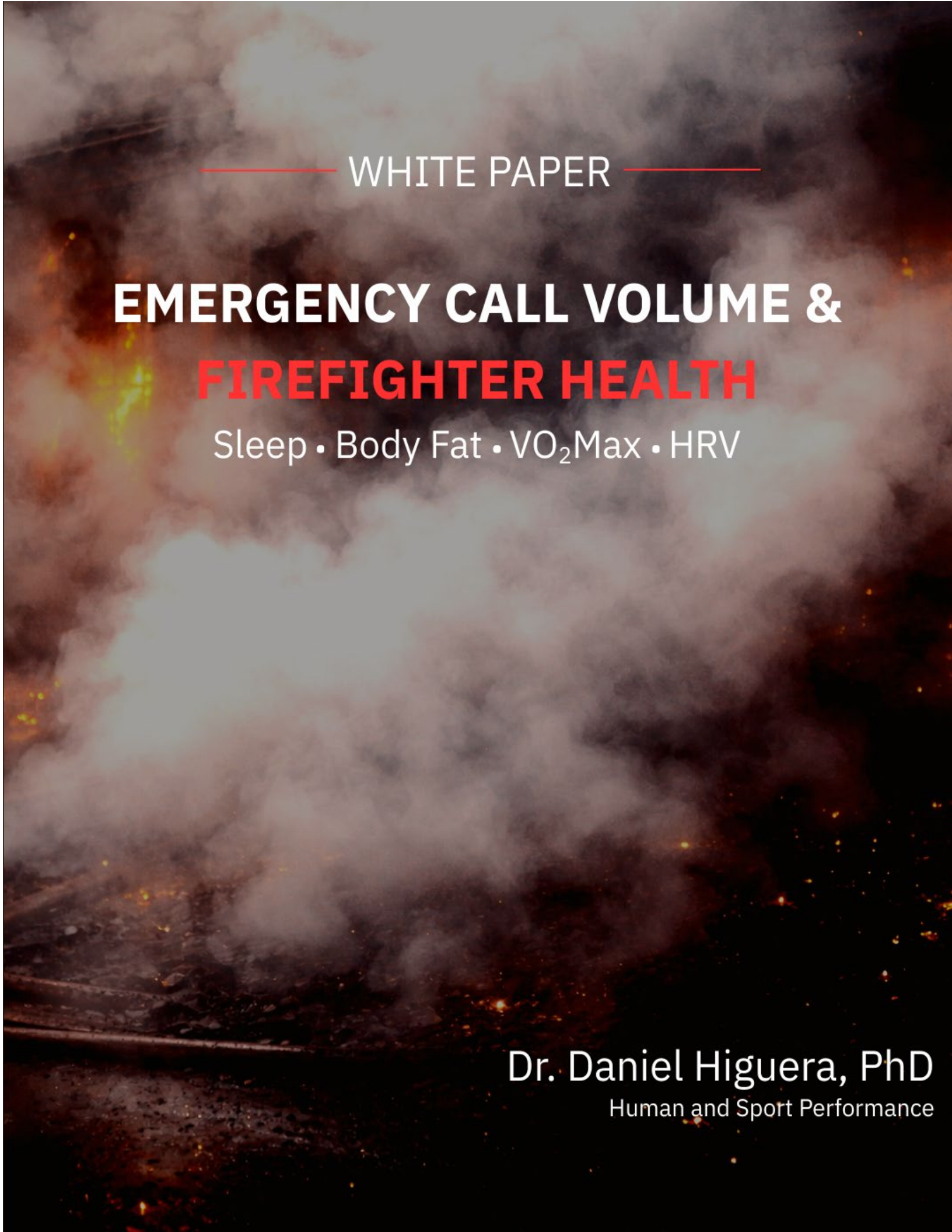

WHITE PAPER

EMERGENCY CALL VOLUME & FIREFIGHTER HEALTH

Sleep • Body Fat • VO_2Max • HRV

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Human and Sport Performance

Table Of Contents

Executive Summary

Fire departments increasingly rely on emergency call volume as a proxy for workload, staffing needs, and operational strain. While higher call volume is often assumed to drive poorer health outcomes among firefighters, limited data exist examining how differing call volume levels relate to sleep, body composition, physical fitness, and physiological stress in real-world fire service settings.

