

An Increasing Volume of Fire Department Calls: The Importance of Call Data Analysis in Firefighter Health Investigations

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Abstract

Numerous health concerns and risk factors for firefighters have been identified, allowing for interventions that have led to various health improvements. However, high call volumes, a major health concern reported by firefighters, has not been incorporated into health investigations. In this study, we analyzed call log information that included call type, time of day, and day of week, from two suburban fire departments across a five-year period (2015-2019). Both departments had an overall increase in call volume from 2015-2019, with rescue and emergency medical services being the most frequent call type each year. On average, the highest call volumes occurred during the afternoon and the lowest call volumes occurred during late night/early morning. A call data analysis could be utilized by healthcare professionals, research personnel, and administrative personnel in various forms to further improve departmental operations, along with firefighter health and quality of life.

Keywords: Firefighter Health; Firefighter Research; Call Data Analysis; Fire Department Call Volumes; Fire Department Call Patterns; Occupational Health

1. Introduction

Firefighting is a unique occupation with a combination of factors that are detrimental to health and wellness.¹⁻⁴ These factors include working shifts that are often a minimum of 24-hours, performing lifesaving duties, exposure to hazardous environments, and handling life-threatening situations.⁵ Evidence indicates that these work environments can produce long-term adverse effects on physical, metabolic, and cardiovascular health.⁶⁻⁸ Firefighters are also at a greater risk for psychological disorders due to traumatic situations, erratic sleep schedules, and repetitive exposure to pain and provocative events.⁹ Researchers have identified several risks and health concerns among firefighters, allowing for interventions that have led to decreased fatalities, morbidities, and injuries.^{3,10} However, high call volumes, a major health concern reported by firefighters, has not been efficiently incorporated into health investigations.^{1,4,5} A call data analysis combined with methods to mitigate health risks may allow for schedule readjustments by providing information about call types and call volume patterns, potentially improving firefighter health investigations and interventions.^{1,4-6}

The increasing trend in department call volumes and lack of call pattern recognition are potentially major risk factors contributing to frequent schedule and sleep interruptions,^{11,12} further resulting in adverse health outcomes among firefighters.^{1,4,5} The U.S. Fire Administration (USFA) and the National Fire Protection Association (NFPA) collect and report fire department call data, yet there is little discussion of this data in literature.^{1,3,11,12} Fire departments in the United States received over 28 million calls in 2019 – a 6% increase from 2017. Among call types, emergency medical and rescue situations are the most frequent calls received. The emergent nature of some calls, as well as the various types of calls, may contribute to stress, as firefighters have reported an increasing volume of calls as a major health concern.¹

Research regarding firefighter health often focuses on the nature of occupational tasks and the associated health outcomes. For example, ergonomic, musculoskeletal, and injury epidemiology studies are frequently conducted among firefighters. Call data analysis could supplement firefighter research by identifying call patterns, aiding the development of health interventions with consideration of firefighter schedules. To our knowledge, this is the first study to investigate fire department call data (i.e., incident type categories and call volume). The goal of this study was to analyze fire department call data for two suburban fire departments across a five-year period to highlight the need of such methods within firefighter health research and administrative planning.

2. Methods

Two suburban fire departments in Oklahoma provided call log information from 2015-2019. Administrative personnel from the two fire departments provided five years of call log reports (2015-2019) that included, but was not limited to, incident type, time of day, and day of the week for calls. During the period of data collection, Metro One had a population of 23,216 with two fire stations, 22 full-time firefighters, and is considered a “bedroom” community with mainly residential housing and minimal commercial space. Metro One’s department responds to all fire and medical emergency calls but does not provide ambulance services. Metro Two had a population of 36,173, four fire stations, 65 full-time firefighters, and a larger amount of

commercial property. Metro Two responds to all fire and medical emergency calls, while also providing ambulance services and advanced medical care. According to both fire chiefs, both departments utilize a 24-hour on and 48-hour off schedule.

