U.S. Firefighter Fatalities Analysis, 2000 – 2015

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Introduction

What will this project deliver?

Insight into the causes of firefighter fatalities:

- What is the leading cause of firefighter fatalities?
- Are certain job types or age groups impacted more than others?
- If so, then what is the number one type of death related to the leading cause?
- Is there anything that can be done to improve the health and safety of firefighters?

Introduction (Cont'd)

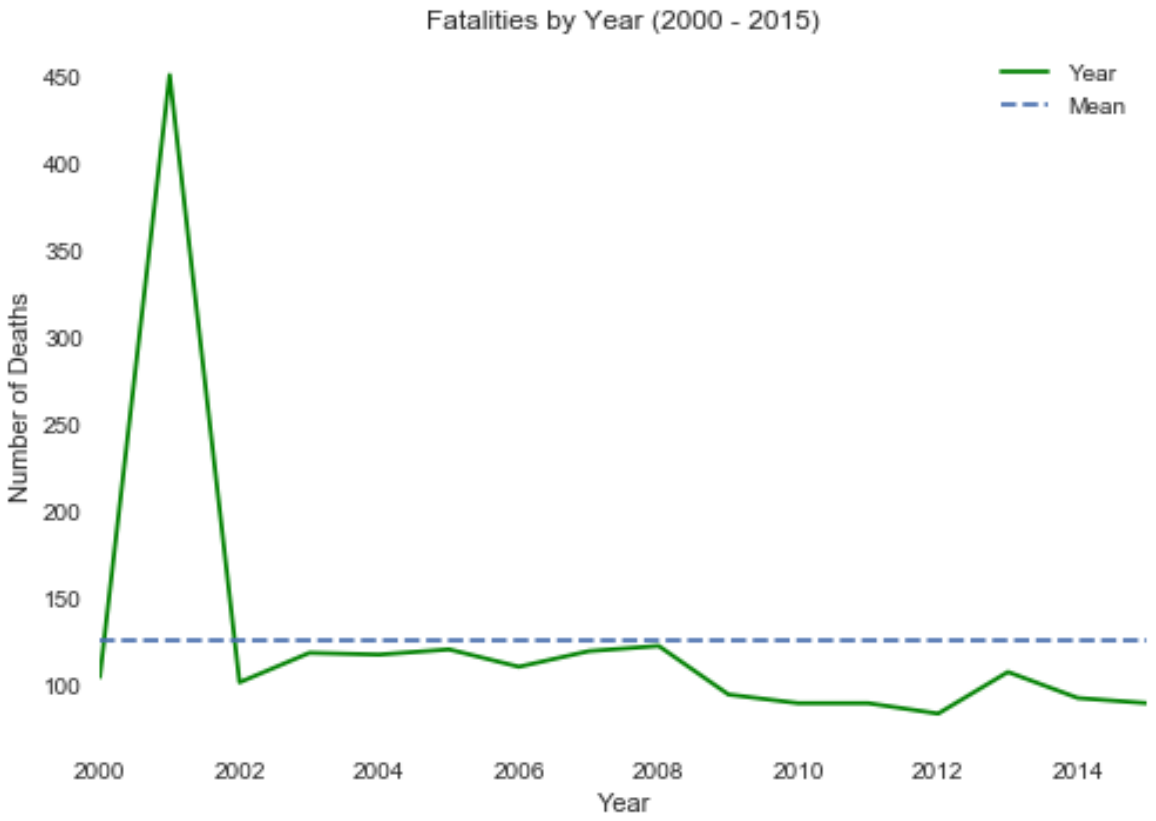
How will the analysis be performed?

- Analysis performed with Python
- Packages used: Pandas, NumPy, Matplotlib, Seaborn, Sklearn, and Statsmodel
- Dataset: *Firefighter Fatalities in the U.S. (2000 – 2015)* acquired from kaggle.com

Where to access project code?