This white paper summarizes findings from a doctoral research study involving 53 career firefighters working 24-hour shifts. Firefighters were grouped into low, moderate, and high call volume categories based on the number of emergency responses completed during a shift. Key health indicators assessed included sleep duration, body fat percentage, aerobic capacity (VO_2max), and heart rate variability, a marker of autonomic nervous system stress and recovery. Age was controlled for in all analyses.

Key Findings

- **Call volume was associated with body fat percentage, but not in a linear or expected way.** Firefighters in the moderate call volume group had significantly lower body fat than those in the low call volume group. Both low and high call volume firefighters fell within the overweight range on average.
- **Sleep duration was poor across all call volume groups.** Regardless of workload, firefighters averaged well below recommended minimum sleep durations following a 24-hour shift, indicating that inadequate sleep may be a systemic issue rather than a call volume dependent one.
- **Aerobic fitness levels were consistently below recommended standards.** Average VO_2max values across all groups failed to meet National Fire Protection Association fitness recommendations, suggesting elevated cardiovascular strain risk during emergency operations independent of call volume.
- **Heart rate variability did not significantly differ between call volume groups.** Although higher call volume firefighters showed numerically lower values, differences were not statistically significant, indicating that chronic occupational stress may blunt detectable differences in short-term physiological stress markers.
- **Overall health risk appeared elevated across the entire sample.** The lack of differences across many variables suggests that firefighters may experience baseline levels of compromised sleep, fitness, and recovery regardless of station workload.

Practical Implications for Fire Departments

- Low call volume assignments should not be assumed to confer health protection.
- Moderate levels of occupational activity may provide protective benefits for body composition when combined with adequate recovery and structure.
- Sleep deficits and substandard fitness appear to be widespread issues requiring department-wide strategies rather than workload-specific interventions.

- Relying solely on call volume as an indicator of firefighter health risk may overlook systemic stressors embedded in shift work, sleep disruption, and station culture.

Conclusion

These findings challenge the assumption that higher call volume alone drives poor firefighter health outcomes. Instead, the data suggests that many health risks are pervasive across the fire service, regardless of workload intensity. Comprehensive wellness strategies that address sleep hygiene, physical fitness, nutrition, and chronic stress are likely necessary to meaningfully improve firefighter health and career longevity.

1. Why Firefighters Question Call Volume and Health

Firefighters know intuitively that busy stations feel harder on the body. More calls usually mean less sleep, fewer chances to train, rushed meals, and more cumulative stress. At the same time, firefighters assigned to slower stations often assume their workload protects them from the long-term health consequences of the job.

Across the fire service, call volume is often used as a shorthand for workload and strain. Firefighters talk about "busy houses" versus "slow houses" as if those labels automatically predict who will be healthier or more worn down over time. However, very few studies have examined whether firefighters working different call volumes actually differ in sleep, fitness, body composition, or physiological stress in meaningful ways.

This matters because firefighters already face elevated risks of cardiovascular disease, injury, and early career disability. If call volume truly drives health risk, then assignment, staffing, and recovery strategies should reflect that. If it does not, then focusing only on call volume may miss the real drivers of firefighter health problems.

The purpose of this white paper is to summarize findings from a firefighter specific research study that examined whether working low, moderate, or high call volumes meaningfully changed key health indicators that firefighters care about and live with every day.

2. How Firefighter Health Was Evaluated

This white paper is based on a research study involving 53 career firefighters working 24 hour shifts. All participants were operational firefighters assigned to frontline apparatus such as engines, trucks, or ambulances. Firefighters in administrative roles or on modified duty were excluded to ensure the results reflected the demands of line work. Firefighters were grouped based on the number of emergency calls they responded to during a 24 hour shift. Call volume was divided into three categories:

- Low call volume (<6 total emergency calls)
- Moderate call volume (7-14 total emergency calls)
- High call volume (15+ total emergency calls)

This approach allowed comparisons between firefighters working slower, average, and busier shifts under real station conditions. The study focused on four health markers that are closely tied to firefighter safety, performance, and long-term health:

2.1 Sleep Duration

Firefighters reported how many hours they slept during a 24 hour shift. Sleep is essential for recovery, cognitive function, cardiovascular health, and injury prevention. Chronic sleep restriction is common in the fire service and is linked to weight gain, poor fitness, and increased disease risk.

