Firefighter Sport Science

Sauna at the Fire Station

Research, Risk, and Operational Realities

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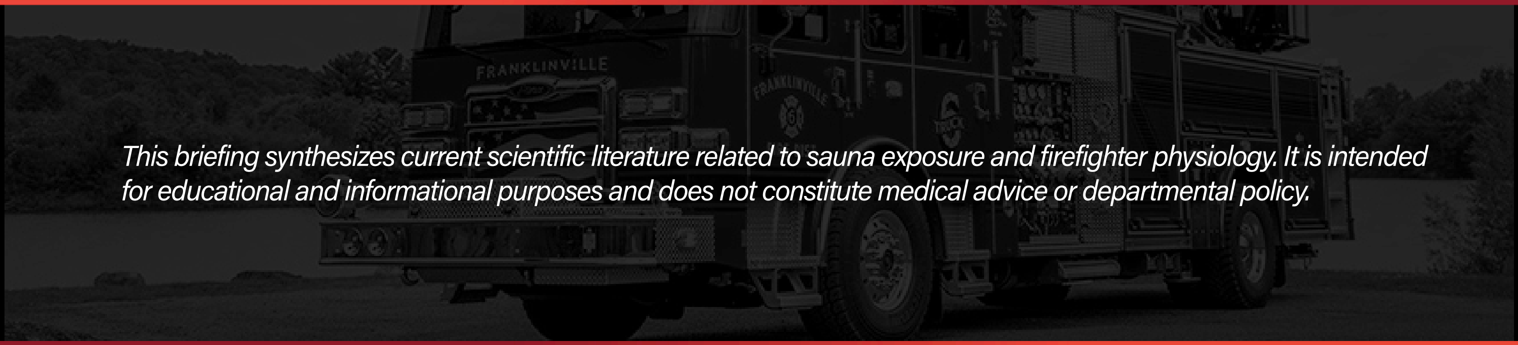

This briefing synthesizes current scientific literature related to sauna exposure and firefighter physiology. It is intended for educational and informational purposes and does not constitute medical advice or departmental policy.

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Research, Risk, and Operational Realities

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Generative AI (Claude Sonnet 4.6, Anthropic, 2025) was used during the preparation of this document to assist with formatting standardization, structural organization, and language consistency review. All AI-assisted outputs were reviewed, edited, and verified by the author, and any content that did not meet accuracy or clarity standards was revised or discarded. The conceptualization, literature interpretation, evidence synthesis, and all substantive intellectual contributions were performed entirely by the author.

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Key Takeaway For

Fire Service Leaders

Sauna installations are becoming increasingly common within fire stations across the United States. The following points summarize the most important conclusions from the scientific literature reviewed in this briefing.

Evidence Area	Strength of Scientific Evidence
Acute cardiovascular responses to sauna	Strong
Long-term cardiovascular associations in general populations	Moderate
Detoxification of PAHs in firefighters	Preliminary
Operational safety during on-duty sauna use	Limited

Interpretation: Most sauna research has been conducted in general populations. Firefighter-specific research remains limited and is still emerging. Ratings reflect study design quality, sample specificity, and consistency of findings across populations.

1. Sauna exposure produces cardiovascular stress
Traditional dry sauna exposure increases heart rate, cardiac output (the total volume of blood your heart pumps per minute), and peripheral circulation as the body attempts to dissipate heat. Although skeletal muscle work is minimal, the cardiovascular system responds in a way that can resemble moderate-intensity aerobic exercise. Sauna should therefore be viewed as a physiological stressor rather than a passive comfort activity.

2. Repeated sauna exposure may support cardiovascular health
Research conducted primarily in general populations has demonstrated associations between regular sauna use and improvements in endothelial function, modest reductions in resting blood pressure, improved vascular compliance, and enhanced thermoregulatory tolerance. These adaptations are believed to occur through repeated cycles of heat-induced vasodilation and vascular shear stress.

3. Firefighters already operate in a high-heat, high-strain occupational environment
Structural fire suppression places substantial stress on the cardiovascular and thermoregulatory systems. Heart rate, core temperature, inflammatory signaling, and sympathetic nervous system activation rise rapidly during emergency operations. Sauna exposure in the station environment therefore represents additional heat stress layered on top of an already demanding physiological workload.

FIRE SERVICE CONTEXT

When sauna exposure is added after operational activity, it should be considered within the broader physiological load experienced during the shift.

4. Firefighter-specific research on sauna is limited.
Only a small number of studies have examined sauna exposure directly in firefighter populations. Early findings suggest that sauna use may contribute to reductions in certain biomarkers associated with combustion-related contaminants such as polycyclic aromatic hydrocarbons (PAHs), when integrated into post-exposure gross decontamination protocols. However, current evidence remains preliminary and should not be interpreted as proof of detoxification or disease prevention.

5. Sauna is not a replacement for exposure-control practices.
The most effective exposure mitigation strategies remain:
- respiratory protection
- on-scene decontamination
- proper gear handling
- personal hygiene practices
- station contamination control

Sauna use should be considered a supplementary recovery or hygiene practice rather than a primary exposure-control method.

6. Governance is essential when sauna equipment is installed in stations.
Without written guidance addressing temperature ranges, exposure duration, hydration expectations, eligibility criteria, and operational readiness, sauna use may become inconsistent and potentially unsafe. Departments that choose to incorporate sauna equipment should ensure its use is governed by clear written policy.

Why This
Briefing Exists

Interest in sauna exposure as a potential health and recovery practice has grown substantially in recent years. Within the fire service, this interest has emerged alongside broader conversations about cardiovascular risk reduction, recovery from shift-related stress, and strategies to mitigate exposure to combustion-related contaminants. As a result, sauna equipment is beginning to appear in fire station environments through donations, wellness initiatives, or departmental investments in recovery infrastructure.

What has not developed at the same pace as this growing interest is a structured understanding of how sauna exposure should be interpreted within the operational realities of firefighting.

Over the past two decades, scientific research examining sauna exposure has expanded considerably. Large observational cohort studies have reported associations between habitual sauna use and reduced cardiovascular mortality in certain populations. Clinical and mechanistic investigations have examined acute blood pressure responses, endothelial function, arterial stiffness, autonomic regulation, inflammatory signaling, and thermoregulatory adaptation. More recently, preliminary research has begun exploring sauna exposure in high-stress occupations, including firefighters.

At first glance, these findings appear promising. Repeated sauna exposure has been associated with modest reductions in blood pressure, improvements in vascular responsiveness, and favorable shifts in certain autonomic and inflammatory markers. Acute exposure reliably increases heart rate and cardiac output (the total volume of blood your heart pumps per minute) in a manner that resembles moderate-intensity exercise, while repeated exposure may promote adaptive responses in endothelial health and heat tolerance. However, scientific plausibility does not automatically translate into operational applicability.

Much of the long-term evidence derives from populations that differ meaningfully from career firefighters. Participants in Finnish cohort studies often engaged in culturally embedded sauna use across decades and were not routinely exposed to the extreme heat, exertion, and physiological stress associated with structural fire suppression. Differences in occupational demands, hydration patterns, sleep stability, and baseline health behaviors may influence both adaptation and risk.

Firefighting, by contrast, involves episodic and physiologically extreme environments. During suppression activity firefighters routinely experience rapid elevations in heart rate, core temperature, sympathetic nervous system activation, coagulation markers, and inflammatory mediators. When a firefighter enters a sauna following a response, the cardiovascular system is not encountering heat stress for the first time. Instead, it is encountering an additional heat stimulus layered onto an already complex physiological workload.

The increasing presence of sauna equipment in fire stations has therefore created a unique intersection: expanding accessibility, evolving but incomplete scientific evidence, and limited consensus regarding how sauna exposure should be operationally framed. In many cases equipment is installed without written governance, defined objectives, exposure ceilings, hydration guidance, or eligibility criteria.

This briefing exists to bring structure to that intersection. It synthesizes current physiological research, identifies where evidence is strongest and where it remains limited, and translates those findings into the operational context of the fire service. Its purpose is not to advocate universally for sauna installation, but to ensure that decisions about its use are informed by physiology, risk awareness, and structured governance.

Heat Exposure and
Acute Physiological Response

Sauna exposure represents a deliberate form of passive heat stress in which ambient temperature is elevated sufficiently to challenge thermoregulatory homeostasis without requiring metabolic work from skeletal muscle (2,5). When environmental temperature exceeds skin temperature by a substantial margin, heat transfer occurs primarily through convection and radiation (in dry sauna) or radiant energy absorption (in infrared). As external heat load increases, the body initiates coordinated thermoregulatory adjustments designed to prevent excessive internal temperature elevation and preserve organ function.

Under controlled conditions, core temperature typically rises within a modest physiological range. In thermoregulatory comparisons of passive heat modalities, dry sauna exposure at approximately 176°F (80°C) delivered in repeated 10-minute bouts increased core temperature from approximately 98.7°F to 99.5°F (37°C to 37.5°C) (1,5). While this magnitude of increase appears numerically small, even fractional elevations in core temperature are sufficient to activate systemic cardiovascular adjustments.

