Risk Factors for Coronavirus Disease 2019 in the Retired Fire Department of the City of New York World Trade Center-Exposed Cohort

Krystal L. Cleven, MD[1,2]; Rachel Zeig-Owens, DrPH[1,2,3]; David Goldfarb, PhD[1,2,3]; Theresa Schwartz[1,3], David Prezant, MD[1,2,3]
Montefiore Medical Center[1]; Albert Einstein College of Medicine[2]; Fire Department of the City of New York[3]

Introduction

The first case of coronavirus disease 2019 (COVID-19) was identified in New York State on 3/1/20 and soon after New York City became the epicenter of the pandemic. As of 5/20/22, over 82 million COVID-19 cases and over 1 million deaths have occurred in the U.S. with just over 5.3 million cases and over 68,000 deaths occurring in New York State.[1,2]

We have previously shown in the Fire Department of the City of New York (FDNY) World Trade Center (WTC)-exposed cohort that rescue/recovery work at the WTC site was associated with obstructive pulmonary diseases which is also a risk factor for severe COVID-19. Additionally, Morozova and colleagues reported a cumulative incidence of COVID-19 of 20% in a cohort of WTC exposed workers/volunteers which was higher than general population estimates.[3] This suggests that perhaps WTC exposure is a unique risk factor for COVID-19.

Since this cohort has been prospectively followed for nearly two decades, the use of this cohort reduces the potential for misclassification of risk factors and selection bias.

The goals of this study include determining the cumulative incidence of COVID-19 from the start of the pandemic and to determine if WTC exposure and as well as other health conditions were associated with COVID-19.

Methods

- The source population was 10,245 FDNY WTC firefighters and emergency medical services (EMS) workers who were alive and retired from FDNY work at the start of study (3/1/20)
- The final study population (N=8,256) included those with 2 years of pre-pandemic monitoring exams and at least 1 exam during the study period (3/1/20 – 8/1/21)
- COVID cases were identified as anyone who self reported COVID infection, COVID hospitalization, or who died from COVID
- Demographic and clinical data were obtained from the medical record
- The degree of WTC exposure was obtained from the medical chart and dichotomized into higher exposure (exposed on 9/11) and lower exposure (exposed on or after 9/12)
- Cumulative incidence and incidence rates of COVID were calculated by work assignment (firefighter vs EMS) and WTC exposure history
- Risk factors for COVID-19 were evaluated using cox proportional hazards regression to evaluate hazard ratios (HR) with 95% confidence intervals (CI) for self-reported COVID-19

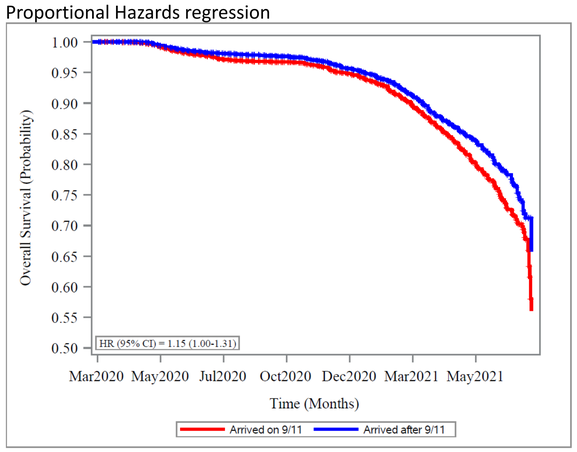
Results

Table 1. Study Cohort Characteristics

Characteristics	N=8,256
Self-reported COVID	
yes	1,081 (13.1)
no	7.175 (86.9)
Sex, n (%)	
Male	8,077 (97.8)
Female	179 (2.2)
Age in years†, mean (SD)	61.2 (8.4)
BMI kg/m^2 mean (SD)	30.3 (4.7)
Race, n (%)	
Non-Hispanic white	7,504 (90.9)
Hispanic	357 (4.3)
Non-Hispanic Black	331 (4.0)
Asian	30 (0.4)
Native American	8 (0.1)
Unknown	26 (0.3)
Work Assignment, n (%)	
Firefighter	7,523 (91.1)
EMS	733 (8.9)
Arrival Time, n (%)	
Morning of 9/11	1,271 (15.4)
Afternoon of 9/11	3,815 (46.2)
9/12	1,493 (18.1)
9/13-9/24	1,295 (15.7)
After 9/24	181 (2.2)
Unknown/missing	201 (2.4)
Smoking history, n (%)	
yes	3,244 (39.3)
no	5,012 (60.7)
Comorbidities, n (%)	
HTN	3,456 (41.9)
OAD*	4,253 (51.5)
Obesity	3,819 (46.3)
Diabetes	448 (5.4)
ILD*	148 (1.8)

Abbreviations: BMI, Body Mass Index; HTN, hypertension; OAD, Obstructive Airways Diseases; ILD, Interstitial Lung Diseases
†Age in years on 3/1/2020;
*WTC-certified condition

Figure 1: Unadjusted Kaplan Meier survival curve and adjusted Cox Proportional Hazards regression



Models control for race, sex, age on 3/1/2020, diabetes, interstitial lung disease, obstructive airways disease, obesity, hypertension and smoking