2.2 Body Fat Percentage

Body fat percentage was used instead of body weight alone to better reflect health risk. Elevated body fat is strongly associated with cardiovascular disease, metabolic dysfunction, and line of duty cardiac events in firefighters.

2.3 Aerobic Capacity (VO_2max)

Aerobic fitness reflects how well the heart and lungs can support physically demanding tasks such as fire suppression, stair climbing, and rescue operations. Lower aerobic fitness increases cardiovascular strain during emergencies and raises the risk of adverse events.

2.4 Heart Rate Variability

Heart rate variability is a physiological marker of how well the nervous system balances stress and recovery. Lower values generally reflect higher stress and reduced recovery capacity. In firefighters, HRV has been proposed as a tool to monitor cumulative occupational stress. Age was accounted for in all analyses to ensure that differences were not simply due to older firefighters being assigned to certain stations or apparatus.

The goal of the study was straightforward: to determine whether firefighters working different call volumes actually differed in sleep, body composition, fitness, and physiological stress in meaningful ways.

3. Key Findings: What the Data Actually Show

This study examined whether firefighters working low, moderate, and high call volumes across a 24-hour shift differed in sleep duration, body fat percentage, aerobic fitness, and physiological stress. A common expectation within the fire service is that higher call volume inevitably leads to worse health outcomes. While the data partially supported this belief, several findings directly challenged this assumption and pointed toward a more complex relationship between workload and health.

3.1 Call Volume and Body Fat Percentage

Firefighters working a moderate call volume demonstrated significantly lower body fat percentage compared to those working low call volume shifts. In contrast, firefighters in both the low and high call volume groups averaged body fat levels that fell within the overweight range. This was the only health variable that differed significantly between call volume groups. Because body fat percentage is a strong predictor of cardiovascular disease risk in firefighters, this finding is particularly meaningful. The observation that firefighters in slower stations exhibited higher body fat than those in moderately busy stations challenges the assumption that fewer calls automatically confer a health advantage. One plausible explanation is that moderate call volume provides sufficient physical activity and structure to limit prolonged inactivity while still allowing opportunities for nutrition, training, and recovery.

Conversely, low call volume shifts may promote extended sedentary behavior, boredom-driven eating, and inconsistent movement patterns throughout the shift. Importantly, this finding does not suggest that higher call volume should be pursued as a health strategy. Firefighters in the high call volume group still averaged body fat values within the overweight range, indicating that excessive workload may negate any benefit gained from increased activity. Taken together, the results suggest that both insufficient and excessive occupational demand may carry health risks, though through different mechanisms.

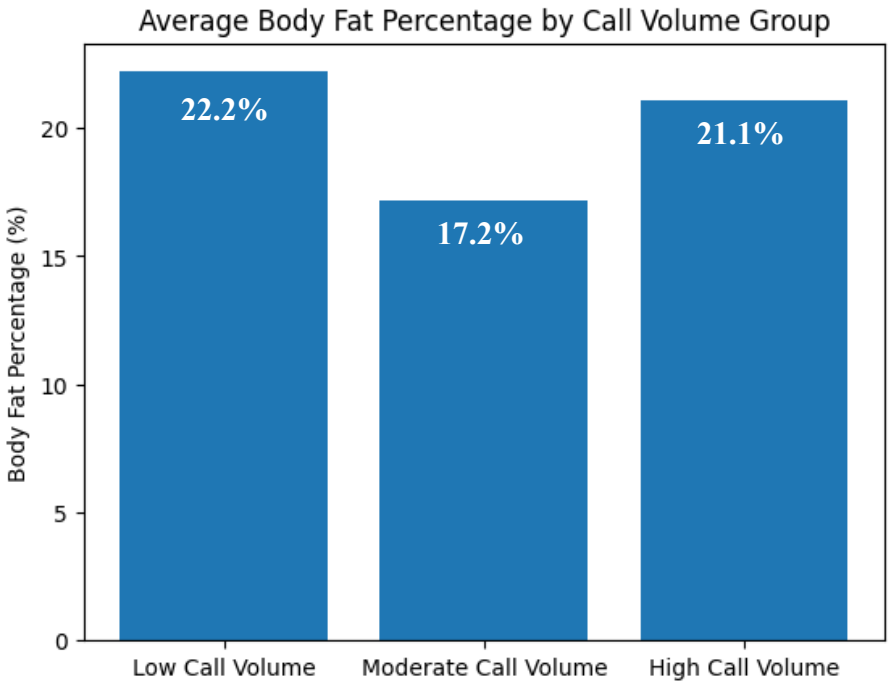

Figure 1. Body Fat % by Call Volume Group.
Average body fat percentage across low, moderate, and high call volume groups. Firefighters working moderate call volume shifts demonstrated lower body fat compared to those in low call volume shifts, while both low and high call volume groups averaged within the overweight range.