Data from each department was consolidated and analyzed using Microsoft Excel (Microsoft Excel, Seattle, WA, United States). Means and standard deviations were calculated for call volumes by time of day and day of the week. Means were calculated for the number of incident types for each category (*Rescue and Emergency Medical Service; Good Intent Call; False Alarm and False Call; Service Call; Fire; Hazardous Condition (No Fire); Special Incident Type; Severe Weather and Natural Disaster; Overpressure Rupture, Explosion, Overheat (No Fire); Incident Type Left Blank*). The data analyses and categorization methods used in our study were adapted from USFA and NFPA reports.^{12,13} According to the USFA Topical Report Series, “runs” or “calls” are interchangeable terms which can be used to define a fire department’s collective response to an incident.¹¹ We chose to use the term “call” in our study.

3. Results

Two suburban fire departments provided call log information from 2015-2019. We analyzed call volumes by time of day (Table 1; Figure 1 & 2), day of week (Table 2), year (Figure 3), and incident types (Table 3 & 4). Metro One demonstrated a 14.3% increase in call volume from 2015 to 2019, and Metro Two demonstrated a 22.2% increase in call volume during the same timeframe. Metro One received the highest volume of calls during the 14:00 hour (14:00-14:59) and Metro Two displayed the highest volume during the 16:00 hour (16:00-16:59). The lowest volume of calls from 2015-2019 for both departments occurred during the 4:00 hour (4:00-4:59). Metro One received the most calls on Mondays, Metro Two received the most calls on Fridays, and both departments received the lowest volume of calls during Sundays, from 2015-2019. *Rescue and Emergency Medical Services (EMS)* was the most frequent incident type for both departments in our study (Metro One = 66.8%; Metro Two = 77.7%).

Table 1: Call Volume Means and Standard Deviations for Metro One and Metro Two by Time of Day

	Metro 1		Metro 2	
Time of Day	Mean	Standard Deviation	Mean	Standard Deviation
<i>00:00</i>	44.8	3.83	123.6	8.59
<i>01:00</i>	48.4	22.57	111.4	20.70
<i>02:00</i>	31.6	8.79	100.2	17.53
<i>03:00</i>	28.6	7.96	96.8	11.39
<i>04:00</i>	26.4	7.09	90	8.80
<i>05:00</i>	28.8	5.81	102.2	8.26
<i>06:00</i>	41.2	1.10	134.4	15.06
<i>07:00</i>	63.8	3.49	196.6	24.96
<i>08:00</i>	76.4	10.45	232.8	31.09
<i>09:00</i>	87.6	13.96	268.2	30.35
<i>10:00</i>	92	8.60	279.2	33.37
<i>11:00</i>	86.4	7.86	286.6	26.35
<i>12:00</i>	89.8	10.16	296	23.99
<i>13:00</i>	93.8	10.28	302.8	14.97
<i>14:00</i>	99.4	5.37	312.6	25.67
<i>15:00</i>	93.8	5.37	298.6	19.65
<i>16:00</i>	91	3.08	316	42.76
<i>17:00</i>	98.2	8.26	307.8	31.99
<i>18:00</i>	96	13.36	297.4	9.10
<i>19:00</i>	85.2	15.09	276.8	26.68
<i>20:00</i>	78.4	6.95	244	17.01
<i>21:00</i>	71.4	6.95	209.8	23.42
<i>22:00</i>	68.8	12.48	177	10.82
<i>23:00</i>	49.8	10.40	149.4	14.28

*N=5, Years 2015-2019

Table 2: Call Volume Means and Standard Deviations for Metro One and Metro Two by Day of the Week

	Metro 1		Metro 2	
Day of the Week	Mean	Standard Deviation	Mean	Standard Deviation
<i>Sunday</i>	220	21.78	666.8	80.11
<i>Monday</i>	246	10.37	749.8	57.77
<i>Tuesday</i>	244.2	22.57	745.2	52.07
<i>Wednesday</i>	236.2	14.17	756.4	84.10
<i>Thursday</i>	240.2	15.92	761.4	44.32
<i>Friday</i>	243	19.34	797.4	49.82
<i>Saturday</i>	231	9.38	733.2	47.09