Table 3. Full Cox proportional hazards model

Characteristic	aHR	95% CI
WTC Exposure		
High (9/11)	1.15	1.00 – 1.31
Low (≥9/12)	ref	
Age, years	0.97	0.96 – 0.98
Sex		
Female	ref	
Male	1.37	0.82 – 2.26
Race		
Non-white	1.01	0.79 – 1.28
white	ref	
Smoker		
Ever	0.95	0.83 – 1.08
Never	ref	
Work assignment		
EMS	ref	
Firefighter	1.15	0.89 – 1.49
Hypertension	0.84	0.74 – 0.95
Obesity	0.98	0.81 – 1.12
OAD	1.06	0.92 – 1.22
ILD	0.99	0.99—1.03
Diabetes	0.90	0.81—1.18

Table 2a Incidence Rates of COVID-19 by WTC Exposure

Exposure Group	COVID cases	Person-years	Incidence rate
Higher exposure	722	4631.15	0.155901
Lower exposure	336	2699.11	0.124486

Incidence rate ratio: 1.25 (95% CI 1.10 – 1.43)
*Those with unknown arrival time were removed (N=23)

Table 2b Incidence Rates of COVID-19 by Work Class

Work Class	COVID cases	Person-years	Incidence rate
Firefighter	993	6890.93	0.144102
EMS	88	613.21	0.143507

Incidence rate ratio: 1.00 (95% CI 0.81 – 1.25)

Table 4a Cumulative Incidence of COVID-19 by Exposure Intensity

Exposure Intensity	Severe COVID	Not severe COVID	No COVID	Total	Cumulative incidence severe	Overall cumulative incidence
Higher Exposure	32	690	4364	5086	0.6	14.2
Lower Exposure	20	316	2633	2969	0.6	11.3
Total*	52	1006	6997	8055	0.6	13.1

Table 4b Cumulative Incidence of COVID-19 by Work Assignment

Work assignment	Severe COVID	Not severe COVID	No COVID	Total	Cumulative incidence severe	Overall cumulative incidence
Firefighters	44	949	6530	7523	0.6	13.2
EMS	8	80	645	733	1.1	12.0
Total	52	1029	7175	8256	0.6	13.1

Results

Demographics and other characteristics of the study population are shown in **Table 1**. The majority of the participants are male (97.8%), Non-Hispanic white (90.9%), and worked as firefighters (91.1%). 61.2% had higher WTC exposure.
The cumulative incidence of COVID-19 in those with the highest WTC exposure was 14.2%, 11.3% for those with lower exposure, 13.2% for firefighters, 12% for EMS workers, and 13.1% overall (N= 1,081). The overall cumulative incidence of severe COVID-19 was 0.6% (**Table 4a and 4b**). The incidence rate of COVID-19 was significantly higher in those with higher WTC exposure (IRR 1.25 95% CI 1.10 – 1.43) but not significantly different between retired firefighters and EMS workers (**Table 2a and 2b**).
Figure 1 and **Table 3** demonstrates that higher WTC exposure significantly increases risk for COVID-19 by 15%. We were underpowered to analyze risk factors for severe COVID specifically. Younger age was also found to be a risk factor for COVID-19 (HR=0.97; 95% CI 0.96-0.98) and HTN seems to be protective (HR=0.84; 95% CI 0.74-0.95).

Conclusions

Our study is the first to examine WTC as a risk factor for COVID-19. Our study found that greater exposure to the hazards at the WTC site was an independent risk factor for COVID-19 infection even when controlling for other known risk factors or confounders reported in earlier COVID-19 studies such as age, sex, race, HTN, OAD, diabetes, increased age, and obesity. We also demonstrated that younger age was a risk factor for COVID-19. It's likely that younger participants, although retired from FDNY work, may still be in the workforce generally, explaining their increased risk for infection. It is possible that WTC exposure causes a unique combination of physiological abnormalities which increases an individual's risk of COVID-19 and perhaps those with this environmental/occupational exposure history should take more strict preventive measures against COVID-19 during future surges.

References

1. Ko JY, Danielson ML, Town M, et al. Risk Factors for Coronavirus Disease 2019 (COVID-19)-Associated Hospitalization: COVID-19-Associated Hospitalization Surveillance Network and Behavioral Risk Factor Surveillance System. Clin Infect Dis 2021;72:e695-e703.
2. Garg S, Kim L, Whitaker M, et al. Hospitalization Rates and Characteristics of Patients Hospitalized with Laboratory-Confirmed Coronavirus Disease 2019 - COVID-NET, 14 States, March 1-30, 2020. MMWR Morb Mortal Wkly Rep 2020;69:458-64.
3. Richardson S, Hirsch JS, Narasimhan M, et al. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. JAMA 2020;323:2052-9.
4. NYSDOH COVID-19 Tracker 2020. Retrieved Feb 28 2022 at https://covid19tracker.health.ny.gov/.
5. The New York Times. (2021). Coronavirus (Covid-19) Data in the United States. Retrieved [Feb 28 2022], from https://www.nytimes.com/interactive/2021/us/covid-cases.html.
6. Weiden MD, Ferrier N, Nolan A, et al. Obstructive airways disease with air trapping among firefighters exposed to World Trade Center dust. Chest 2010;137:566-74.
7. Morozova O, Clouston SAP, Valentine J, Newman A, Carr M, Luft BJ. COVID-19 cumulative incidence, asymptomatic infections, and fatality in Long Island, NY, January-August 2020: A cohort of World Trade Center responders. PLoS One 2021;16:e0254713

This research was supported by NIOSH contract #200-2017-93426
The research described was supported by NIH/National Center for Advancing Translational Science (NCATS) Einstein-Montefiore CTSA Grant Number UL1TR002556)

For more information, please contact:
kcleven@Montefiore.org