3.2 Call Volume and Sleep Duration

Sleep duration was consistently poor across all call volume groups. Firefighters averaged well below recommended minimum sleep durations regardless of whether they worked low, moderate, or high call volumes, and no statistically significant differences were observed between groups. All groups reported sleeping fewer than five total hours during the 24-hour shift period. This study did not distinguish whether sleep occurred in a single continuous bout or was fragmented across multiple periods, but the overall duration remained uniformly low.

These findings are important because firefighters often attribute inadequate sleep solely to nighttime emergency calls. While alarms clearly disrupt sleep, the results suggest that sleep deprivation may be a baseline feature of the occupation rather than a problem isolated to busy

stations. Anticipation of calls, communal sleeping environments, irregular schedules, and psychological stress may all contribute to shortened sleep even during quieter shifts. These findings do not imply that nighttime calls are irrelevant or that sleep quality is equivalent across stations. Rather, they indicate that improving firefighter sleep likely requires broader approaches than simply addressing call volume alone**.**

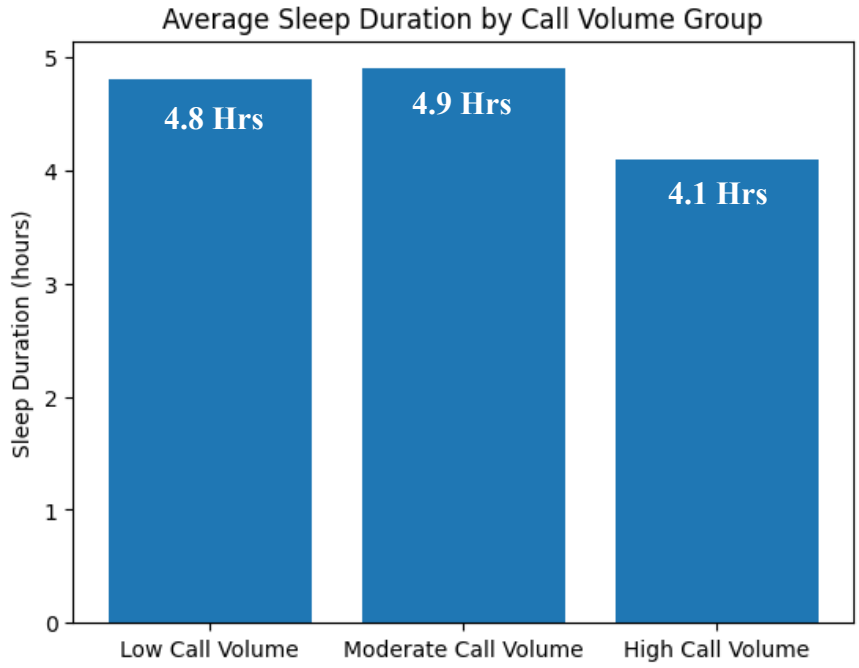

Figure 2. Sleep Duration and Call Volume
Average self-reported sleep duration following a 24-hour shift across low, moderate, and high call volume groups. Sleep duration was consistently low across all groups, with no meaningful differences observed between call volume categories.

3.3 Call Volume and Aerobic Fitness (VO_2max)

Aerobic fitness, measured as relative VO_2max, was below National Fire Protection Association recommended standards of 42 $ml \cdot kg^{-1} \cdot min^{-1}$ across all call volume groups. Call volume did not significantly differentiate aerobic capacity. This finding has important implications for firefighter safety, as aerobic fitness is critical for sustaining high-intensity tasks such as fire suppression, stair climbing, and victim rescue. Lower aerobic capacity increases cardiovascular strain during emergency operations and is associated with a higher risk of adverse cardiac events. The uniformly low fitness levels observed across all groups suggest that workload alone does not explain deficits in aerobic capacity. Instead, long-term factors such as training consistency, recovery limitations, cumulative fatigue, and cultural norms surrounding fitness likely play a larger role. These results should not be interpreted as a lack of discipline among firefighters, nor do they suggest that busy stations prevent fitness or that slower stations

automatically provide sufficient time to train. Rather, they point toward a systemic fitness challenge that affects firefighters regardless of assignment.