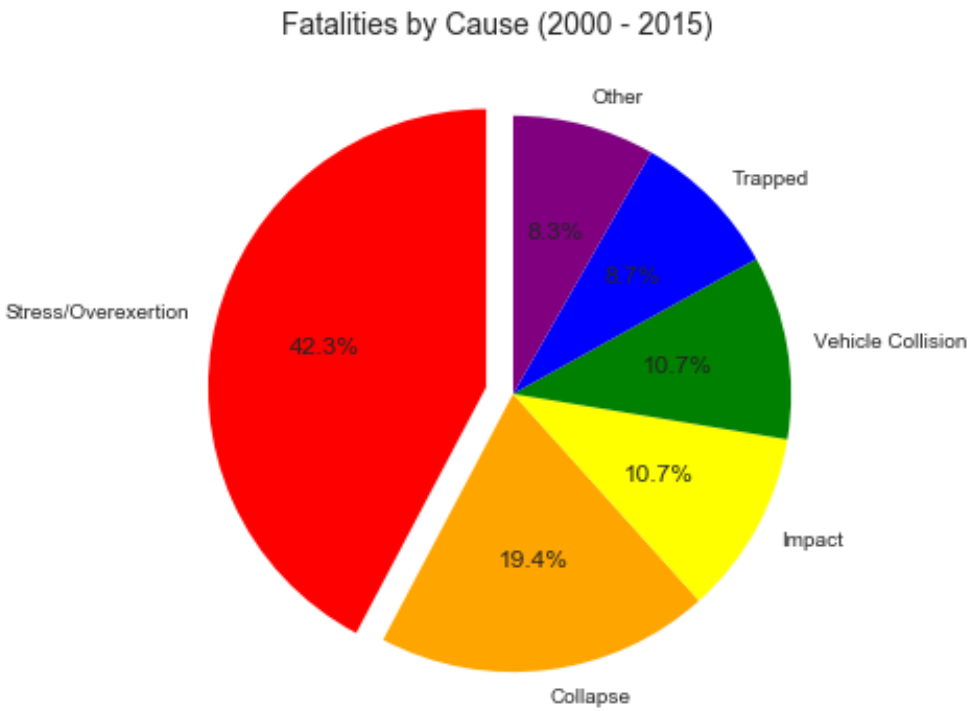
GitHub: https://github.com/akront1104/Capstone_Project_Firefighter_Fatalities.git

Number of Firefighter Deaths Per Year



In 2001, 343 out of 451 deaths reported were from the September 11 attacks. Average death count for all causes between 2000 – 2015 is 125.

What is the leading cause of firefighter fatalities?



Other includes: Fall, Exposure, Disorientation, Assault, Smoke, Unknown, and Contact

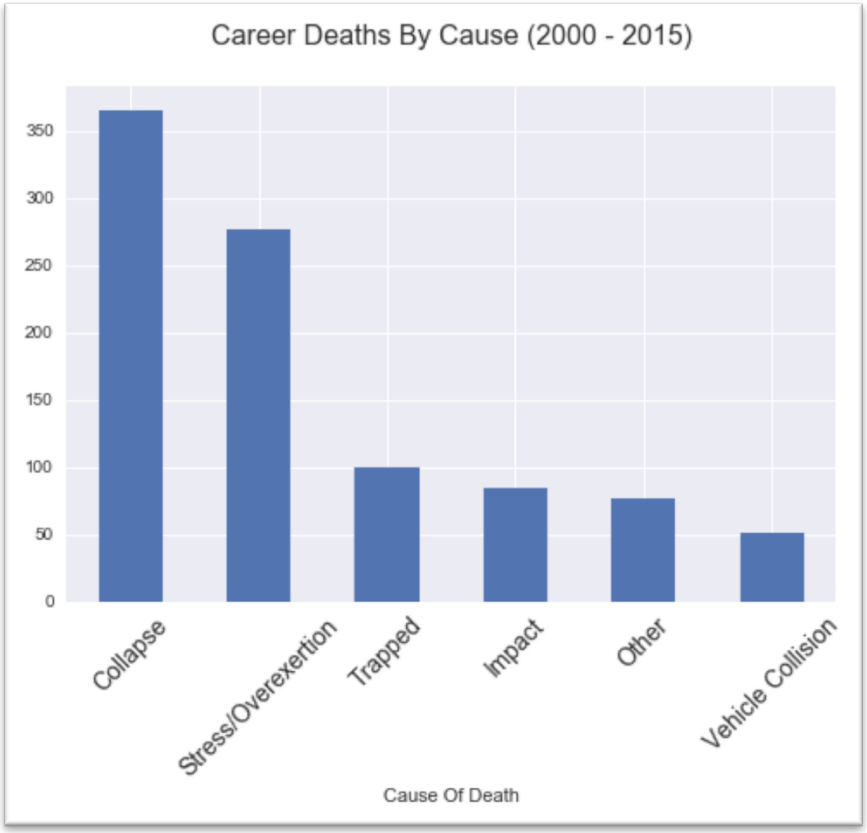
42% of firefighter fatalities are due to overexertion and stress.