As core temperature rises, cutaneous vasodilation occurs via sympathetic cholinergic pathways. Blood flow is redistributed toward the skin to facilitate heat dissipation through radiation and evaporative cooling. This peripheral vasodilation reduces systemic vascular resistance. To maintain arterial pressure and organ perfusion, cardiac output must increase. Dry sauna exposure increased cardiac output from approximately 5.0 L/min at baseline to approximately 7.3 L/min during exposure, with heart rate increasing by approximately 34 beats per minute (1). Infrared sauna exposure in the same comparison increased heart rate by approximately 26 beats per minute and cardiac output by approximately 1.6 L/min but produced minimal measurable change in core temperature under the specific protocol used (8). This distinction reinforces that internal heat storage and not ambient warmth alone drives the magnitude of cardiovascular response.

Sweat production increases rapidly during heat exposure as eccrine glands are activated under sympathetic control. In the dry sauna condition described above, average sweat loss was approximately 1.45 lbs. (0.66 kg) during exposure. Infrared saunas in that comparison produced lower sweat loss, approximately 0.86 lbs (0.39 kg) (8).

These values reflect a meaningful rise in myocardial workload. Although metabolic oxygen consumption during sauna exposure remains substantially lower than during dynamic exercise, the hemodynamic demand placed on the heart can resemble moderate-intensity aerobic activity in terms of cardiac output.

Acute fluid loss results in transient reductions in plasma volume if hydration is not maintained. Hemoconcentration may occur during exposure, increasing blood viscosity and potentially influencing orthostatic tolerance immediately afterward. In healthy individuals, these shifts are typically reversible with rehydration. However, individuals who are dehydrated, sleep-restricted, or taking anti-hypertensive medications, transient dizziness, light-headedness, or presyncope symptoms may occur due to combined vasodilation and reduced circulating volume.

Acute blood pressure responses during sauna exposure are more dynamic. Peripheral vasodilation tends to lower systemic vascular resistance, and transient reductions in systolic and diastolic pressure may occur during recovery. Meta-analytic data examining short-term cardiovascular responses to sauna indicate modest acute decreases in blood pressure following exposure in some populations, though these effects vary depending on baseline cardiovascular status and medication use (11). Acute reductions are typically short-lived and should not be interpreted as permanent anti-hypertensive effects.

Autonomic nervous system activity shifts during heat exposure. Active heating requires sympathetic activation to coordinate cardiovascular adjustments, leading to reductions in heart rate variability (HRV) during exposure. Autonomic responses to passive heat stress are characterized by increased sympathetic tone during heating, with parasympathetic reactivation occurring during the recovery phase (7). These shifts are expected physiological responses to thermal stress rather than pathological findings. The long-term implications for autonomic regulation depend on repetition and baseline autonomic balance and cannot be inferred from a single exposure session.

Operational Translation: What This Means for Firefighters

- Sauna exposure is not a passive or neutral activity. Even though the body is not performing muscular work, the cardiovascular system is actively responding to thermal stress. Heart rate rises, cardiac output increases, blood vessels dilate, and fluid is lost through sweating.
- A sauna session places a measurable workload on the heart that can resemble moderate aerobic activity from a circulatory standpoint, even though metabolic demand remains low. For firefighters, this distinction matters because the cardiovascular system may already be elevated following suppression activity.
- After a fire response, heart rate, core temperature, and sympathetic nervous system activity are often already increased due to physical exertion, protective equipment, and environmental heat. Entering a sauna during that period effectively layers an additional thermal stimulus onto an already stressed physiological state.
- Under controlled conditions with adequate hydration and recovery, passive heat exposure may function as a manageable cardiovascular stimulus. However, when combined with dehydration, sleep restriction, or recent high-intensity fireground work, the same exposure can increase cumulative cardiovascular load and contribute to symptoms such as dizziness, orthostatic intolerance, or excessive fatigue.
- Understanding these responses helps clarify why timing, hydration, and recovery status become critical variables when considering sauna use within the fire service environment.

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From Acute Stress to Chronic Adaptation:

Repeated Heat Exposure and Cardiovascular Remodeling

The acute physiological responses described represent immediate protective adjustments to thermal stress. The scientific question that follows is whether repeated, structured exposure produces adaptation. Repeated passive heat exposure has been examined in both mechanistic trials and observational cohorts. While long-term randomized firefighter-specific outcome data does not exist, several lines of evidence from general populations suggest that repeated heat exposure can induce measurable cardiovascular remodeling.

One of the most consistently reported adaptations involves endothelial function. The endothelium regulates vascular tone, nitric oxide bioavailability, inflammatory signaling, and thrombosis. Impaired endothelial function is an early marker of atherosclerosis and cardiovascular disease. Systematic reviews of regular dry sauna exposure have reported improvements in vascular function markers consistent with enhanced endothelial responsiveness (6,3). Mechanistically, repeated vasodilation increases shear stress along the vascular wall, stimulating nitric oxide production and improving endothelial-dependent vasodilation.

Repeated sauna exposure has also been associated with reductions in resting blood pressure. A recent meta-analysis of randomized and quasi-experimental studies reported reductions in systolic blood pressure averaging approximately 5–8 mmHg following repeated sauna exposure protocols (4). At a population level, a 5 mmHg reduction in systolic blood pressure is associated with meaningful reductions in cardiovascular event risk. It is important to emphasize that these findings derive primarily from general populations and controlled study conditions. Nevertheless, the magnitude of change is physiologically meaningful.

Arterial stiffness represents another relevant target. Increased arterial stiffness elevates cardiac afterload and is associated with cardiovascular risk. Some controlled heat exposure studies have demonstrated reductions in arterial stiffness indices following repeated sauna sessions, suggesting improved vascular compliance (6,8). Improvements in vascular compliance reduce left ventricular workload and may contribute to improved hemodynamic efficiency.

Repeated heat exposure has also been associated with plasma volume expansion. While acute sessions reduce plasma volume through sweat loss, repeated exposures appear to stimulate compensatory expansion of circulating plasma volume over time. Plasma volume expansion increases stroke volume, reduces heart rate at a given workload, and enhances thermoregulatory efficiency. These adaptations are well described in heat acclimation literature and are mechanistically consistent with repeated sauna exposure protocols (2). For firefighters operating in hot environments, improved plasma volume status may enhance tolerance to thermal strain.

Autonomic regulation may also adapt with repetition. Acute heat exposure decreases heart rate variability (HRV) during heating due to sympathetic predominance. However, repeated heat exposure protocols have been associated in some populations with improvements in resting autonomic balance and parasympathetic activity during recovery phases (1,9). In a profession characterized by chronic sympathetic activation, even modest improvements in autonomic flexibility may be meaningful.

KEY POINT

The physiological value of sauna comes from repeated exposure over time, which may improve vascular function, blood pressure regulation, heat tolerance, and autonomic recovery.

Heat Shock Proteins

Beyond hemodynamic remodeling, repeated heat exposure activates cellular stress-response pathways that may contribute to systemic resilience. When core temperature rises sufficiently and remains elevated for a sustained period, heat shock factor-1 (HSF-1) becomes activated. HSF-1 translocates to the nucleus and upregulates transcription of heat shock proteins (HSPs), including members of the Hsp70 family such as Hsp72. Heat shock proteins function as molecular chaperones.

They stabilize unfolded or misfolded proteins, assist in protein refolding, and facilitate degradation of damaged proteins, thereby protecting cellular integrity during stress. Experimental work indicates that achieving sufficient internal temperature elevation is necessary to meaningfully stimulate HSP expression. Elevating core temperature into the range observed during controlled sauna exposure appears sufficient to activate components of this response. The magnitude of HSP induction is influenced by both temperature elevation and duration of exposure.

Intracellular Hsp72 is generally regarded as cytoprotective. It participates in modulating inflammatory signaling pathways and may reduce activation of pro-inflammatory cascades under certain conditions. Mechanistic reviews have described the potential for repeated heat therapy to reduce chronic low-grade inflammation and improve vascular health markers through overlapping pathways involving endothelial function and cellular stress adaptation (2).

Heat shock proteins are particularly relevant in the context of oxidative and inflammatory stress. Firefighters are exposed to repeated oxidative stress through environmental exposures, intermittent extreme exertion, sleep disruption, and sympathetic activation. While it would be inappropriate to claim that sauna "detoxifies" or eliminates these exposures, it is physiologically plausible that repeated controlled heat exposure may strengthen cellular stress-response capacity through HSP upregulation. It is critical, however, to maintain boundaries. Heat shock protein activation is an adaptive response to controlled stress. Excessive thermal strain, particularly when layered onto dehydration or cardiovascular instability, may overwhelm adaptive capacity rather than enhance it.

The distinction between hormetic stimulus (a controlled stressor that prompts the body to adapt and grow stronger, the same principle behind exercise) and harmful stress depends on dose and recovery.