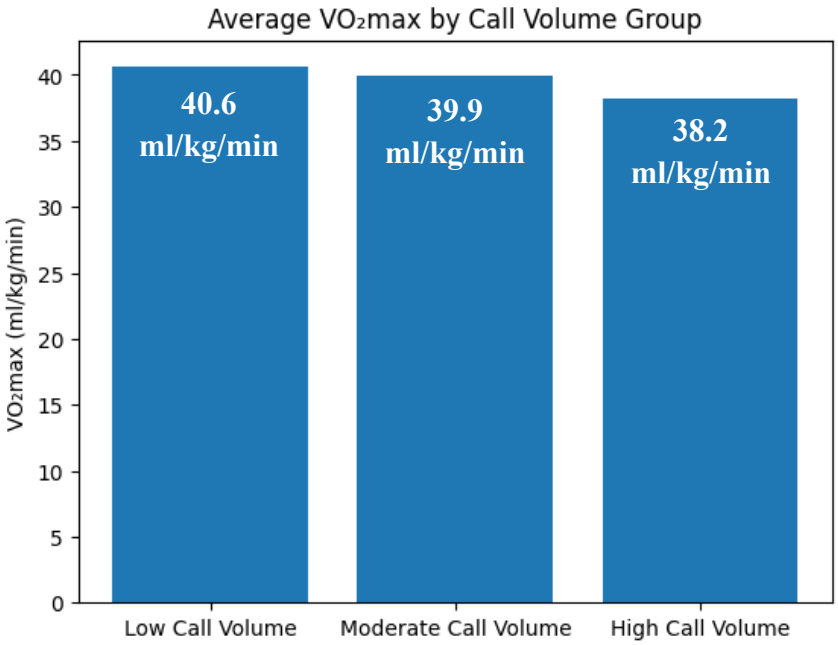

Figure 3. VO_2max by Call Volume Group.
Aerobic fitness was consistently below recommended standards across all groups, with no meaningful differences observed between call volume categories.

3.4 Call Volume and Physiological Stress (Heart Rate Variability)

Physiological stress, assessed through heart rate variability, tended to be lower in firefighters working high call volume shifts, but these differences were not statistically significant. Heart rate variability reflects the balance between stress and recovery within the autonomic nervous system, and higher workloads are often expected to produce clear reductions in this measure.

The absence of strong differences between call volume groups suggests that firefighters may operate under a consistently elevated baseline level of physiological stress, independent of workload. In practical terms, the occupation itself may place firefighters in a chronic stress state that limits the ability to detect short-term differences between varying call volumes. This finding does not indicate that firefighters are not stressed, that call volume has no impact on recovery, or that heart rate variability lacks value. Instead, it suggests that chronic occupational stress may mask differences that would otherwise be more apparent in less demanding professions.

3.5 The Bigger Pattern Firefighters Should Notice

When these findings are considered together, a broader pattern becomes clear. Across sleep, aerobic fitness, and physiological stress, firefighters demonstrated compromised health markers regardless of call volume assignment. The lack of significant differences between

groups should not be interpreted as evidence of good health. Rather, it suggests that many firefighters experience inadequate sleep, substandard fitness, and elevated stress across the fire service as a whole. This shifts the focus away from blaming specific stations or workloads and toward understanding firefighter health as an occupational exposure shared broadly across the profession.

4. Interpretation: What These Findings Mean for Firefighters

The most important takeaway from this study is not tied to a single variable or statistic. It is the broader pattern that emerges when all findings are considered together. Firefighter health challenges appear to be systemic, not confined to busy stations, slow stations, or specific assignments.

4.1 Low Call Volume Does Not Equal Low Health Risk

Many firefighters assume that working a slower house protects them from long-term health consequences. The data do not support that assumption. Firefighters in the low call volume group averaged body fat levels in the overweight range, reported poor sleep duration, demonstrated aerobic fitness below recommended standards, showed physiological stress patterns similar to other groups

This suggests that inactivity, disrupted sleep, and occupational stress persist, even when calls are infrequent. Long periods of sitting, irregular movement, boredom-driven eating, and anticipation of calls may still negatively affect health. These findings are consistent with previous research comparing health outcomes of firefighters assigned at low and high call volume stations. For firefighters, this means that assignment alone does not determine risk. Health is influenced by what happens during downtime just as much as what happens during emergency response.

