group Middle School	46,22±27.83, (26,10-91,40)	4	0,71
Group High School	41,30±12.19, (43,60-69,80)	19	0,75
Group Associate Degree	34,10±11.40, (45,00-65,00)	23	0,72
Group Undergraduate	52,71±6.54, (47,80-66,00)	30	0,74
Group Postgraduate	63,05±10.84, (32,90-89,80)	5	0,72

Table 8 Other Groups Affecting SRI Scores

Groups	SRI (%) ± SD, (CI_{95})	n	Cronbach's alpha
Women	49,97±8.66, (47,50-68,10)	21	0,75
Men	42,98±6.57, (49,20-62,00)	62	0,78
Sport (+)	38,78±8.50, (48,90-64,10)	44	0,73
Sport (-)	51,48±5.86, (48,30-63,00)	39	0,73
Substance Addiction (+)	33,36±10.05, (44,70-62,80)	30	0,84
Substance Addiction (-)	51,19±5.92, (50,70-64,80)	53	0,82
Covid-19 (+)	49,08±9.41, (51,70-71,20)	28	0,71
Covid-19 (-)	42,54±6.48, (46,10-59,50)	55	0,77

group consuming alcohol once a week reported a better quality of life than the group consuming alcohol 1-2 times per week. Regarding educational attainment, the postgraduate group exhibited a superior quality of life compared to individuals with primary, secondary, high school, associate, and undergraduate education. The undergraduate group also demonstrated a better quality of life than the primary, secondary, high school, and associate degree groups. Women reported a better quality of life than men. Lastly, the non-sporting group displayed a better quality of life than the sporting group (Table 9).

Table 9 Comparison of SRI Scores Across Various Demographic and Lifestyle Groups

Groups	SRI (%)±SD	Statistical Test	p Value	Significantly Different Groups (Post-Hoc Analysis)
Age Groups		Kruskal-Wallis H Test		
18-24	60,57±6.84		0,03	18-24 >25-34
25-34	38,68±12.64		0,02	18-24 >45-65
35-44	49,28±7.79		0,02	25-34>45-65
45-65	27,70±12.30		0,03	35-44>45-65
Alcohol Using Groups		Kruskal-Wallis H Test		
Non-Alcoholic Group	44,42±6.03		0,03	Alcohol Using 1-2 Times a Week Group > Non-Alcoholic Group
Once a Week Group	61,46±6.52		0,04	Alcohol Using Once a Week Group > Alcohol Using 1-2 Times a Week Group
Alcohol Using 1-2 Times a Week Group	52,82±5.17			
Education Level Groups		Kruskal-Wallis H Test		
Elementary School	31,75±23.72		0,03	Postgraduate School > Elementary School
Middle School	46,22±27.83		0,02	Postgraduate School > Middle School
High School	41,30±12.19		0,03	Postgraduate School > High School
Associate Degree	34,10±11.40		0,02	Postgraduate School > Associate Degree
Undergraduate School	52,71±6.54		0,02	Postgraduate School > Undergraduate School
Postgraduate School	63,05±10.84		0,02	Undergraduate School > Elementary School
			0,04	Undergraduate School > Middle School
			0,02	Undergraduate School > High School
			0,03	Undergraduate School > Associate Degree
Sex		Mann-Whitney U Test		
Women	49,97±8.66		0,01	Women > Men
Men	42,98±6.57			
Sport Situation		Mann-Whitney U Test		
Sport (+)	38,78±8.50		0,02	Sport (-) > Sport (+)
Spor (-)	51,48±5.86			
Substance Addiction Groups		Mann-Whitney U Test		
Substance Addiction (+)	33,36±10.05		0,02	Substance Addiction (-) > Substance Addiction (+)
Substance Addiction (-)	51,19±5.92			

Age Groups and SRI Scores

Among the age groups of individuals directly involved in forest fire intervention and affected by associated air pollution, the 18-24 age group exhibited high SRI scores, whereas the 45-65 age group demonstrated low scores. A significant difference in quality of life was observed when comparing the SRI scores across the participating age groups: 45-65 years (SRI: 27.70 ±12.30), 18-24 years (SRI: 60.57±6.84), 25-34 years (SRI: 38.68±12.64), and 35-44 years (SRI: 49.28±7.79) ($p<0.05$). Consistent with this, a significant difference in quality of life was also noted when comparing the 25-34 age group with the 18-24 age group ($p<0.05$) (Figure 1).