Occupational Bridge: Chronic Adaptation in a High-Risk Population

Cardiovascular events remain the leading cause of line-of-duty death in the fire service. Firefighters exhibit elevated prevalence of hypertension, metabolic syndrome components, sleep disruption, and autonomic imbalance. Acute fire suppression activities produce rapid increases in heart rate, blood pressure, platelet activation, and arterial stiffness. The chronic adaptations associated with repeated sauna exposure such as improved endothelial responsiveness, reductions in resting blood pressure, enhanced vascular compliance, plasma volume expansion, and potential modulation of inflammatory pathways, may target mechanisms implicated in this risk profile (6).

This does not mean sauna prevents cardiac events. It does not replace fitness. It does not compensate for unmanaged hypertension or poor cardiorespiratory conditioning. What it suggests is more measured: when integrated appropriately within a comprehensive health framework, repeated controlled heat exposure may serve as a passive adjunct that supports vascular health and stress resilience.

Physiological logic is coherent. The magnitude of effect depends on frequency, dose, individual baseline health status, and recovery context. Before discussing protocol, governance, or operational application, it is essential to understand that the value of sauna exposure in this population derives from repeated structured exposure that produces adaptation, not from isolated sessions pursued for comfort alone.

Operational Translation: What This Means for Firefighters

- Heat adaptations do not occur after a single session, they gradually develop through repeated, structured exposure over weeks or months, similar to how cardiovascular adaptations develop with exercise training.
- Improvements in endothelial function, reductions in resting blood pressure, plasma volume expansion, and potential increases in heat shock protein expression all reflect cumulative physiological responses to repeated thermal stress.
- Value of sauna lies in consistent exposure that occurs under controlled conditions, not in occasional use immediately following high-intensity fireground activity. When applied appropriately, repeated heat exposure may act as a mild cardiovascular stimulus that complements fitness and overall health practices.
- Heat exposure layered onto dehydration, extreme fatigue, or unmanaged cardiovascular risk factors can shift from adaptive stimulus to unnecessary physiological strain. In practical terms, sauna should be understood as a long-term conditioning adjunct.

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Cardiovascular Risk in Firefighters and Interaction With Heat Exposure

Cardiovascular events remain the leading cause of line-of-duty death in the fire service, accounting for approximately 45% of on-duty fatalities annually; a proportion that has remained consistent across decades of surveillance data (1,3). Unlike traumatic fatalities, cardiovascular events often reflect the interaction between chronic underlying disease and acute physiological stress. Understanding how passive heat exposure intersects with this risk profile requires first understanding the baseline cardiovascular landscape of the profession.

Firefighters demonstrate elevated prevalence of hypertension, dyslipidemia, increased central adiposity, impaired glucose tolerance, and reduced cardiorespiratory fitness relative to optimal occupational standard (9). Even in physically capable personnel, subclinical atherosclerosis and endothelial dysfunction may be present (12). The occupational environment compounds this baseline risk through repeated episodic stressors.

During structural fire suppression, heart rate rises rapidly toward near-maximal levels within seconds of alarm response, blood pressure increases, and core temperature rises substantially under heavy protective gear (10,11). Platelet activation and transient increases in coagulation markers have been documented during and after suppression activities. Arterial stiffness has been shown to increase acutely following firefighting tasks, temporarily elevating cardiac afterload. Sympathetic nervous system activation predominates during emergency responses and may persist into recovery. These acute stressors occur in individuals who may already possess underlying cardiovascular vulnerability.

KEY POINT

Firefighters already operate under significant cardiovascular strain from underlying health risk and emergency response stress, so any additional heat exposure such as sauna must be considered within the context of this cumulative physiological load.

The risk is not simply heat, but heat layered onto preexisting vascular strain. When passive heat exposure is introduced into this context, its effects must be interpreted carefully.

Acute Interactions With Existing Cardiovascular Load

As previously described, dry sauna exposure can increase heart rate by approximately 30–35 beats per minute and cardiac output by more than 2 liters per minute. Peripheral vasodilation reduces systemic vascular resistance, and sweat loss approaches 1.2–1.5 lbs. (0.5–0.7 kg) under certain conditions. In normotensive, hydrated individuals, these responses are generally well tolerated.

However, in firefighters who are recently heat-stressed, dehydrated, or sympathetically activated, the addition of further vasodilation and plasma volume reduction may transiently increase cardiovascular instability. Orthostatic symptoms may become more likely. Individuals taking antihypertensive medications may experience exaggerated blood pressure reductions. Those with undiagnosed coronary artery disease may be more vulnerable during periods of combined tachycardia and reduced diastolic perfusion time. This does not imply that sauna exposure is unsafe in firefighters. However, it does emphasize that timing, hydration status, and baseline health matter. The same heat exposure that may stimulate adaptation in a rested, hydrated firefighter could represent additive strain in one who has just completed interior attack in high-heat conditions.

Chronic Adaptations and Risk Modification

At the same time, repeated controlled heat exposure has been associated in general populations with reductions in systolic blood pressure averaging approximately 5–8 mmHg, improvements in endothelial function, and favorable changes in vascular compliance (2,3,4,8). Observational data from long-term Finnish cohorts demonstrate associations between frequent sauna use and reduced cardiovascular mortality, including reduced risk of sudden cardiac death (4,6,7). While these associations cannot be assumed to transfer directly to firefighters, the directionality of effect is consistent with improved vascular resilience.

Improved endothelial responsiveness enhances nitric oxide-mediated vasodilation and may reduce chronic vascular inflammation. Lower resting blood pressure reduces left ventricular workload. Improved arterial compliance reduces afterload and mechanical stress on the heart.

Plasma volume expansion improves stroke volume and thermoregulatory capacity. These adaptations, if achieved, would theoretically increase tolerance to acute hemodynamic spikes during fire suppression.

The distinction between acute risk and chronic benefit is central. A single exposure increases cardiac workload transiently. Repeated structured exposure may remodel vascular function over time. The risk-benefit equation depends on whether sauna exposure is applied strategically as part of long-term conditioning or haphazardly layered onto already taxed physiology.

Sympathetic Activation, Autonomic Regulation, and Vulnerability in the Fire Service

The autonomic nervous system plays a central role in cardiovascular risk within the fire service. Firefighters operate in an environment defined by unpredictable alarm activation, rapid mobilization, circadian disruption, sleep fragmentation, and constant cognitive vigilance. When tones drop, the body prepares for immediate action. Heart rate increases, blood pressure rises, myocardial contractility strengthens, glucose is rapidly mobilized for energy, and blood flow is redirected away from non-essential vascular beds through peripheral vasoconstriction. These responses are designed to support rapid physical performance during emergency response. However, the occupational realities of the fire service mean that these physiologic reactions occur repeatedly and often without adequate recovery. Over time, this pattern can create a baseline state of elevated sympathetic nervous system activity in many firefighters. While these responses are highly adaptive during acute emergencies, the consequences change when sympathetic dominance becomes chronic rather than episodic.

Chronic sympathetic dominance has been associated with reduced heart rate variability (HRV), impaired baroreflex sensitivity, increased resting heart rate, endothelial dysfunction, and elevated cardiovascular event risk. Reduced HRV reflects diminished autonomic flexibility which means the ability to transition efficiently between sympathetic activation and parasympathetic recovery. In practical terms, it reflects a cardiovascular system that remains “on alert” even during periods that should be restorative.

Acute heat exposure introduces additional autonomic demand. During active heating, the sympathetic nervous system must increase activity to coordinate cutaneous vasodilation, sweating, and the cardiovascular adjustments necessary to maintain blood pressure and organ perfusion. As sympathetic influence rises, heart rate variability typically decreases during the heating phase. Passive heat exposure therefore produces a predictable autonomic pattern: sympathetic activation during heating followed by parasympathetic reactivation during the recovery period (10,11).

These responses are physiologically appropriate and represent the body’s normal reaction to thermal stress. The central question is not whether sympathetic activation occurs during sauna exposure, it does. The more important question is whether the individual possesses sufficient autonomic flexibility to restore parasympathetic balance efficiently after the exposure ends. In firefighters with preserved autonomic balance characterized by adequate sleep, good cardiorespiratory fitness, controlled blood pressure, and healthy metabolic status, the oscillation between sympathetic activation during heating and parasympathetic rebound during recovery may function as a hormetic stimulus. The cardiovascular system is challenged transiently and then allowed to recalibrate. Over repeated exposures, this pattern may enhance autonomic adaptability. Some evidence suggests that structured heat exposure protocols may improve indices of autonomic regulation during recovery phases, though data remain limited and population-specific (10,11).

In contrast, in firefighters operating in chronic sympathetic overdrive, additional sympathetic activation required during sauna exposure may represent additive strain rather than adaptive stimulus. If parasympathetic recovery is blunted due to baseline autonomic dysfunction, the individual may not return to baseline efficiently following exposure. Instead of oscillation, there is stacking. And stacking sympathetic load has consequences. Elevated resting heart rate increases myocardial oxygen demand. Reduced diastolic filling time during tachycardia can impair coronary perfusion, especially in individuals with subclinical coronary artery disease. Chronic autonomic imbalance contributes to vascular stiffness and arrhythmogenic vulnerability. In individuals with impaired autonomic regulation, acute stressors such as suppression activity or passive heat, may transiently increase arrhythmic susceptibility.