4.2 Moderate Occupational Activity May Be Protective Under the Right Conditions

The finding that firefighters in the moderate call volume group had lower body fat than those in the low group is worth paying attention to. This does not mean that being busier is better. Instead, it suggests that a balance between activity and recovery may matter more than call volume alone. Moderate workloads aid the firefighter in increasing daily movement and energy expenditure, reduce prolonged sedentary time, and provide structure to the shift without overwhelming recovery capacity. When combined with adequate opportunities to eat, train, and recover, this balance may support healthier body composition. For firefighters, the implication is not to seek more calls, but to recognize that movement and structure during a shift matter, even on slower days.

4.3 Sleep Problems Are Likely Built Into the Job

Sleep duration was consistently low across all call volume groups. This suggests that poor sleep is not simply a result of how many calls occur overnight but more so a cumulative outcome

of anticipation of alarms, communal sleeping environments, irregular circadian rhythms, mental stress and rumination, and difficulty fully disengaging from readiness

This means that firefighters should not interpret poor sleep as a personal failure or something that only happens at busy houses. Instead, sleep disruption appears to be a core occupational exposure of firefighting. Improving sleep will likely require intentional strategies that go beyond call volume reduction alone.

4.4 Fitness Deficits Reflect Long-Term Constraints, Not Single Shifts

Aerobic fitness did not differ between call volume groups, but it was consistently below recommended standards. This indicates that fitness is shaped by long-term habits, culture, and recovery, not by how busy a single shift happens to be. The common challenges firefighters face when it comes to regular exercise are inconsistent opportunities to train, fatigue after shifts, competing life demands such as injuries, and limited recovery time. These constraints exist regardless of station assignment. As a result, fitness deficits should be understood as an occupational challenge, not an individual shortcoming.

4.5 Chronic Stress May Level the Playing Field

Heart rate variability did not differ significantly between call volume groups. One interpretation is that firefighters operate under chronically elevated stress, which reduces the ability to detect short-term differences between workloads. Rather than meaning firefighters are not stressed, this suggests the opposite. Baseline stress levels may already be high enough that additional calls do not produce easily measurable changes in short-term physiological markers. For firefighters, this reinforces the idea that recovery, mental health, and stress management deserve attention even when shifts feel manageable.

4.6 The Bigger Message Firefighters Should Take Away

Taken together, these findings point to a difficult but important reality. Firefighter health challenges are not limited to specific stations, call volumes, or individuals. They are embedded in the structure of the job itself. This does not mean change is impossible. It means that blaming and shaming individual firefighters is unproductive, assuming certain assignments are “safe” is misleading, and improving health requires intentional, consistent strategies. Firefighters deserve wellness approaches that acknowledge the realities of the job rather than ignoring them.

5. What Firefighters Can Actually Do With This Information

The findings from this study are not meant to suggest that firefighter health outcomes are simply a matter of individual effort or motivation. Instead, the data point toward a more realistic conclusion. Some aspects of health are influenced by individual behavior, while others are shaped by the structure and demands of the job itself. Both need to be acknowledged to have an honest conversation about firefighter health.

One of the clearest messages from this study is that working a slower station does not automatically protect health. Firefighters assigned to low call volume shifts still demonstrated elevated body fat, poor sleep duration, and substandard aerobic fitness. This suggests that long periods of inactivity, extended sitting, and irregular movement during downtime can quietly accumulate health risk. On slower shifts, downtime can either support recovery and training or reinforce sedentary patterns and boredom-driven eating. The difference is not call volume itself, but how that time is used.

High call volume shifts present a different challenge. While busy shifts may increase movement, they also increase fatigue, stress, and disruption to normal routines. Firefighters should not view high call volume as a substitute for structured fitness or as a protective factor against health decline. Instead, busy shifts should be treated as periods of stress exposure where the primary goal is maintaining basic nutrition, hydration, and movement while protecting recovery afterward. Expecting optimal training or performance on high call volume shifts is often unrealistic and counterproductive.