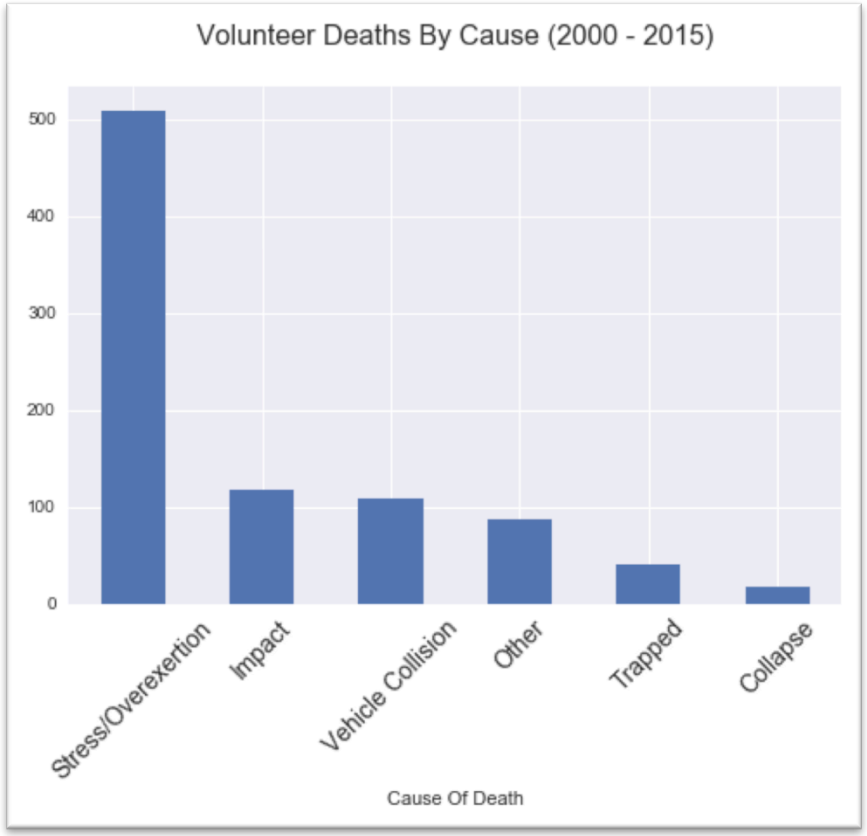
Firefighter Fatalities by Job Type

Job Type	Number of Deaths
Career	953
Volunteer	880
Wildland Full-Time	46
Wildland Contract	40
Wildland Part-Time	35
Paid-on-Call	26
Part-Time (Paid)	16
Industrial	6
Total	**2002**

Highest Rates of Death	
Career	48%
Volunteer	44%

What is the most common cause of death for a Career and Volunteer firefighter?





The most common cause of death for Career and Volunteer firefighters is stress and overexertion. The problem is greater among Volunteer firefighters. This has been a consistent trend each year, except for 2001. In 2001, a major cause of death for Career firefighters was collapse, due to the 9-11 attacks.

What is the leading type of death due to Stress and Overexertion?