This is not theoretical speculation. Sudden cardiac events in firefighters often occur during or shortly after periods of intense exertion or acute stress. The underlying pathology is typically atherosclerotic cardiovascular disease layered with acute physiological triggers. Sympathetic surges, combined with transient hemodynamic instability, can precipitate events in susceptible individuals. Sauna exposure introduces another sympathetic surge.

In healthy individuals with intact autonomic flexibility, this surge is controlled and followed by parasympathetic reactivation. In vulnerable individuals, recovery may be incomplete. The difference lies not in the sauna itself but in the baseline autonomic state of the user.

Heart rate variability provides a useful conceptual model here. HRV reflects beat-to-beat variation in heart rate and serves as a surrogate marker of autonomic balance. Lower HRV has been associated with increased cardiovascular morbidity and mortality. Firefighters with high call volume, sleep disruption, and elevated occupational stress frequently demonstrate reduced HRV in observational work. If baseline HRV is already suppressed, additional sympathetic activation without sufficient recovery may exacerbate autonomic imbalance.

Importantly, this does not imply that sauna exposure should be avoided in individuals with autonomic vulnerability. It implies that context and monitoring matter. A firefighter using sauna immediately after interior attack, while dehydrated and sleep restricted, may experience cumulative sympathetic load.

The same firefighter using sauna off duty, hydrated, rested, and metabolically stable, may experience adaptive oscillation. Thus, the interaction between sauna exposure and cardiovascular risk is conditional. It depends on baseline autonomic tone, hydration status, blood pressure control, metabolic health, and timing relative to operational stress.

Heat exposure is neither inherently protective nor inherently harmful. It is a stressor. Whether that stress becomes adaptation or additive burden depends on the integrity of the recovery systems that follow.

For departments considering sauna integration, this section carries an important implication: the physiological benefit of heat exposure cannot be separated from broader wellness infrastructure. Sleep hygiene, hydration policies, blood pressure screening, and cardiorespiratory fitness standards influence whether sauna exposure functions as conditioning or cumulative strain. Understanding sympathetic activation and autonomic vulnerability clarifies why written governance, timing guidance, and eligibility considerations are not administrative excess. They are physiologically grounded safeguards in a profession where cardiovascular events remain the leading cause of line-of-duty death.

Operational Translation: What This Means for Firefighters

- Firefighters already operate under significant cardiovascular strain. Many personnel carry underlying risk factors such as hypertension, metabolic abnormalities, or early vascular dysfunction, and emergency response rapidly elevates heart rate, blood pressure, core temperature, and sympathetic nervous system activity.
- Additional heat exposure such as sauna is introduced, it is not acting on a resting body but on a cardiovascular system that may already be stressed from operational demands.
- Sauna use in the fire service must consider timing, hydration, and recovery status so that additional heat exposure supports recovery rather than compounding cumulative cardiovascular load.

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Infrared vs Dry Sauna:

Physiological Differences, Thermal Dose, and Cardiovascular Load

Infrared sauna and traditional dry sauna are often grouped together under the broad label of "heat therapy," yet they are not interchangeable exposures from a thermophysiological standpoint. The mechanism of heat delivery, the degree of internal heat accumulation, the magnitude of sweat loss, and the cardiovascular load imposed on the body differ in ways that are operationally meaningful for the fire service. These differences matter because the physiologic effect of sauna use is determined less by the fact that a person "feels hot" and more by the actual thermal dose delivered to the body.

Traditional dry sauna heats the surrounding air, typically within a range of approximately 158°F - 194°F (70–90°C), although the literature reports broader traditional sauna ranges extending from 113°F (45°C) to 212°F (100°C) depending on the setting and protocol. Heat transfer occurs primarily through convection and radiation from the heated air and surrounding surfaces. As ambient temperature exceeds skin temperature, heat is absorbed and progressively transferred inward. The body responds by increasing skin blood flow, stimulating sweating, and redistributing cardiac output toward the skin in an effort to maintain thermal homeostasis. In practical terms, traditional dry sauna is designed to raise internal heat storage. Traditional dry sauna bathing commonly occurs in environments around 176°F–212°F (80–100°C) with relatively low humidity, and that these conditions are associated with substantial cardiovascular and thermoregulatory responses (5).

In a study with the most direct thermophysiological comparisons, which compared dry sauna and far-infrared sauna under standardized conditions, dry sauna was delivered as three 10-minute bouts at a target setting of 176°F (80°C) with short thermoneutral breaks between bouts, whereas far-infrared sauna was delivered as a continuous 45-minute exposure beginning at 114°F (46°C) and gradually increasing to 149°F (65°C) (1). Despite both being classified as passive heat therapy, the internal physiologic response was meaningfully different. Traditional sauna increased core temperature by approximately 0.7°F (0.4°C), heart rate by approximately 34 beats per minute, and cardiac output by approximately 2.3 L/min above baseline. Sweat loss averaged approximately 1.45 lbs (0.66 kg) (1).

By contrast, far-infrared sauna increased heart rate by approximately 26 beats per minute and cardiac output by approximately 1.6 L/min, but produced little measurable rise in core temperature under that specific protocol, with lower sweat loss of approximately 0.85 lbs (0.39 kg) (1). These findings indicate that traditional dry sauna imposed the larger internal thermal dose and the greater cardiovascular burden.

That distinction is physiologically important. Cardiovascular strain scales closely with internal heat storage. As core temperature rises, cutaneous vasodilation intensifies, plasma volume shifts become more pronounced, and the heart must increase output to maintain blood pressure and organ perfusion while also supporting heat dissipation. Dry sauna therefore produces a larger thermoregulatory demand because it drives greater internal heat accumulation. Infrared sauna, under comparable exposure durations, may still feel hot and can still produce sweating, but the lower internal heat storage observed in controlled conditions suggests a more conservative hemodynamic profile. It could be concluded that far-infrared sauna is the least impactful of the passive heat modalities tested for raising core temperature and for eliciting downstream cardiovascular responses.

The difference between modalities is also seen in the more applied recovery literature, although those protocols are less thermo-physiologically rigorous. One study compared infrared sauna, dry sauna, warm water immersion, and passive recovery following submaximal exercise in athletes and non-athletes (5). Their infrared sauna was set at 113 ± 35°F (45 ± 2°C), while their "dry sauna" protocol used 104± 35°F (40 ± 2°C) for 20 minutes. In that study, body temperature was not significantly different across recovery modalities, and both infrared and dry sauna contributed to recovery-related outcomes in non-athletes (5). This study is useful for showing that both modalities can serve as thermal recovery tools, but it does not overturn the more detailed thermophysiologic comparison from the Atencio et al. (1) study described above because its "dry sauna" exposure was relatively mild and its primary outcomes were recovery markers rather than internal heat dose and cardiovascular load.

The firefighter-specific literature adds another layer. In a study done in firefighters, participants were assigned to a post-live-fire far-infrared sauna protocol showered first, then entered a 120°F (49°C) far-infrared sauna for 20 minutes, and then showered again immediately afterward (2). This protocol did not significantly raise core temperature, but it did increase heart rate during and after treatment, suggesting that even lower-temperature infrared sauna can add measurable cardiovascular stress following firefighting activity. The study arrived at a nuanced conclusion: far-infrared sauna may impose a lower internal heat dose than dry sauna, but it is not physiologically neutral, especially when layered onto recent fireground exertion.

Another operationally relevant difference between modalities involves heat shock and hormetic signaling. Experimental work indicates that meaningful activation of heat shock pathways depends on achieving sufficient internal temperature elevation for a sufficient duration (3). Although both sauna modalities may stimulate adaptive pathways to some degree, the larger core temperature elevations seen with traditional dry sauna suggest that it is more likely to provide a robust hormetic stimulus. This may be beneficial when the goal is vascular adaptation, heat acclimation, or cardiovascular conditioning.

At the same time, a stronger stimulus also means a greater requirement for hydration, recovery, and careful timing relative to operational heat strain.

From a mechanistic perspective, traditional dry sauna should therefore be understood as a higher thermal dose exposure, whereas infrared sauna is generally a lower thermal dose exposure under comparable durations. Neither modality is inherently superior. They simply impose different magnitudes of physiologic stress. For departments considering installation or governance, the decision is not cosmetic. It is a decision about internal heat accumulation, cardiac workload, plasma volume shifts, sweat loss magnitude, potential heat shock activation, and the total cumulative physiologic load placed on the firefighter. Traditional dry sauna may provide a stronger stimulus for vascular adaptation and heat acclimation when used appropriately and repeatedly. Infrared sauna may offer a more conservative profile when cardiovascular reserve is uncertain or when a department wishes to prioritize cautious on-duty access. The decision between modalities should therefore be framed in terms of physiological dose and intended objective, not preference or marketing language.