Across all call volume groups, aerobic fitness levels were consistently below recommended standards. This reinforces an important point. Fitness is not determined by a single shift, a specific station, or a particular week. It is shaped by long-term habits that persist across inconsistent schedules, poor sleep, and competing demands. Firefighters benefit most from training approaches that prioritize consistency over perfection and sustainability over intensity. Programs that only work when sleep is ideal or schedules are predictable are unlikely to succeed in the fire service.

Sleep emerged as one of the most compromised variables regardless of call volume. Firefighters frequently attribute poor sleep to nighttime calls, but these findings suggest that sleep disruption is more deeply embedded in the occupation. Anticipation of alarms, communal sleeping environments, irregular schedules, and mental stress all contribute to shortened and fragmented sleep. While firefighters cannot control alarms or shift structure, they can influence sleep hygiene behaviors, recovery practices on days off, and how they transition off shift. Treating sleep as a skill that requires intention rather than as a luxury the job may eventually allow is a more productive framework.

It is also important to recognize where personal responsibility reasonably ends. Firefighters do not control staffing levels, shift schedules, station environments, or call timing. Acknowledging these constraints does not remove accountability, but it does prevent misplaced self-blame. Understanding the limits of individual control allows firefighters to engage with wellness efforts realistically and to advocate for better conditions using data rather than frustration.

Perhaps the most valuable outcome of this research is its ability to change how firefighters talk about health. Instead of attributing health outcomes to specific stations or individual choices alone, the data support a broader understanding that firefighting itself carries health risks across assignments. This shifts the conversation away from blame and toward shared responsibility, long-term planning, and meaningful support. Firefighters equipped with evidence

are better positioned to protect their own health and to push for changes that reflect the realities of the job.

6. Conclusion

This study set out to examine whether emergency call volume meaningfully differentiates firefighter health across sleep duration, body composition, aerobic fitness, and physiological stress. While many firefighters reasonably expect higher call volume to drive worse health outcomes, the findings tell a more complex and, in some ways, more concerning story.

Across low, moderate, and high call volume assignments, firefighters demonstrated consistently poor sleep duration, aerobic fitness below recommended standards, and signs of elevated physiological stress. The only variable that differed significantly between groups was body fat percentage, with firefighters in the moderate call volume group exhibiting lower levels than those in the low call volume group. Rather than identifying a single "problem" workload, these findings suggest that firefighter health challenges are widespread and not confined to specific stations or assignments.

The absence of meaningful differences across most health markers should not be interpreted as good news. Instead, it indicates that many firefighters may be operating under a baseline level of compromised recovery and fitness regardless of call volume. Sleep disruption, chronic stress, and long-term constraints on consistent training appear to be embedded features of the profession rather than consequences of isolated operational demands.

For firefighters, this reframes the conversation around health. Working at a slower station does not guarantee protection, and working a busier station does not fully explain health decline. The data point toward a need to look beyond call volume alone and to consider how shift structure, recovery opportunities, cultural expectations, and long-term habits interact to shape health over the course of a career.

Importantly, these findings do not place responsibility solely on individual firefighters. While personal choices matter, the results highlight the limits of individual control within a demanding occupational environment. Firefighter health should be understood as a shared responsibility between the individual and the system in which they operate.

Taken together, this research supports a broader and more honest approach to firefighter wellness, one that acknowledges the realities of the job while emphasizing sustainable strategies for sleep, fitness, and recovery. Improving firefighter health will likely require moving beyond assumptions about workload and toward comprehensive, evidence-informed solutions that address the structural demands of the profession.

About the Author

Daniel Higuera, PhD is a professor of kinesiology whose work focuses on improving firefighter health, fitness, and career longevity. His research explores the applicability of wearable technology for firefighters and examines how occupational demands such as emergency call volume, sleep disruption, physical fitness, and chronic stress influence firefighter performance and long-term health outcomes.

Dr. Higuera has worked closely with over 25 fire departments through health and wellness programs, fitness assessments, and applied research initiatives, allowing him to study firefighters in real operational environments rather than laboratory-only settings. His work emphasizes translating scientific evidence into practical insights that firefighters and departments can use to better understand health risks embedded in the job. This white paper is based on doctoral research involving career firefighters working 24-hour shifts and reflects commitment to evidence-based, firefighter-centered approaches to health and performance.

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