Effect of Alcohol Use on SRI Scores

Within the groups stratified by alcohol consumption, a significant difference in quality of life was observed when comparing the non-alcohol use group (SRI: 44.42±6.03) with the group reporting alcohol use 1-2 times per week (SRI: 52.82±5.17) ($p<0.05$). Furthermore, a significant difference in quality of life was also noted when the group consuming alcohol once a week was compared with the group consuming alcohol 1-2 times per week (SRI: 61.46±6.52) ($p<0.05$) (Figure 2).

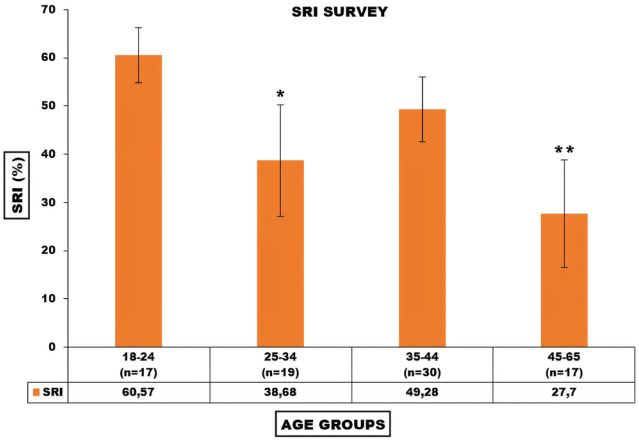

Figure 1

Age Groups and SRI Scores. Each point is expressed as SRI (%) and SD. *p<0.05; compared according to 18-24 age group. **p<0.05; compared according to 18-24, 25-34 and 35-44 age groups. In the figure means *p < 0.05 and ** p < 0.05.

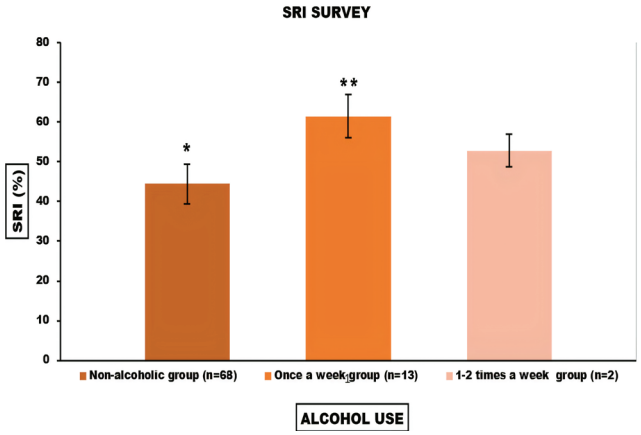

Figure 2

Effect of Alcohol Use on SRI Scores. Each point is expressed as SRI (%) and SD. *p<0.05; compared to the once a week group, **p<0.05; compared to the 1-2 times a week group. In the figure means *p < 0.05 and ** p < 0.05.