Career Stress

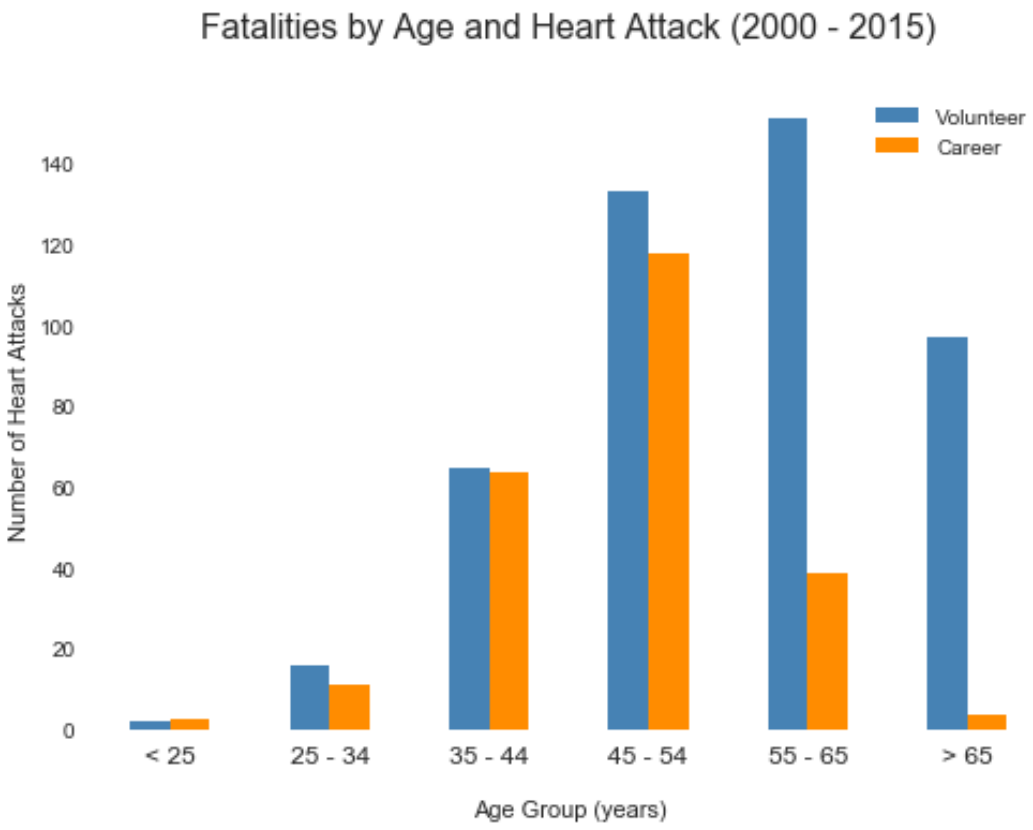
Nature Of Death	Count
Heart Attack	241
Stroke	23
Other	8
Heat Exhaustion	3
Unknown	1

Volunteer Stress

Nature Of Death	Count
Heart Attack	472
Stroke	29
Other	4
Heat Exhaustion	3
Unknown	1

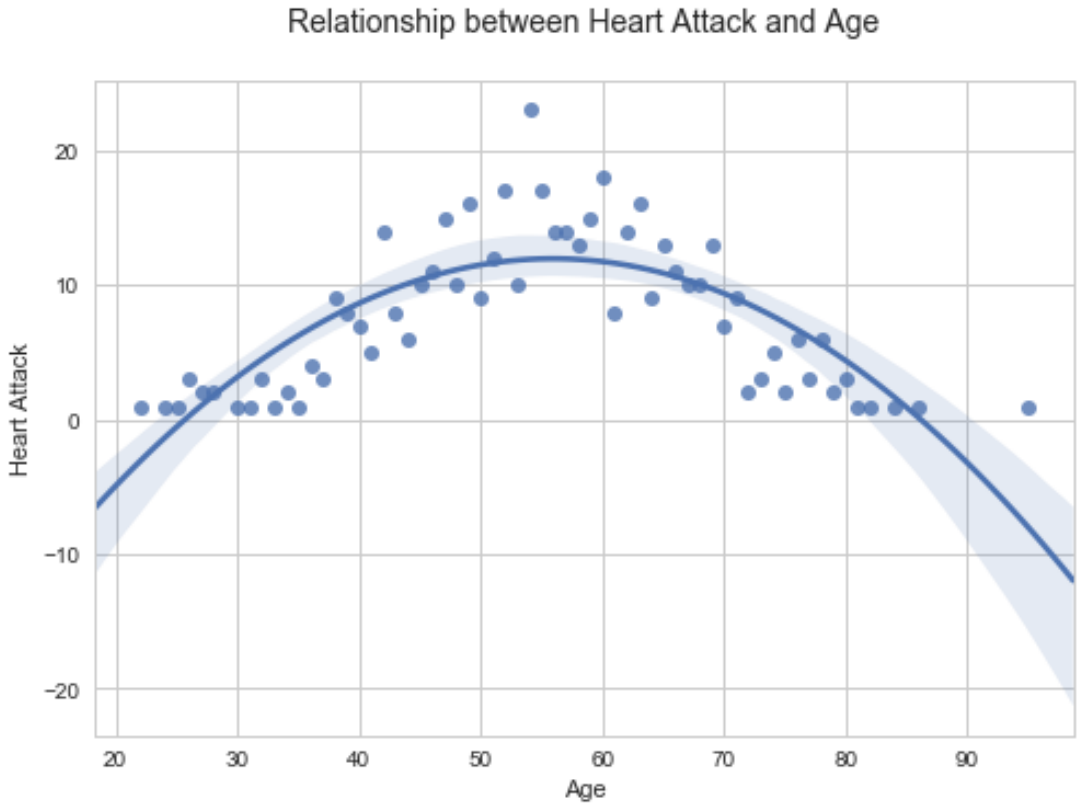
Leading Type of Death

Between what ages is it likely for Career and Volunteer firefighters to have a heart attack?