Summary Table: Infrared vs Traditional Dry Sauna

Feature	Dry Sauna	Infrared Sauna	Practical Meaning for Fire Service
Primary heat delivery	Heats ambient air; convection and radiation	Radiant heat to superficial tissues	Heat is experienced differently, and internal heat storage is not the same
Common temperature range in literature	158–194°F (70–90°C)	104–140°F (40–60°C)	Traditional sauna generally exposes firefighters to a higher ambient heat load
Core temperature response	Increased by ~.7°F (0.4°C)	Minimal measurable increase	Internal heat storage is greater in traditional dry sauna
Heart rate response	Increased by ~34 bpm	Increased by ~26 bpm	Both stress the cardiovascular system; traditional generally more so
Cardiac output response	Increased by ~2.3 L/min	Increased by ~1.6 L/min	Traditional dry sauna imposes greater circulatory demand
Sweat loss	~1.45 lbs (0.66 kg)	~0.85 lbs (0.39 kg)	Traditional sauna produces larger fluid shifts and may require greater hydration attention
Potential adaptive stimulus	Stronger hormetic / heat acclimation stimulus	Lower-dose thermal stimulus	Traditional may better support conditioning goals; infrared may better suit conservative on-duty access
Operational concern	Greater cardiovascular strain if layered onto recent suppression activity	Lower internal dose but still not physiologically neutral	Both require timing, hydration, and policy guidance

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Sauna Therapy for Detox in Firefighters:

What the Evidence Supports & What It Does Not

Within the fire service, the term "detox" is often used loosely. In scientific terms, however, two distinct processes must be separated if the discussion is going to remain credible. The first is exposure control, which refers to reducing ongoing contact with combustion byproducts through respiratory protection, gross decontamination, proper gear handling, showering, and station contamination control. The second is physiologic elimination, which refers to the body's internal processing and excretion of absorbed chemicals, typically evaluated through biomarkers in urine or blood. The firefighter sauna literature touches the second concept, but it cannot be interpreted without first acknowledging the primacy of the first.

Polycyclic aromatic hydrocarbons (PAHs) are among the most widely studied firefighter contaminants because they are common products of incomplete combustion and because they can be absorbed through multiple routes. PAHs can be absorbed by inhalation, skin contact, and ingestion, may accumulate in adipose tissue, and are subsequently metabolized and excreted in urine as hydroxylated PAH metabolites (OH-PAHs) (4). Urinary PAH-OHs are established biomarkers of short-term firefighter exposure, reflecting exposure through inhalation, skin contact, and ingestion (1). A systematic review reinforces that urinary hydroxylated PAH metabolites are the dominant biomonitoring approach in firefighter studies, precisely because PAH exposure occurs through multiple routes and the urinary signal reflects internal dose rather than environmental contamination alone (2).

That distinction matters because firefighter exposure is not limited to the fire scene itself. Firefighters could demonstrate increased urinary PAH biomarkers even during shifts without fire calls, with on-duty/no-fire shifts associated with an 8.2–8.3% increase in 2-hydroxyfluorene and a 37.7% increase in 1-hydroxypyrene compared with pre-shift levels (4). This serves as evidence that station-based or equipment-related exposure continues beyond active suppression, which is consistent with findings that PAHs were still detectable on "cleaned and ready-to-use" equipment.

A separate fire-station exposure study reported that airborne PAHs within fire stations may contribute meaningfully to firefighters' total PAH body burden (3). Taken together, these findings support an important premise for fire service leaders that exposure management is not just a fireground issue but a station environmental issue as well.

A study by Burgess published in 2020 is often cited in fire service conversations as evidence that sauna "works," but that interpretation needs to be refined. The strongest and most definitive finding in that study was not the sauna arm; it was the fireground exposure-control intervention. Tucson firefighters implemented a structured package that included SCBA use by engineers, wash-down of entry teams, isolation of contaminated equipment, and showering and washing of gear on return to station. Those changes significantly reduced mean total urinary PAH-OHs in engineers by 40.4% and in firefighters by 36.2% (1). These are powerful findings because they demonstrate that reducing exposure at the source meaningfully reduces internal biomarker burden.

The sauna portion of this study was a separate randomized pilot conducted after live-fire training in Scottsdale firefighters. After two burn-building evolutions, firefighters completed standard rehab and decontamination, showered, and then those randomized to treatment entered a far-infrared sauna at 120°F (49°C) for 20 minutes, wearing station PT clothing, sitting on clean towels, and showering again immediately afterward. Urinary PAH metabolites were then measured using 12-hour pre-exposure and 12-hour post-exposure composite urine samples. The sauna group showed a 43.5% lower geometric mean of total urinary PAH-OHs compared with controls after 12 hours, but this difference was not statistically significant, and the authors explicitly concluded that further evaluation of infrared sauna treatment is needed (1).

That is the correct interpretation of the Burgess study. The study does not prove that sauna independently detoxifies firefighters. It does show, however, that a structured post-exposure infrared sauna workflow, embedded within showering and decontamination, may be associated with lower urinary PAH biomarkers. The mechanism, however, remains unresolved. Because subjects showered before and after sauna, it is difficult to determine whether the observed signal was related to sweat-mediated elimination, altered dermal contamination dynamics, enhanced circulation, or the simple benefit of a tightly sequenced hygiene protocol. The author raises this uncertainty and does not claim a definitive detox mechanism.

A follow-up study by Saber published in 2025 reported much stronger data supporting sauna use for detox in firefighters because it did find a meaningful reduction in urinary PAH biomarkers (4). The study recruited 26 firefighters from three Danish stations and tested three different intervention strategies: sauna, improved fire suits, and showering. The sauna intervention required firefighters to shower after returning from a fire call and then sit in a dry sauna for 15 minutes at 176°F (80°C). Investigators measured both dermal PAHs using neck skin wipes and internal PAH dose using urinary OH-PAH biomarkers.

The sauna intervention significantly reduced several urinary biomarkers. In the study's two statistical models, sauna reduced hydroxyfluorene by about 28–33%, hydroxylated phenanthrenes by about 33–35%, and 1-hydroxypyrene by about 37%, with hydroxylated naphthalenes significantly reduced in one of the two models (4). The author's conclusion was clear: the sauna intervention significantly reduced urinary PAH metabolites, with the largest reduction observed in 1-hydroxypyrene.

At the same time, the author complicates simplistic detox narratives in two useful ways. First, the sauna intervention reduced urinary biomarkers while dermal PAH exposure remained unaffected, meaning the signal likely reflects something more complex than simply "washing contaminants off the skin." Second, standard showering alone significantly reduced dermal PAHs by 63.9%, yet the dedicated "shower intervention" did not significantly reduce urinary PAH metabolites. This suggests that surface decontamination and internal biomarker reduction are related but not identical phenomena. Sauna may be interacting with physiology or timing in ways that are not yet fully explained, but the study does not prove that sweat is the primary elimination route.

What the Two Firefighter Studies Support Together

When the two studies are interpreted together, a balanced picture emerges. The strongest evidence remains source control and exposure reduction. The Burgess study demonstrates that operational contamination-control measures materially reduce urinary PAH biomarkers in firefighters. The Saber study reinforces that decontamination and equipment management matter because dermal contamination increases sharply after fire calls, cleaned equipment can still carry PAHs, and firefighters may be exposed even during non-fire shifts.

At the same time, both firefighter studies suggest that sauna may have a role as a structured adjunct within a broader post-exposure sequence. The far-infrared sauna protocol was associated with a sizeable but non-significant reduction in urinary PAHs after live-fire training. And a 15-minute 176°F (80°C) sauna after showering significantly reduced several urinary PAH biomarkers. This is not enough to claim that sauna independently detoxifies firefighters, but it is enough to justify a more nuanced and clinically honest statement: when embedded in structured hygiene and contamination-control workflows, sauna may influence internal PAH biomarker levels in firefighters.

Study	Population	Sauna Protocol	Primary Biomarkers	Main Findings
Burgess 2020	Arizona firefighters; live-fire training and separate fireground intervention work	Far-infrared sauna, 120°F(49°C), 20 min, after shower, followed by second shower	10 urinary PAH-OHs, including 1-hydroxypyrene	Sauna group had 43.5% lower total urinary PAH-OHs vs control, but not statistically significant.
Saber 2025	26 Danish firefighters from 3 stations; repeated-measures intervention study	Dry sauna, 176°F (80°C), 15 min, after shower following fire call	Urinary OH-PAHs + dermal neck wipes	Sauna significantly reduced urinary 2-OHFLU, ∑OHPHE, and 1-OHPYR (~37%); Dermal PAHs remained unaffected.