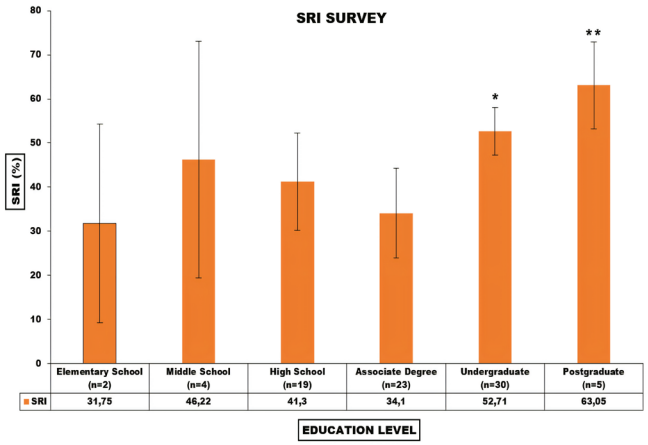

Figure 3

Relationship between Education Level and SRI Scores. Each point is expressed as SRI (%) and SD. *p<0.05; when compared according to elementary school, middle school, high school and associate degree groups.**p<0.05; when compared according to elementary school, middle school, high school, associate degree and undergraduate groups. In the figure means *p < 0.05 and ** p < 0.05.

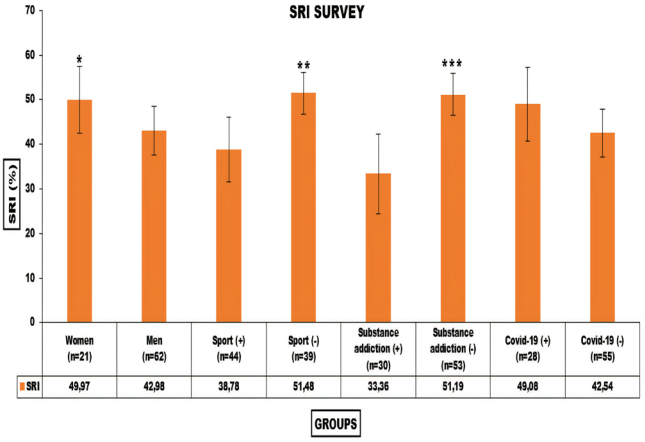

Figure 4

Other Groups Affecting SRI Scores. Each point is expressed as SRI (%) and SD. *p<0.05; compared to the men group, **p<0.05; compared to the sports group, ***p<0.05; compared to the substance addiction group. In the figure means *p < 0.05, ** p < 0.05 and *** p < 0.05.

Relationship Between Education Level and SRI Scores

Among the groups stratified by educational attainment among individuals directly involved in forest fire intervention, a significant difference in quality of life was observed when the postgraduate group (SRI: 63.05±10.84) was compared with the elementary school group (SRI: 31.75±23.72), middle school group (SRI: 46.22±27.83), high school group (SRI: 41.30±12.19), associate degree group (SRI: 34.10±11.40), and undergraduate group (SRI: 52.71±6.54). (p<0.05) Similarly, a significant difference in quality of life was found when comparing the undergraduate group with the elementary school, middle school, high school, and associate degree groups(p<0.05) (Figure 3).

Other Groups Affecting SRI Scores

A significant difference in quality of life (p<0.05) was observed when comparing the female group (SRI: 49.97±8.66) with the male group (SRI: 42.98±6.57) among study participants. Furthermore, a significant difference (p<0.05) in quality of life, based on SRI scores, was found between the non-sports group (SRI: 51.48±5.86) and the sports group (SRI: 38.78±8.50). Substance addiction (smoking) was identified as another factor influencing quality of life; a significant difference (p<0.05) in quality of life, according to SRI scores, was analyzed between the non-substance addiction group (SRI: 51.19±5.92) and the substance addiction group (SRI: 33.36±10.05) (Figure 4).