For both Career and Volunteer firefighters, most heart attack deaths occurred among persons aged **45 – 54 years**.

Is there a correlation between heart attack and age?



The maximum number of heart attack fatalities is between 45 – 65 years of age. After 65, the graph begins to decrease. Most Career firefighters retire after 65 years of age, which explains why it decreases after that point. Stress-related deaths are rare below the 31 – 35 years of age and, when they occur, often include underlying medical conditions.

Statistical Analysis

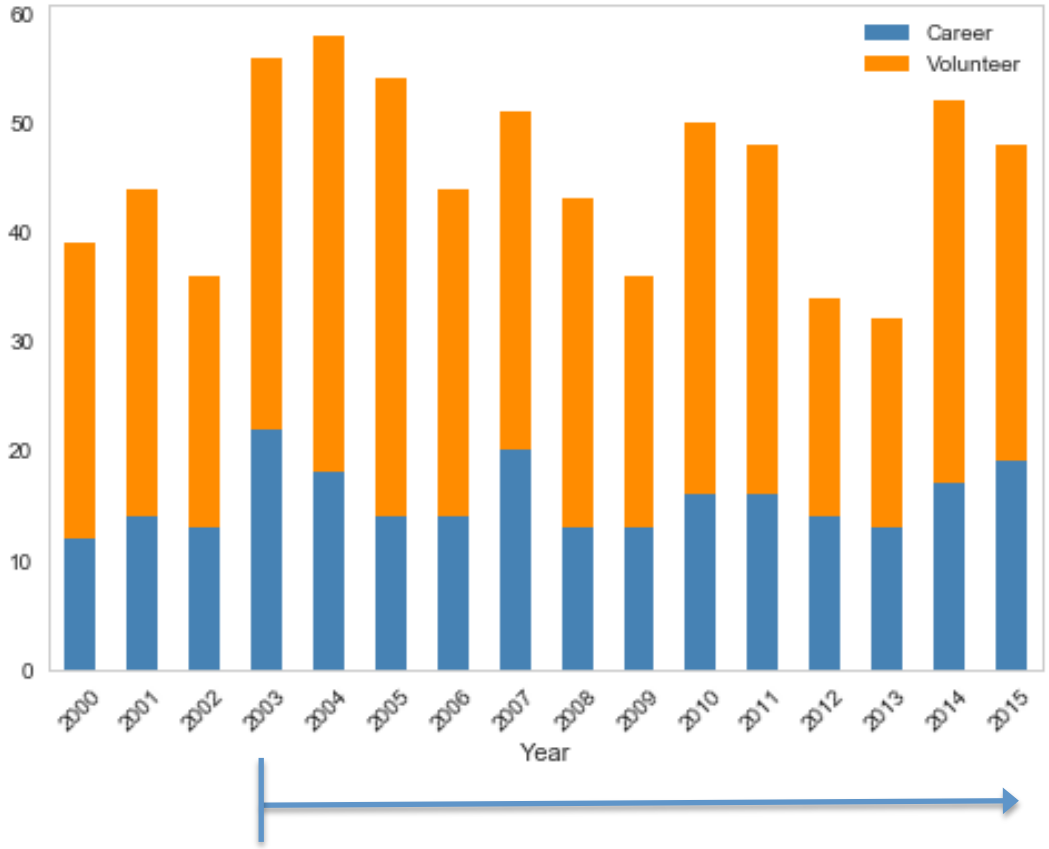
Chi-square test to validate the relationship between heart attack and age

	Age Group					
	< 25	25 – 34	35 – 44	45 – 54	55 – 65	> 65
# Career Heart Attack	3	11	64	118	39	4
# Volunteer Heart Attack	2	16	65	138	151	97
P-value (significance level of 0.05)	0.65	0.34	0.93	0.34	4.46e-16	2.17e-20

P-value < 0.05

The relationship between the number of Career and Volunteer heart attack fatalities aged 55 and up is statistically significant.

Has the heart attack death rate decreased after the Heart-Healthy Firefighter Program was implemented?



7% decrease from 2003 – 2014

About the Program

In 2003, the National Volunteer Fire Council (NVFC) launched the Heart-Healthy Firefighter Program to reduce the number of firefighter deaths from heart attack. The program provides firefighters with fitness and nutritional education.