Operational Translation: What This Means for Firefighters

- Firefighter PAH exposure can occur outside of active fire responses, including through contaminated gear, equipment, apparatus, and the station environment.
- Some firefighter studies show lower urinary PAH biomarkers when sauna is used after showering, suggesting a potential role within a structured post-exposure workflow.
- Sauna is best viewed as a supplementary recovery or exposure-management tool, not a replacement for core contamination-control practices.
- If departments implement sauna programs, they should be integrated into a broader hygiene and recovery protocol and governed by clear operational policies.
- Preventing contaminant absorption remains the most effective "detox strategy." Sauna, if used, should occur downstream of exposure control and decontamination procedures rather than replacing them.

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Sauna, Mental Health, and
Psychological Recovery

The preceding sections of this briefing have described the physiological demands of the fire service in measurable terms: elevated sympathetic nervous system activity, sleep fragmentation, circadian disruption, reduced heart rate variability, and cumulative cardiovascular load. These are documented biological consequences of sustained occupational stress. What the physiological literature alone does not capture is the psychological dimension that accompanies them and that, in many cases, compounds them.

Firefighters operate in an environment defined by repeated exposure to traumatic incidents, unpredictable alarm activation, shift-based sleep disruption, and the sustained cognitive vigilance required by a profession where critical decisions occur under time pressure. Over time, the occupational stress burden carried by many firefighters extends beyond acute physiological responses and into patterns of anxiety, emotional fatigue, and psychological strain that the fire service has historically underaddressed. These patterns are not incidental to the physiological picture described elsewhere in this briefing. Chronic psychological stress and chronic sympathetic nervous system activation share the same neurobiological substrate. The autonomic imbalance, reduced parasympathetic recovery, and blunted heart rate variability discussed in the cardiovascular risk section are equally features of prolonged occupational psychological stress.

Understanding this connection matters when evaluating sauna's potential role in firefighter health, because three peer-reviewed studies now examine sauna's associations with psychological and neurological outcomes in ways that extend meaningfully beyond the cardiovascular literature. An important qualification applies to everything that follows: none of these studies were conducted in firefighter populations. Their findings cannot be assumed to transfer directly to individuals operating under the specific physiological demands of the fire service. They are discussed here because the direction of evidence is consistent, the study designs are among the strongest available in this domain, and the questions they address such as those on acute psychological recovery, long-term mental health resilience, and brain health over decades, are directly relevant to the occupational context of firefighting.

A recent study investigated the physical and mental health effects of sauna use across three studies involving 1,907 participants in the United Kingdom (1). The research applied the Social Cure model which is a framework demonstrating that social group membership protects health through mechanisms of belonging, shared identity, and access to social resources.

Across all three studies, the findings were consistent. In Study 1, a longitudinal pre-post design in which 33 participants completed a validated questionnaire on how they felt before and after a traditional sauna session, wellbeing scores improved significantly following exposure. In Study 3, a separate longitudinal pre-post design with 74 participants at a sauna event, subjective reports of positive feelings increased significantly following exposure, while feelings of subjective distress and psychological burden decreased with a large, statistically significant effect. In Study 2, an analysis of 1,798 participants, weekly sauna attendance was significantly associated with self-reported mental health improvements, and that association was partially mediated through a sense of social belonging (1). The indirect pathway through belonging was particularly robust in predicting mental health outcomes suggesting that the relational dimension of communal sauna use may contribute independently to its psychological effects.

At a mechanistic level, the research demonstrated that among participants who were more strongly bonded to their sauna community, the experience of emotional synchrony, sharing the same emotional and physical state with others during the session, fully mediated the relationship between social connection and improved positive affect following exposure (1). Participants who perceived the sauna experience as ritually meaningful and emotionally connected with others showed the greatest post-session improvements in affect.

Peer connection and social cohesion are consistently identified as protective factors against occupational psychological injury in high-stress professions. The Social Cure model suggests that the shared experience of enduring a demanding physical environment alongside colleagues may generate psychological benefits that exceed what heat exposure alone would produce. In a professional context where unit cohesion and peer belonging already function as buffers against occupational stress, this pathway is not unfamiliar, it is a dimension that sauna, when used communally, may be positioned to support.

Long-Term Psychological Resilience: Psychotic Disorders Over 25 Years of Follow-Up

A 2018 study examined the prospective association between sauna bathing frequency and the risk of psychotic disorders in 2,138 Finnish men for a median of nearly 25 years and documented who developed psychotic disorders over that time (2). Men who used the sauna four to seven times per week had approximately 77% lower risk of developing a psychotic disorder compared to men who used it only once a week. It's important to note that the association held up after the researchers adjusted for age, body weight, smoking, diabetes, heart disease, education, cholesterol, alcohol, socioeconomic status, physical activity, and inflammation (2). It did not change when they also adjusted for how long each sauna session lasted or how hot it was. The finding was consistent across every subgroup they examined (2).

The authors proposed several mechanistic pathways through which regular sauna exposure may influence psychosis risk. Chronic sauna use appears to reduce circulating cortisol which is the primary stress hormone, by as much as 10 to 40%, directly blunting the hypothalamic-pituitary-adrenal axis activity that has been strongly implicated in psychotic symptom development and exacerbation (2). Repeated sauna exposure also reduces markers of oxidative stress and systemic inflammation, both of which have been associated with the pathophysiology of psychotic disorders (2). Additionally, the regularity and social context of sauna participation may reduce isolation and foster connection, factors independently associated with reduced psychosis risk (2).

The caveats to this study are important to mention. This study was conducted in Finnish men only. The definition of psychotic disorders used in the study was broad and included some dementia-related psychosis. It is an observational study, meaning it shows association and not proof of cause and effect (2). The authors also acknowledged that some men who were already developing mental health problems early might have stopped using the sauna, which could account for part of the difference.

Brain Health Over the Long Term: Dementia Risk Across 39 Years

A separate study examined dementia specifically in 13,994 Finnish men and women followed for 39 years, with 1,805 dementia cases diagnosed over that period (3). This is the largest and longest study of sauna and brain health in the literature. People who bathed about three times per week (nine to twelve sessions per month) had a 19% lower risk of dementia over the full 39-year follow-up compared to those bathing four or fewer times per month (3). During the first 20 years, that difference was far more pronounced: people bathing three times per week had about half the dementia risk of those who bathed infrequently (a 53% reduction) (3). That association was not changed when the researchers accounted for age, gender, education, physical activity, smoking, alcohol, blood pressure, or metabolic health factors (3). It was observed equally in men and women.

The study also identified an important dose boundary with direct governance relevance. Participants bathing at temperatures of 212°F (100°C) or above demonstrated a doubled dementia risk during the first 20 years of follow-up compared to those bathing below 176°F (80°C) (3). The most favorable temperature range for dementia protection was 176–210°F (80–99°C). This finding reinforces the principle established throughout this briefing, that passive heat exposure operates within a therapeutic range, and that excessive thermal dose represents a qualitatively different physiological stimulus with potentially adverse rather than protective consequences.

The mechanisms proposed by the investigators are consistent with findings discussed elsewhere in this briefing. Heat shock proteins, activated by the core temperature elevation associated with sauna exposure, play a recognized role in protecting against the protein misfolding and aggregation that underlie Alzheimer's disease and related neurodegenerative conditions (3). Improvements in endothelial function and cerebral blood flow resulting from repeated passive heat exposure may reduce vascular contributions to cognitive decline. Longitudinal associations between sauna bathing and reduced systemic inflammation may attenuate neuroinflammatory processes implicated in neurodegenerative disease progression (3). The sleep-promoting effects of passive body heating, the stress reduction associated with regular sauna participation, and the social contact and cognitive engagement that accompany habitual use may each contribute additional protective influence (3).

Occupational Bridge: What This Evidence Means for Firefighters

Taken together, these three studies describe a pattern that is consistent across acute, medium-term, and long-term time frames. Regular sauna exposure is associated with measurable improvements in emotional wellbeing and reductions in negative affect in the near term (1); with substantially reduced risk of psychotic disorders across nearly 25 years of prospective follow-up (2); and with reduced dementia incidence across a 39-year longitudinal window (3). The mechanistic pathways proposed across all three studies converge on physiological processes already established in this briefing: cortisol and inflammatory regulation, autonomic modulation, sleep architecture, and the neurological consequences of chronic stress.

The fire service context does not change what these studies found. It does, however, change how they should be interpreted. Firefighters carry a psychological and physiological burden that differs meaningfully from the Finnish general population cohorts on which much of this evidence is based. Sleep disruption in the fire service is common, and the sympathetic nervous system activation is constant, frequent, and cumulative. The psychological weight of repeated traumatic exposure is not equivalent to the everyday stressors faced by participants in observational cohort studies. These differences mean that the magnitude of potential benefit, and the conditions under which that benefit would be realized, cannot be assumed to mirror what these studies observed.

Sauna is not a treatment for post-traumatic stress, occupational depression, or any clinical mental health condition. It does not replace peer support programs, professional behavioral health resources, or clinical intervention. Departments that invest in sauna equipment should not position it as a mental health solution, and no individual should interpret access to a sauna as a substitute for professional care when that care is needed.

What the evidence supports is a more circumscribed role: sauna, used regularly and in the company of colleagues, may serve as one component of a comprehensive recovery strategy that supports psychological decompression, social connection, and the long-term neurological resilience that the cumulative demands of this profession place at ongoing risk.