Discussion

In the investigation of respiratory complaints attributed to air pollution during forest fires, statistically significant findings emerged from comparisons across age, alcohol consumption, education level, substance addiction (smoking), sports participation, and gender groups. Concurrently, a review by Mermit, SRI scores yielded crucial insights into evaluating the impact of both potential and confirmed respiratory complaints on quality of life. (18). While this assertion is generally accurate, it is crucial to expand the understanding of air pollution beyond industrialization to encompass the impact of uncontrolled natural fires. Statistical analyses by Bert and Stephen further concluded that the persistence of urban air pollution, characterized by ultra-fine particulate matter, induces significant cardiopulmonary toxicity (19). From a holistic perspective, the gases and particulate matter emitted during forest fires are observed to induce cardiopulmonary, immune, and cellular dysfunctions (20). Although this study did not yield direct results concerning cardiopulmonary factors, the data derived from the analysis of age groups, alcohol-consuming groups, and substance-addicted groups corroborate this perspective regarding the effects and indicators of respiratory complaints on quality of life.

Sapkota et al. reported that forest fires intensively release numerous particles, including (CO), (CO2) and various organic gases, which subsequently accumulate in the atmosphere. In this context, both particle size and chemical composition play crucial roles in their environmental and health impacts. (21). Polan et al. highlight that both the size of particles and their chemical composition are crucial factors influencing the respiratory system. They specifically note that particles smaller than 2.5 micrometers can penetrate the deepest pulmonary tissues, resulting in systemic inflammation (22). Building on this, Karavitis et al. contend that prolonged exposure to air pollution compromises the epithelial cell barriers within the respiratory tract. They further assert that chronic diseases, alcohol consumption, and smoking exacerbate the detrimental effects of air pollution, leading to molecular dysfunctions (23). Interestingly, the study revealed that the SRI score of the non-alcoholic group was lower than that of the other alcohol-consuming groups. This unexpected observation may stem from various unmeasured or confounding factors within the non-alcoholic group. Potential influences include pre-existing health conditions like allergies or asthma, socioeconomic disparities, environmental exposures such as passive cigarette smoke, nutritional deficiencies, obesity, or undiagnosed cardiovascular and renal diseases, all of which could have adversely impacted their SRI scores. In contrast, the SRI scores for the group with substance addiction were consistently low, aligning with existing literature.

Kelly et al. (2011) reported a significant association between air pollution exposure and the prevalence of respiratory diseases, including asthma and chronic bronchitis (24). The findings indicate no statistically significant difference in health impacts between long-term exposure to ambient air pollution and inhalation of particulate matter and harmful gases emitted during extensive forest fires. Furthermore, Nakane demonstrated, through statistically supported research, that specific particulate matter concentrations (ppm values) in the atmosphere are implicated in the etiology of pulmonary diseases, subsequently contributing to the development of other chronic conditions (25). The development of chronic respiratory diseases is influenced by both environmental factors and lifestyle choices. While a direct correlation between educational attainment, sports participation, and respiratory health has yet to be thoroughly explored in the existing literature, observations indicate a higher incidence of respiratory issues among individuals involved in forest fire intervention and those residing in forested areas. This study's findings suggest that higher educational levels positively correlate with an improved quality of life for individuals experiencing actual or potential respiratory complaints. Notably, the most compelling results emerged from the comparative analysis between participants engaged in regular physical activity and their sedentary counterparts.

A notable finding from the cross-sectional study, which utilized the SRI scale, was the elevated SRI score observed in the non-sporting groups. Snedden et al.'s study demonstrated that physical activity and sports positively influence quality of life (26). Consequently, the sports group's low SRI score, comprising individuals directly involved in forest fire intervention, appears inconsistent with the findings of this study. This discrepancy can be elucidated from two perspectives: firstly, the principle of reverse causality, as highlighted in the meta-analysis by Kim et al. (27). Thus, individuals with pre-existing low quality of life, or those whose quality of life has diminished due to health issues, might initiate exercise to improve their circumstances or alleviate symptoms. Thus, sports or physical activities could be seen not as a cause of reduced quality of life, but rather as a consequence or a coping mechanism. Furthermore, in their review of compulsive exercise, Lichtenstein et al. reported that

this condition contributes to injuries and impairments in social relationships and overall life, even though they did not classify it as a psychological disorder (28). Sports programs tailored for professionals may contribute to the development of compulsive exercise, and engaging in excessive or inappropriate types of physical activity can result in injuries or fatigue, consequently diminishing quality of life.