*N=5, Years 2015-2019

Table 3: Incident Type for Metro One from 2015-2019

Incident Type Category	2015	2016	2017	2018	2019	Mean	Standard Deviation
<i>Rescue and Emergency Medical Service</i>	1022	1092	1152	1113	1169	1109.6	57.71
<i>Good Intent Call</i>	132	141	124	169	153	143.8	17.74
<i>False Alarm and False Call</i>	162	144	162	138	174	156	14.70
<i>Service Call</i>	86	95	109	158	99	109.4	28.40
<i>Fire</i>	59	71	78	60	41	61.8	14.06
<i>Hazardous Condition (No Fire)</i>	47	53	91	72	74	67.4	17.64
<i>Special Incident Type</i>	5	4	2	1	5	3.4	1.82
<i>Severe Weather and Natural Disaster</i>	1	3	4	3	20	6.2	7.79
<i>Overpressure Rupture, Explosion, Overheat (No Fire)</i>	6	5	0	3	3	3.4	2.30

Table 4: Incident type for Metro Two from 2015-2019

Incident Type Category	2015	2016	2017	2018	2019	Mean	Standard Deviation
<i>Rescue and Emergency Medical Service</i>	3731	3950	3984	4099	4468	4046.4	270.73
<i>Good Intent Call</i>	170	209	254	283	310	245.2	56.28
<i>False Alarm and False Call</i>	336	381	372	398	382	373.8	23.11
<i>Service Call</i>	224	260	340	366	300	298	57.69
<i>Fire</i>	139	157	123	121	130	134	14.66
<i>Hazardous Condition (No Fire)</i>	71	78	103	108	115	95	19.35
<i>Special Incident Type</i>	7	2	2	0	3	2.8	2.59
<i>Severe Weather and Natural Disaster</i>	7	2	8	2	5	4.8	2.77
<i>Overpressure Rupture, Explosion, Overheat (No Fire)</i>	1	7	3	2	0	2.6	2.70
<i>Incident Type Left Blank</i>	0	10	6	7	15	7.6	5.50