Operational Translation: What This Means for Firefighters

- Three peer-reviewed studies report associations between regular sauna use and improved emotional wellbeing following sessions, reduced risk of psychotic disorders, and reduced dementia incidence. None were conducted in firefighters. None establish causation. The findings are consistent and biologically plausible.
- The mental health benefits observed in these studies were more strongly mediated through feelings of social belonging and shared experience than through the heat itself. Regular sauna use with colleagues may engage pathways that isolated sauna use does not.
- Sauna is not a treatment for PTSD, depression, or any clinical mental health condition. It does not substitute for behavioral health services, peer support programs, or professional mental health care.
- Regular sauna use may contribute one component of a broader recovery strategy: supporting psychological decompression, reducing negative affect following operationally demanding shifts, and potentially contributing to long-term neurological resilience in a profession that places both at sustained risk.

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Sauna Protocols
Used In Research

Understanding how sauna exposure has been studied in scientific literature requires recognizing that research protocols are designed to deliver controlled thermal stimuli under stable conditions. Investigators manipulate variables such as temperature, duration, frequency, and recovery conditions in order to measure physiological responses with precision. These protocols are not designed to mirror the operational environment of fire stations, but rather to isolate how passive heat exposure affects cardiovascular function, thermoregulation, and metabolic processes.

Much of the foundational sauna literature originates from Finland, where sauna bathing is deeply embedded in cultural practice and has been examined in large population cohorts. Traditional Finnish sauna exposure typically occurs in dry saunas heated to approximately 176–212°F (80–100°C) with relatively low humidity levels around 10–20% (7). Importantly, the temperature reported in these studies is usually measured at head height, meaning that temperature at lower bench levels may be significantly cooler. Bench height, ventilation, and humidity adjustments, such as pouring water onto sauna stones, can influence the perceived heat stress and the physiological load experienced during a session.

KEY POINT

Sauna temperature reported in research studies represents ambient air temperature at measurement height, not the exact thermal dose experienced by the individual. Bench height, humidity changes, and ventilation can substantially alter physiological stress even when the reported temperature remains the same.

In terms of duration, research consistently describes sauna exposure as short, episodic bouts of heating rather than prolonged continuous exposure. Review literature commonly reports exposure durations between 5 and 20 minutes, with the exact duration determined by tolerance and comfort (1,7). Time spent in heat is a critical determinant of internal heat storage. As the body accumulates heat, core temperature rises, peripheral vasodilation increases, heart rate accelerates, and sweat losses accumulate. These physiological responses collectively determine the cardiovascular workload generated by the session.

Large cohort studies also provide insight into habitual sauna use patterns. In the Kuopio Ischemic Heart Disease cohort, which followed more than two thousand Finnish men over several decades, the average sauna session lasted approximately 14 minutes, and most participants reported sauna use two to three times per week, with some individuals bathing more frequently (6). The long-term cardiovascular outcome data derived from this cohort reflect consistent repeated exposure over years, rather than sporadic sauna use.

Outside of large observational cohorts, experimental research often employs standardized intervention protocols designed to measure acute physiological responses to passive heat exposure. A meta-analysis examining the cardiovascular effects of sauna bathing reported that acute exposure typically produces a core temperature increase of approximately 0.5°C (≈1°F) and an increase in heart rate of roughly 18 beats per minute. The same analysis observed modest acute reductions in both systolic and diastolic blood pressure following sauna sessions (2). These responses indicate that sauna bathing places a measurable circulatory demand on the body that resembles moderate aerobic activity from a cardiovascular perspective, despite relatively low metabolic workload.

Infrared sauna protocols differ from traditional Finnish sauna exposures in both temperature and mechanism of heat delivery. A frequently cited clinical protocol is Waon therapy, which utilizes far-infrared heating at approximately 60°C (140°F). Participants typically remain in the sauna for about 15 minutes, followed by a period of warm resting recovery intended to maintain elevated body temperature (3,4). Compared with traditional dry sauna exposures, infrared protocols generally operate at lower ambient temperatures while relying on radiant heat to warm superficial tissues.

Comparative thermoregulation studies demonstrate that these modalities produce different physiological responses. Traditional dry sauna exposure tends to generate greater elevations in core body temperature and higher sweat losses, whereas infrared sauna exposure typically produces more modest increases in core temperature but still elevates heart rate and peripheral circulation (5).

These differences reflect distinct mechanisms of heat transfer. Dry sauna primarily heats the surrounding air, which then transfers heat to the body through convection and radiation, while infrared systems deliver radiant energy directly to the skin surface. When examining sauna research collectively, it becomes clear that "protocol" does not represent a single universal formula. Instead, it represents a controlled attempt to deliver a reproducible thermal dose.

Temperature, exposure duration, session frequency, and recovery conditions are deliberately manipulated to generate measurable physiological responses. Because these studies are conducted in controlled environments with stable baseline physiology, the protocols described in the literature should be understood as maps of how heat exposure has been tested scientifically, rather than operational guidance for occupational settings.

Table: Sauna Protocols Used in Research Studies

Study	Heat Modality	Temperature	Duration	Frequency	Key Findings
Laukkanen et al. (7)	Dry sauna	176 - 212°F (80–100°C)	14 minutes	2–7 sessions/week	Higher sauna frequency associated with reduced cardiovascular mortality
Laukkanen & Laukkanen (6)	Dry sauna	176 - 212°F (80–100°C)	5–20 minutes	Habitual weekly exposure	Increased heart rate, vasodilation, and sweating
Hussain & Cohen (2)	Dry sauna	176 - 194°F (80–90°C)	5–20 minutes	Acute sessions	↑ HR ~18 bpm, ↑ core temp ~0.5°C, ↓ blood pressure
Kihara et al. (4)	Far-infrared sauna	140°F (60°C)	~15 minutes	Repeated sessions	Improved cardiac output and circulation
Imamura et al. (3)	Far-infrared sauna	140°F (60°C)	~15 minutes	Repeated sessions	Improved endothelial function
Kukkonen-Harjula & Kauppinen (5)	Dry vs infrared	Dry Sauna 176 - 194°F (80–90°C); Infrared 104–140°F (40–60°C)	10–20 minutes	Experimental	Dry sauna produces greater sweat loss and core temp rise

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Why Research Protocols Do Not Translate **Directly to the Fire Station**

It is tempting to interpret sauna research protocols as ready-made guidance for operational use. Temperature, duration, and frequency are often presented in a way that suggests a simple and transferable formula. However, research protocols are designed to control variables, whereas the fire station environment is defined by variable and often unstable conditions. When the factors that determine thermal dose, cardiovascular load, and recovery capacity are inconsistent, the same "protocol" no longer represents the same physiological exposure, and the same outcomes cannot be assumed to transfer.

In controlled studies, participants typically begin sauna exposure under standardized baseline conditions. Subjects are generally hydrated, have not recently undergone acute heat stress, and are not operating under conditions of sleep deprivation or sympathetic overactivation. Many protocols also include structured recovery periods following heat exposure. For example, Waon therapy protocols incorporate approximately 15 minutes of infrared sauna exposure followed by a supervised recovery period under warm conditions to stabilize hemodynamic responses and support thermal unloading (5,6). Similarly, meta-analytic work examining sauna interventions often includes defined rest periods of 20–30 minutes following exposure, which influence cardiovascular recovery and autonomic rebalancing (4). These recovery conditions are not incidental. They are part of the physiological stimulus being studied.

In contrast, the fire station environment rarely allows for controlled recovery. Firefighters may exit a sauna session and immediately return to duty, respond to an alarm, or re-enter a high-intensity operational environment. This interruption alters the physiological meaning of the exposure. The cardiovascular system may still be in a vasodilated, fluid-shifted state when additional stress is imposed, increasing cumulative load.

Thermal dose is another point of divergence. In research, thermal dose is carefully controlled through consistent combinations of temperature, duration, and environmental conditions. In practice, thermal dose is influenced by a broader set of variables, including bench height, humidity, ventilation, and individual physiology at the time of exposure (8).

At the fire station, the same nominal protocol can represent a fundamentally different exposure. Firefighters may begin a sauna session already warm from personal protective equipment (PPE) use, dehydrated from prior calls, sleep-restricted, or sympathetically activated. Fire suppression activities have been shown to produce rapid increases in heart rate, core temperature, and cardiovascular strain, often approaching near-maximal levels during active operations (3,9). Entering a sauna in this state is not equivalent to entering a sauna from a rested baseline. The body is already closer to its physiological limits, and additional heat exposure represents layered stress rather than isolated stimulus.

Hydration status further complicates translation. Even under controlled laboratory conditions, passive heat exposure produces measurable fluid loss. In thermoregulatory comparisons, dry sauna exposure has been associated with sweat losses of approximately 1.45 lbs (0.66 kg), while infrared sauna produces lower but still meaningful losses (1). In a fire service context, these losses may occur on top of existing dehydration from operational demands. Reduced plasma volume can contribute to hemoconcentration, orthostatic instability, and increased cardiovascular strain. A protocol that is safe under hydrated conditions may become unstable when layered onto dehydration.