Individual genetic predispositions may influence susceptibility to air pollution. Specifically, Liao et al. highlighted that polymorphisms in genes regulating inflammatory responses could account for the varying severity of respiratory complaints among individuals (29). In this cross-sectional study conducted in the Mediterranean and Aegean regions, the observed respiratory complaints attributable to genetic factors might stem from ancestral exposure to past forest fires. The elevated SRI scores found in the non-athletic, non-alcoholic, and COVID-19 survivor groups suggest a potential association with this phenomenon. Therefore, pharmacogenetic studies could facilitate the development of personalized protective strategies for at-risk populations.

Significant differences observed across age, alcohol, and substance abuse groups indicate a potential role for psychological factors. In support of this, Öztekin and Örki concluded that significant negative human and natural events impacting society can precipitate the emergence of psychosocial stressors, including post-traumatic stress disorder (PTSD), anxiety, and depression (30). Conversely, Caulfield indicated that from a respiratory physiology perspective, anxiety and stress can exacerbate respiratory complaints by augmenting bronchoconstriction or inflammatory responses (31). The findings from age, alcohol, and substance abuse groups, particularly among those directly involved in forest fire intervention and exposed to air pollution, corroborate these assertions. Notably, with advancing age, psychological factors become more prominent, correlating with a low SRI score. Similarly, the literature supports the observation of low SRI scores in individuals with substance abuse. Conversely, within alcohol groups, the low SRI scores among non-alcohol users imply the presence of other potential metabolic diseases and suggest a substantial role for environmental factors.

Turkoglu examined respiratory system diseases in children and adolescents from a psychological perspective, reporting significant age-group differences (32). Numerous studies have explored the relationship between psychology and respiration, a perspective further supported by the significant differences observed among this study's age, alcohol use, and substance addiction groups. While limited research currently addresses the impact of global warming and its projected climate changes on the respiratory system, Çimen et al.'s literature review highlighted that global warming and subsequent adverse climatic conditions exacerbate air pollution, leading to various respiratory system diseases, particularly upper respiratory tract infections (33). Large forest fires, frequently occurring in densely forested regions and often during specific seasons, can significantly exacerbate global warming and, consequently, climate change. This creates conditions conducive to the development of respiratory system diseases and various socio-environmental illnesses, such as 'metropolitan bronchitis,' which is characterized by respiratory symptoms.

Moore et al. demonstrated that pathogenic bioaerosols and other biological agents, alongside chemical particles, constitute components of air pollution during forest fires (34). A review by Deng et al. indicates that pathogenic bioaerosols may be a primary cause of respiratory tract infections and allergic reactions, potentially exacerbating respiratory complaints (35). Research exploring the intricate relationship among air pollution, pathogenic bioaerosols, and respiratory tract infections provides crucial insights into the etiology of respiratory complaints. Thus, pathogenic aerosols likely represent a significant factor contributing to the statistically significant differences observed between the groups in this study. Given these findings, it's crucial to acknowledge that the interactions between pathogens in forest fire smoke and the resulting immune responses in the respiratory tract warrant further investigation.

Study Limitations

Individuals participating in the study were exclusively composed of teams that intervened in the 2021 forest fires in Turkey's Mediterranean and Aegean regions (Antalya, Muğla, Isparta, Burdur and surrounding areas). Fire types, intervention strategies, climatic conditions, and the socio-cultural structure of the participants may differ from region to region. The findings obtained cannot be directly generalized to first responder teams across the country or in other geographies.

The sample size (n=83) of the study is small. Consequently, there is a risk of failing to detect relationships or differences that actually exist but have a small effect size. Furthermore, a small sample size reduces the precision of the findings obtained.

Participants were selected using a convenience sampling method. This is a significant factor that limits the extent to which the results can represent the wider population. The findings are specific only to the group included in the study, and generalization of the findings to broader populations requires cautious interpretation.