Figure 1: Call Volume by Time of Day for Metro One from 2015-2019

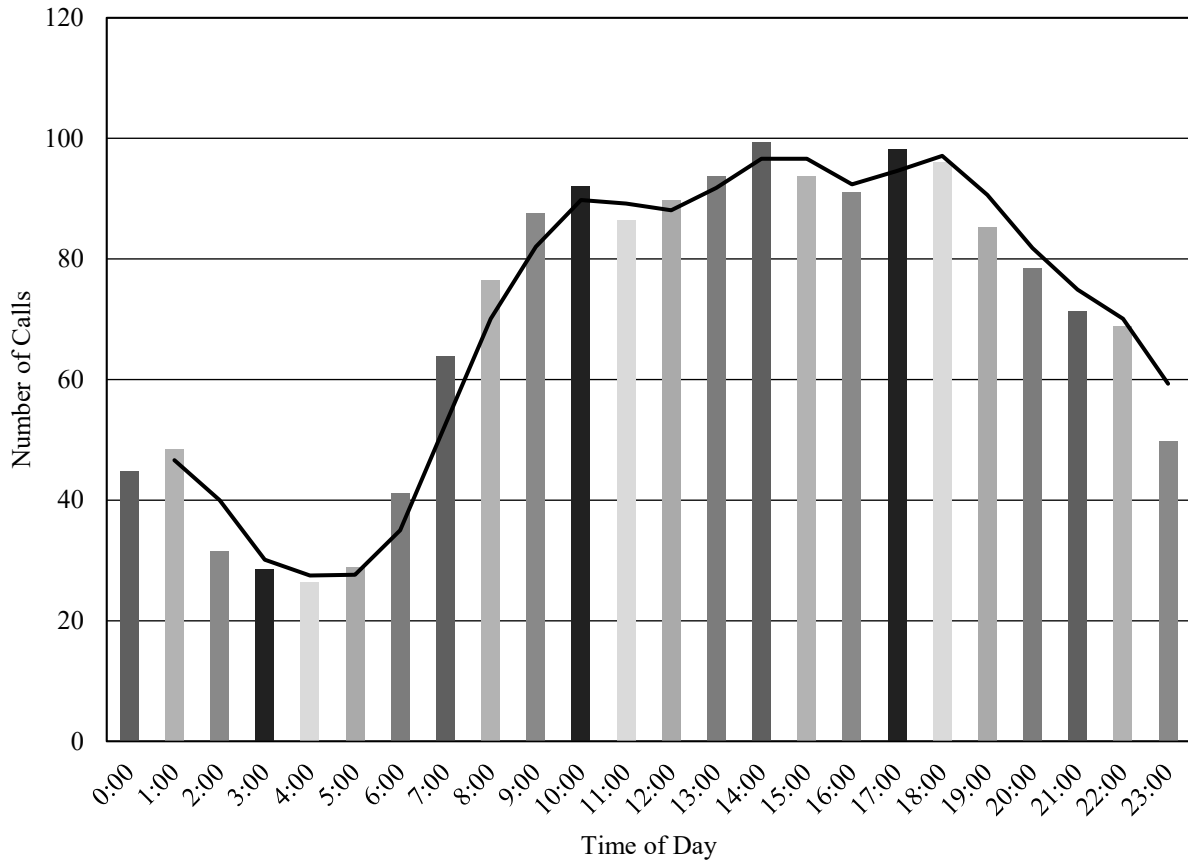


Figure 2: Call Volume by Time of Day for Metro Two from 2015-2019

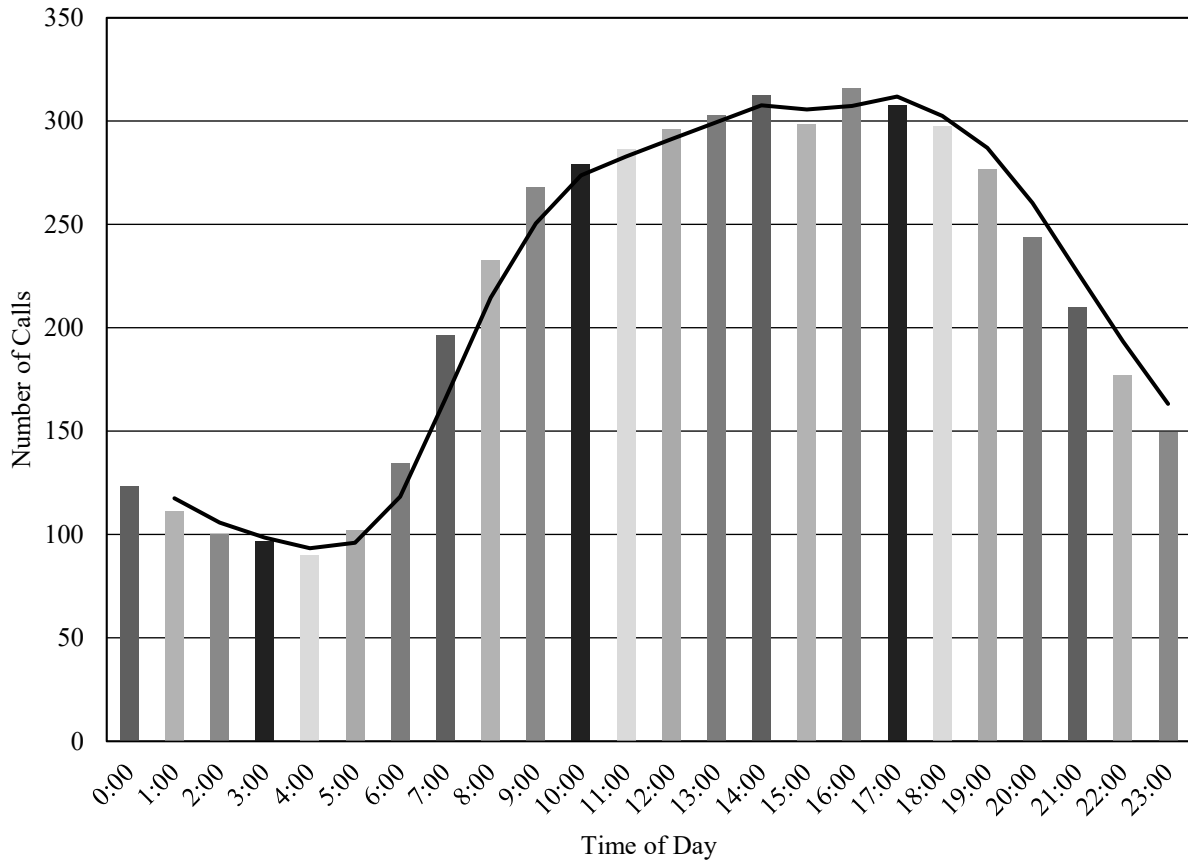
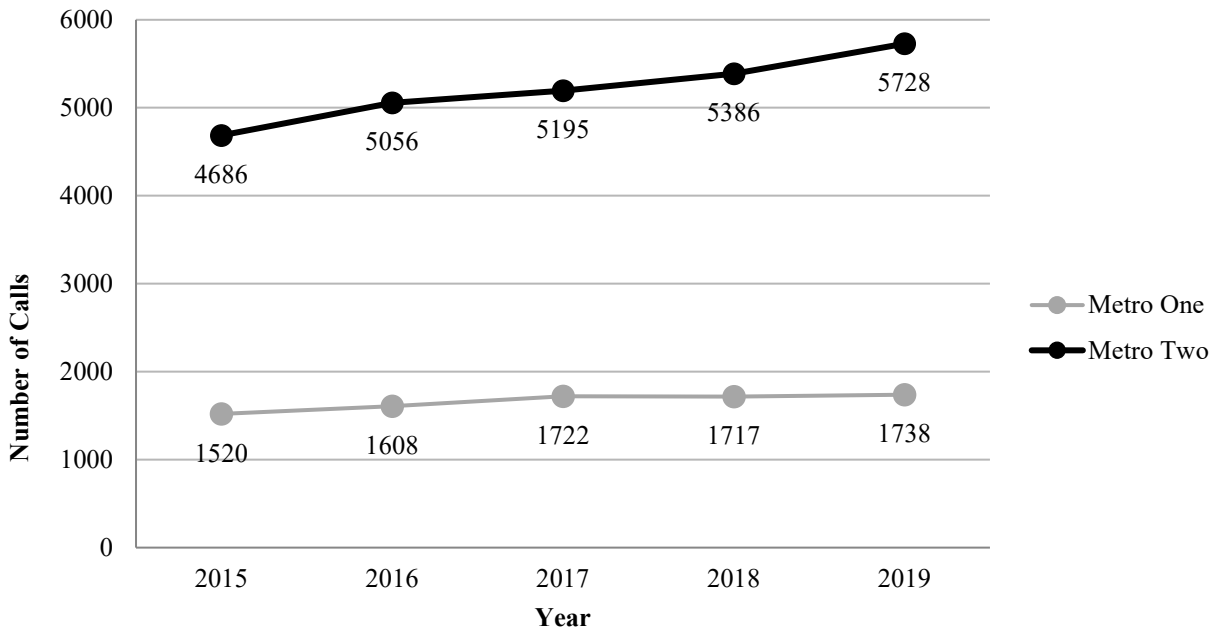


Figure 3: Call Volume by Year for Metro One and Metro Two from 2015-2019



4. Discussion

Call data from two suburban fire departments (2015-2019) was analyzed to identify incident type and call volume frequencies. Many of the results found in this study are similar to those of national reports.^{11,12} From 2015-2019, *rescue and emergency medical services* was the most frequent call type among both departments in our study. The highest average call volume for both departments was generally observed during the afternoon hours. The lowest volume of calls per time of day generally occurred during the late night/early morning hours. The lowest volume of calls per day of the week during the five-year period analyzed were on Sundays.