Random Forest Classifier

The classification goal is to predict firefighter heart attack fatalities

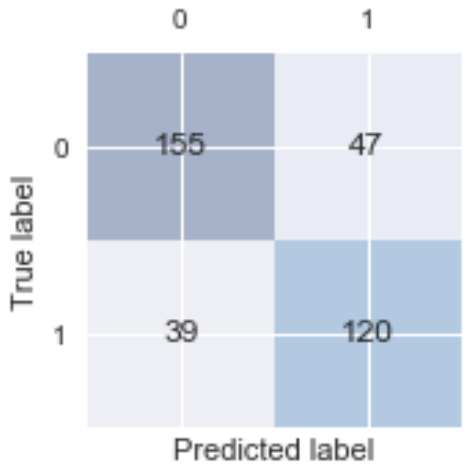
Top 10 features selected for this model using Recursive Feature Elimination (RFE):

Features	Coef	Std Err	z	P > |z|	[0.025	0.975]
Age	0.0663	0.005	12.759	0.000	0.056	0.076
Year	-0.0015	0.000	-8.773	0.000	-0.002	-0.001
Firefighter	0.2005	0.136	1.472	0.141	-0.066	0.467
Career	0.2648	0.245	1.082	0.279	-0.215	0.744
Volunteer	0.8885	0.244	3.648	0.000	0.411	1.366
On-Duty	0.1825	0.187	0.977	0.328	-0.184	0.549
Fire Scene	-0.9746	0.189	-5.167	0.000	-1.344	-0.605
Vehicle Driver	-1.3398	0.242	-5.542	0.000	-1.814	-0.866
Emergency	-0.3901	0.191	-2.047	0.041	-0.764	-0.017
Property Type (Road)	-1.1946	0.176	-6.791	0.000	-1.539	-0.850

Random Forest Classifier (Cont'd)

Evaluating the model using a train (75%) and test (25%) split and estimating the classification performance

Confusion Matrix



* 0 = Not Heart Attack | 1 = Heart Attack

120 out of the 159 sampled data made a correct prediction of a Heart Attack Fatality.

5-Fold Cross Validation

- CV Accuracy of Random Forest classifier on test set: 72.60
- CV Accuracy of Random Forest classifier on training set: 72.07

Using the best selected features (X), the Random Forest Classifier predicts a heart attack fatality correctly 72% of the time, without knowing the firefighters medical history.

Summary

- Each year, an average of 125 firefighters die in the line of duty from a variety of causes including, but not limited to, extreme physical exertion, underlying medical conditions, and structural collapse. **Heart attack remains the leading cause of firefighter line-of-duty deaths.**
- During 2000 – 2015, there was a total of 953 career and 880 volunteer firefighters fatalities.
- **42% of fatalities were caused by stress and overexertion**. Stress or overexertion includes all firefighter deaths that are cardiac or cerebrovascular in nature, such as heart attacks and strokes, as well as other events, such as extreme climatic thermal exposure.
- The median age was 55 years (range: 19 – 95 years) for volunteers and 48 years (range: 20 – 74 years) for career firefighters.
- For both volunteer and career firefighters, most heart attack deaths occurred among persons **aged 45 – 54 years**.
- The majority of heart attack deaths were attributed to stress and overexertion in both volunteer (93%) and career (87%) firefighters.
- While the NYFD have taken steps to improve firefighters health and safety, we still see a high proportion of deaths due to cardiac issues.

What to do Next?

Recommendation:
Implement a behavioral component to the Heart-Healthy Firefighter program. Behavioral intervention can improve the firefighters relative health status or help change their stage of readiness. The program should be mandatory for all firefighters.

Excerpts backing up recommendation:

- "Firefighters experience a number of **work-related stressors and repeated exposure to traumatic events that can put them at even greater risk of suffering from behavioral health issues, such as anxiety and depression."** Excerpt From: U.S. Fire Administration. "*Critical Health and Safety Issues in the Volunteer Fire Service*."

- In an article about firefighter heart health, NFFF Executive Director Ronald Siarnicki noted: **"If more firefighters are aware of their potential risks for cardiovascular disease and receive guidance on how to manage their lifestyles, the fire service may continue to see fewer incident-related deaths…** There will always be incidents that are beyond our control, and there will continue to be line-of-duty deaths, but when there is something like this that can be corrected, it just makes sense to take those preventative steps."

- More information on behavioral interventions and why they are key to any health program: https://www.ncbi.nlm.nih.gov/books/NBK25527/