Since this study has a cross-sectional design, its ability to determine the cause-and-effect direction of the relationships between variables is limited. As all data were collected at a single point in time, it cannot be clarified whether the observed relationships are due to the intervention experience or to an underlying health status. This only expresses a correlation, and more comprehensive studies are needed to understand which variable is the cause and which is the result.

As an observational study, not all confounding factors could be controlled. Unmeasured or unknown confounders that were not included in our study model, but which may be related to both respiratory complaints and quality of life, could have influenced the study findings.

Despite these limitations, the conducted study provides pioneering evidence examining the relationship between respiratory symptoms and quality of life at a cross-sectional level in forest fire intervention teams. The absence of multivariate regression analyses limits the interpretations and the findings obtained have been primarily treated as group comparisons.

In addition to the limitations discussed above, the cross-sectional and self-report survey nature of the data introduces further methodological constraints that must be carefully considered when interpreting the findings. Specifically, the retrospective nature of the survey data increases the risk of recall bias, as participants may not accurately remember their past exposures and symptoms. Furthermore, the reliance on self-report to assess health behaviors and outcomes introduces social desirability bias. This means participants may tend to underreport undesirable behaviors or overreport favorably viewed conditions to align with perceived social norms. To mitigate this risk, the survey was administered on a completely anonymous and voluntary basis. Despite these collective limitations, the data obtained provide important insight into the participants' experiences and symptoms.

Conclusion

This cross-sectional and analytical study preliminarily investigated the relationship between quality of life, linked to respiratory complaints, and socio-demographic and lifestyle factors in a small (n=83) and convenience sample group of individuals who responded to the 2021 Mediterranean and Aegean Forest fires.

Forest fires release numerous toxic gases and particles, significantly degrading air quality. Following these events, individuals residing near affected regions and personnel from public, private, and non-governmental organizations (NGOs) involved in fire suppression efforts frequently experience severe respiratory diseases, which diminish their quality of life. The harmful effects of air pollution from forest fires on various organs can manifest years later, leading to chronic and fatal conditions like cancer, chronic obstructive pulmonary disease (COPD), and asthma. To mitigate these potential damages, it is crucial to address the serious consequences of forest fires within the framework of preventive health services. Accordingly, educational initiatives should be systematically integrated into the programs of public, private sector, and NGO institutions.

The escalating global warming inevitably leads to climate changes that can cause respiratory system diseases. Regional large forest fires and the subsequent adverse weather conditions represent a significant component of these climate changes, potentially leading to numerous respiratory complaints, especially when compounded by factors like age, alcohol, and substance addiction. Furthermore, existing respiratory pathologies exacerbated by forest fires are worsened by factors such as alcohol and cigarette use, which can further reduce the respiratory rate. Consequently, the detrimental effects of air pollution from forest fires on life expectancy and quality should be considered within this broader context.

Given the rise in air pollution, extensive research is being conducted on preventive health services. This study specifically demonstrates that forest fires inflict irreversible damage to the respiratory tract. Therefore, forest fires warrant consideration as a crucial component of preventive health strategies.

In this study, 'exposure to forest fires' and 'air pollution caused by forest fires' specifically denote smoke exposure. A key limitation was the inability to directly measure smoke concentrations. Nevertheless, significant findings were derived using parameters such as presence in the fire zone and exposure to fire-emitted gases. Future research should aim to quantify smoke exposure using biomarkers and/or air quality sensors.

As a result, individuals actively involved in forest fire suppression will inevitably experience respiratory complaints, which will adversely impact their quality of life. The quality of life indicators, as determined by SRI scores and linked to potential or confirmed respiratory issues, are directly influenced by factors including age, alcohol use, substance addiction, sports participation, and education level. Therefore, this study underscores the necessity for a more detailed examination of air pollution events like forest fires on human health and the various factors influencing respiratory physiology.