Efficient and rapid response times to EMS situations have shown to be very time sensitive, as slower responses have demonstrated higher fatality rates.¹⁴ The repeated and increased physiologic and psychologic stress associated with emergent life-threatening situations may contribute to adverse health conditions among firefighter populations, such as anxiety, depression, insomnia, and cardiovascular conditions.^{1,6,7} By utilizing a periodic call data analysis, an accurate estimate of call types and call type frequencies would allow associated healthcare and administrative personnel to target firefighters recurrently exposed to traumatic situations. In doing so, therapeutic health interventions could be implemented for those individuals to mitigate adverse health outcomes. Overall, the call data analysis used in this study may be utilized by healthcare practitioners and administrative personnel in various forms to improve departmental operations, with the goal of improving long-term firefighter health.

Firefighters' fluctuating and stressful work schedules are often an underlying risk factor for many of the adverse health outcomes observed in this occupation.^{1,3,5,6} Using this call data analysis may provide an overarching opportunity to alleviate problems surrounding fire departments' daily operations and scheduling. Based on the results of our study and similar findings from national reports,¹¹ weekday afternoons can be identified as high call volume times. With this evidence, administrative personnel may attempt to avoid mandatory events during this time (weekday afternoons) to benefit firefighters and community members with increased preparedness. Low call volume times could also be used to increase readiness for high-demand emergency situations, with the goal to reduce firefighter stress risks and improve response efficiency to community demands.¹⁴ Additionally, low call volume times could be targeted to allow for department-wide activities. For example, scheduling department-wide training and health interventions on Sunday, based on results from this study, may lower interruptions from incoming calls. Additionally, departments may benefit by designating early morning hours (i.e., 6:00-8:59) for exercise, as allocated exercise time for firefighters has been a key goal highlighted by the International Association of Fire Fighters (IAFF).^{8,15-17} Scheduling exercise times during low call volume periods may improve exercise adherence and allow time for other wellness initiatives, ultimately improving firefighter health and quality of life.⁸

In general, low volume and high-volume times may be accurately estimated using call data analytics, allowing for schedule adjustments as needed for optimal working and health conditions. While the findings of this study are specific to the two agencies investigated, fire department administrative personnel may be better able to plan and schedule training, health interventions, and daily tasks for firefighters on duty by using a form of call data analysis. This

may improve adherence to specific health regimens, reduce job stress, and improve time management within this population.

4.1 Strengths and Limitations

The insight this study provides regarding call volumes for the two departments investigated can be used to focus on management and healthcare strategies to improve firefighter health and quality of life. While our study may lack generalizability, due to a small sample size (two fire departments), the similarities between our study and NFIRS reports suggest that similar analyses could be conducted to aid administrative planning and scheduling for departments.¹¹ To the authors knowledge, this study is the first to emphasize the importance of analyzing departmental call information and health among suburban fire departments. Future research into fire department call data may benefit from a larger sample size composed of more fire departments located in different geographic regions. A greater understanding of these factors may be useful in the development of healthcare and wellness interventions within these populations.

5. Conclusion

A trend of increasing call volumes was observed for both fire departments over the course of the time analyzed. The increase in call volume over time may indicate a trend that will continue, so it is important to recognize the influence of high call volumes to prevent the introduction of further unnecessary risks to firefighters. Poor cardiovascular and mental health, along with poor sleep health, could be perpetuated unless interventions are applied to alleviate these issues. Healthy firefighters and efficient response time is critical to social safety, as the occupational tasks provide invaluable medical and protective services for communities.¹ Responding to calls is an increasingly frequent demand as demonstrated by findings from our study and national reports,^{11,12} yet fire department call data analysis has yet to be efficiently introduced into firefighter health investigation. Multiple health factors related to high call volumes have been reported as major health concerns among firefighters, further highlighting the need to investigate fire department call data.^{1,5,6} By identifying call patterns for fire departments, administrative scheduling and planning could be tailored to improve overall health and quality of life among firefighters.¹⁸ Further, other studies have demonstrated that health interventions for departments provide an increase in overall health and fitness, with a reduction in medical costs.^{8,19}

References

1. Jahnke SA, Poston WSC, Jitnarin N, Haddock CK. Health concerns of the U.S. fire service: perspectives from the firehouse. *Am J Health Promot.* 2012;27(2):111-118.
2. Banes CJ. Firefighters' Cardiovascular Risk Behaviors: Effective Interventions and Cultural Congruence. *Workplace Health Saf.* 2014;62(1):27-34.
3. Wimberley P. Improving cardiovascular risk profiles in firefighters. *Nurs Health (Alhambra).* 2016;4(3):32-35.
4. Patterson PD, Weaver MD, Frank RC, et al. Association between poor sleep, fatigue, and safety outcomes in emergency medical services providers. *Prehosp Emerg Care.* 2012;16(1):86-97.
5. Watkins SL, Shannon MA, Hurtado DA, Shea SA, Bowles NP. Interactions between home, work, and sleep among firefighters. *Am J Ind Med.* 2021;64(2):137-148.
6. Wolkow AP, Barger LK, O'Brien CS, et al. Associations between sleep disturbances, mental health outcomes and burnout in firefighters, and the mediating role of sleep during overnight work: A cross-sectional study. *Journal of Sleep Research.* 2019;28(6). doi:10.1111/jsr.12869
7. Smith DL, Manning TS, Petruzzello SJ. Effect of strenuous live-fire drills on cardiovascular and psychological responses of recruit firefighters. *Ergonomics.* 2001;44(3):244-254.
8. La Reau AC, Urso ML, Long B. Specified Training to Improve Functional Fitness and Reduce Injury and Lost Workdays in Active Duty Firefighters. *J Exerc Physiol Online.* 2018;21(5). https://o2x.com/wp-content/uploads/2018/10/JEPonlineOCTOBER2018_Urso.pdf
9. Stanley IH, Boffa JW, Hom MA, Kimbrel NA, Joiner TE. Differences in psychiatric symptoms and barriers to mental health care between volunteer and career firefighters. *Psychiatry Res.* 2017;247:236-242.
10. Fahy RF, Petrillo JT, Molis JL. Firefighter Fatalities in the US--2019. NFPA Research. Published online 2019:1-26.
11. Fire Department Overall Run Profile as Reported to the National Fire Incident Reporting System (2019). Vol 21. U.S. Fire Administration; 2021. <https://www.usfa.fema.gov/downloads/pdf/statistics/v21i1.pdf>
12. Fire department calls. Published June 2021. Accessed July 8, 2021. <http://www.nfpa.org/News-and-Research/Data-research-and-tools/Emergency-Responders/Fire-department-calls>
13. Data, Publications and Library. U.S. Fire Administration. Accessed September 30, 2021. <https://www.usfa.fema.gov/data/>

14. Blanchard IE, Doig CJ, Hagel BE, et al. Emergency medical services response time and mortality in an urban setting. *Prehosp Emerg Care*. 2012;16(1):142-151.
15. Beaton R, Murphy S, Salazar M, Clark Johnson L. Neck, Back, and Shoulder Pain Complaints in Urban Firefighters: The Benefits of Aerobic Exercise. *Journal of Musculoskeletal Pain*. 2002;10(3):57-67. doi:10.1300/j094v10n03_04
16. Jafari M, Zolaktaf V, Ghasemi G. Functional Movement Screen Composite Scores in Firefighters: Effects of Corrective Exercise Training. *J Sport Rehabil*. 2020;29(1):102-106.
17. International Association of Fire Fighters Division of Occupational Health, Safety and Medicine. *The Fire Service Joint Labor Management Wellness-Fitness Initiative*. 4th ed. International Association of Fire Fighters; 2018. https://www.iaff.org/wp-content/uploads/2019/04/WFI_Manual_2018.pdf
18. MacKinnon DP, Elliot DL, Thoemmes F, et al. Long-term effects of a worksite health promotion program for firefighters. *Am J Health Behav*. 2010;34(6):695-706.
19. Griffin SC, Regan TL, Harber P, et al. Evaluation of a fitness intervention for new firefighters: injury reduction and economic benefits. *Inj Prev*. 2016;22(3):181-188.