The intensive release of chemical and biological particles from forest fires directly impacts respiratory function and, consequently, quality of life. To enhance the quality of life and enable early identification of existing or potential health issues in individuals directly involved in forest fire response, routine health screening procedures are essential. These screenings should specifically include pulmonary function tests, evaluation of cardiovascular parameters, and the development of health policies addressing the potential for post-traumatic stress disorder. Beyond periodic health screenings as part of preventive health services, establishing peer support groups with a focus on sociological aspects is crucial. Such initiatives can alleviate emotional burdens through the solidarity of individuals who have undergone similar experiences.

Developing psychological and sociological preventive health services should precede forest fire events. It's crucial to utilize personal protective equipment (PPE) specifically designed for forest fires or other extraordinary blazes involving the dispersion of chemical-biological particles. This PPE must include high-temperature-resistant, ergonomic masks offering superior gas and particle filtration. Furthermore, a fresh air breathing apparatus for use during a fire should be supplied with adequate spares, and its periodic maintenance must be conducted without interruption. Regular drills on both maintenance procedures and the proper use of this breathing apparatus are also essential.

Direct intervention in forest fires presents numerous risks. Thus, beyond personal protective equipment, technological devices capable of monitoring body temperature and heart rate should be supplied, and these physiological parameters meticulously tracked throughout fire suppression operations.

In any emergency, meticulous work planning and systematic organization are paramount. To mitigate direct exposure to toxic gases and particles, optimal working hours, shifts, and rest periods must be established. Work scheduling should prioritize flexibility and be people-oriented, thereby avoiding prolonged and continuous shifts.

Approaches incorporating psychological and sociological support alongside the provision of physical equipment are not merely practical measures; they also significantly enhance the quality of life by positively influencing the SRI scores of field personnel directly involved in fire suppression.

The findings obtained from this study, due to the nature of its cross-sectional design, only demonstrate a correlation, and the ability to establish a causal relationship between variables is limited.

Analyses indicate that participants in the 45-65 age group have a statistically lower quality of life score related to respiratory complaints compared to the 18-24 age group. This suggests an association highlighting the potential for advanced age to be more negatively affected following fire exposure.

Individuals who reported substance addiction have significantly lower quality of life scores compared to those who did not. This finding is consistent with existing literature, suggesting that substance use exacerbates the potential negative effects of fire exposure.

A higher level of education was found to be associated with a better quality of life.

The finding that those who do not participate in sports have higher SRI scores than those who do, and that some groups who use alcohol report higher scores than non-users, must be interpreted cautiously due to methodological limitations such as reverse causality, social desirability bias, or unaddressed confounding factors.

In conclusion, this study suggests that factors such as age and substance use have a potential impact on respiratory complaints and quality of life for fire response teams in Turkey's Mediterranean and Aegean regions. It is recommended that these preliminary data be used to guide the planning of regional and post-exposure intervention programs.

Future studies should employ larger and randomly selected samples. Self-reported data should be supported by objective biological and physiological measurements, and the effect of confounding factors should be controlled through multivariate analyses.

Conflict of Interest Statement
The authors have no conflicts of interest to declare.

Ethical Approval
The study in question was carried out with the decision numbered 10 and dated 10.11.2021 of the Suleyman Demirel University Health Sciences Ethics Committee. The study was conducted in accordance with the ethical principles stated in the Declaration of Helsinki of the World Medical Association (WMA).

Consent to Participate and Publish
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Availability of Data and Materials
Datasets generated and/or analyzed during the current study will be made available by the corresponding author upon request from the editor or reviewers.

Artificial Intelligence Statement
The authors declare that they have not used any type of generative artificial intelligence for the writing of this manuscript, nor for the creation of images, graphics, tables or their corresponding captions.

Authors Contributions
TB: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Validation; Visualization; Writing-original draft; Writing- review & editing.

MS: Validation; Writing-original draft; Formal analysis; Critics

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