Population differences also limit direct translation. Much of the long-term outcome data comes from Finnish cohorts where sauna use is habitual, consistent, and integrated into daily life, often occurring multiple times per week over decades (7). Fire station sauna use, by contrast, is often sporadic and influenced by shift schedules, station culture, and operational demands. Sporadic exposure may provide intermittent physiological stress without sufficient repetition to induce the chronic adaptations observed in cohort studies.

Finally, the intended purpose of research protocols differs from the purpose of station governance. Research protocols are designed to answer specific physiological questions under controlled conditions. Station governance is designed to reduce risk, maintain operational readiness, and protect personnel. Even when a protocol demonstrates favorable outcomes such as reduced blood pressure or improved vascular function, it does not follow that the same protocol should be implemented on duty. Instead, the protocol provides insight into dose-response relationships, which must then be interpreted within the context of operational risk.

For these reasons, research protocols should be understood as an evidence map rather than an implementation template. They demonstrate what passive heat exposure can do under controlled conditions. They do not define what sauna use should look like in an operational environment where heat stress, hydration, recovery, and readiness are continuously changing. Translating sauna research into the fire service requires not replication, but interpretation and governance.

Operational Translation: What This Means for Firefighters

- Sauna research does not reflect fire station conditions. Studies are conducted in controlled environments with hydrated, rested participants and structured recovery periods, which is fundamentally different from the unpredictable, high-stress nature of on-duty firefighting.
- A firefighter's starting condition determines the risk. Entering a sauna already heat-stressed, dehydrated, or fatigued from suppression activity significantly increases cardiovascular strain compared to entering in a rested, recovered state.
- Heat is cumulative, not isolated. Sauna exposure layered on top of recent fireground stress adds to total physiological load, which can either support recovery or compound strain depending on timing, hydration, and recovery status.
- Protocols from research are not operational guidelines. Sauna use in studies is designed to control dose and produce adaptation over time, whereas on-duty use must prioritize recovery, readiness, and safety rather than replicating research-based exposure patterns.

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Interpreting Sauna Use in the

Fire Station Environment

The preceding sections establish two critical points. First, sauna research describes controlled thermal exposures that produce measurable physiological responses under stable conditions. Second, those conditions do not directly translate to the fire station. The next step is not to replicate research protocols, but to interpret what sauna exposure means within the operational reality of firefighting.

Firefighters operate within a physiologically demanding environment characterized by episodic high-intensity exertion, environmental heat exposure, dehydration risk, sleep disruption, and sustained sympathetic activation. Structural fire suppression has been shown to produce rapid elevations in heart rate, often approaching near-maximal levels, along with increases in core temperature, blood pressure, and markers of coagulation and vascular strain (2,6). These responses do not immediately return to baseline following the end of a call. Residual physiological strain may persist into the recovery period.

When sauna exposure is introduced into this context, it must be understood as an additional thermal and cardiovascular stimulus layered onto an already elevated baseline. Passive heat exposure increases heart rate, cardiac output, and peripheral vasodilation while promoting fluid loss through sweating (3,5). From a circulatory standpoint, sauna exposure can resemble moderate aerobic activity despite low metabolic demand. In isolation, this stimulus may be well tolerated. In a firefighter who is already heat-stressed or dehydrated, it represents cumulative load.

The concept of cumulative load is central to interpreting sauna use in the fire service. Each stressor (fire suppression, sleep disruption, dehydration, and passive heat exposure) places demand on the same cardiovascular and thermoregulatory systems. When these stressors are appropriately spaced and recovery capacity is sufficient, adaptation may occur. When they are layered without adequate recovery, physiological strain accumulates. This distinction explains why the same sauna session may function as a recovery modality in one context and as an added stressor in another.

Hydration status is a critical determinant of this balance. Passive heat exposure produces measurable fluid loss even under controlled conditions, with studies demonstrating sweat losses approaching 0.88–1.5 lbs (0.4–0.7 kg) per session depending on modality and duration (1).

In firefighters, these losses may occur on top of existing dehydration from operational demands. Reduced plasma volume contributes to hemoconcentration, decreased stroke volume, and increased cardiovascular strain. In this state, sauna exposure may increase the likelihood of orthostatic symptoms, fatigue, or impaired tolerance to subsequent exertion.

Timing relative to suppression activity further modifies the risk–benefit profile. Following a fire response, firefighters may present with elevated heart rate, residual core temperature elevation, sympathetic predominance, and reduced plasma volume. Introducing additional heat exposure during this window increases total cardiovascular demand. While a fit and well-hydrated firefighter may tolerate this additional load, individuals with underlying cardiovascular risk factors such as hypertension, reduced cardiorespiratory fitness, or subclinical atherosclerosis, may experience a higher degree of strain (4). The physiological question is not whether sauna is beneficial in general, but whether it is being applied at a time when the body can respond adaptively.

Autonomic regulation also plays a role in how sauna exposure should be interpreted. Acute heat exposure requires sympathetic activation to support vasodilation and thermoregulation, resulting in temporary reductions in heart rate variability during heating (3). Recovery following sauna exposure may involve parasympathetic reactivation. However, in the fire station environment, recovery may be interrupted by alarm response or operational demands. If parasympathetic recovery is truncated, the intended oscillation between stress and recovery may not occur as expected.

For these reasons, sauna use in the fire station should be framed in terms of purpose and context, rather than attempting to replicate research protocols. Off-duty sauna use may be oriented toward progressive exposure and potential cardiovascular adaptation, reflecting patterns observed in cohort studies where repeated exposure is associated with improved vascular function and reduced cardiovascular risk (4).

On-duty sauna use, by contrast, must prioritize recovery, readiness, and risk management.

This distinction leads to a practical framework for interpretation. Sauna exposure may be most appropriate on duty when applied under conditions that support physiological stability: adequate hydration, sufficient time elapsed since suppression activity, absence of immediate response expectations, and conservative exposure duration.

In this context, the objective shifts away from maximizing thermal dose and toward supporting circulation, promoting relaxation of peripheral vasculature, and facilitating recovery processes.

Ultimately, the value of sauna in the fire service is not determined solely by temperature or duration, but by how it is integrated into the broader physiological and operational context of the firefighter. When applied with awareness of cumulative load, hydration status, and timing relative to suppression activity, sauna may serve as a useful adjunct within a comprehensive recovery strategy. When applied without regard to these factors, it risks becoming an additional stressor layered onto an already demanding profession.

Operational Translation: What This Means for Firefighters

- Fire suppression already elevates heart rate, core temperature, and cardiovascular strain. Entering a sauna on top of that is an additional stressor, not a separate or neutral activity.
- A firefighter's condition going into the sauna determines whether it helps or hurts. Hydration status, recovery from the last call, sleep, and current fatigue level all influence whether sauna exposure supports recovery or compounds strain.
- Using the sauna too soon after suppression or while still heat-stressed, dehydrated, or sympathetically activated, can increase cardiovascular load, whereas using it after adequate recovery may support circulation and relaxation.
- On duty, sauna is for recovery. It should be applied conservatively, with the priority being operational readiness, safety, and maintaining the ability to respond effectively.

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Elements of Fire Station Governance and Written Policy

The growing interest in sauna use within the fire service reflects an increasing awareness of recovery practices, cardiovascular health, and occupational exposure management. However, introducing sauna use into the fire station environment requires more than simply installing equipment. Sauna exposure represents a controlled physiological stressor that produces meaningful cardiovascular, thermoregulatory, and fluid balance responses. When implemented without clear governance, sauna use can quickly shift from a structured recovery practice into an unregulated activity with inconsistent safety practices and unclear operational boundaries.

Fire departments routinely manage operational risks through written policies that define expectations, responsibilities, and safety parameters. Apparatus operations, training evolutions, and rehabilitation during emergency incidents are all governed through structured procedures for this reason. Sauna use should be approached in the same manner. A clearly defined governance framework ensures that sauna exposure remains consistent with firefighter safety, operational readiness, and departmental risk management practices.

Several foundational elements should be addressed when departments consider sauna use in the station environment.

First, departments should clearly define the purpose of sauna use within the organization. Sauna may be used as a voluntary recovery modality, as part of broader wellness initiatives, or as a supportive component of hygiene practices following fireground exposure. Establishing a defined purpose prevents misunderstandings and avoids exaggerated claims regarding detoxification or disease prevention. Clear purpose also ensures that sauna use aligns with departmental health and wellness objectives rather than becoming an informal recreational activity.

Second, governance should address eligibility and voluntary participation. Sauna exposure produces meaningful cardiovascular strain through increased heart rate, peripheral vasodilation, and fluid loss through sweating. These responses are normal physiological adaptations but may not be appropriate for every individual in every circumstance. Written policy should therefore emphasize voluntary participation, encourage individual responsibility for self-assessment of health status, and identify conditions where caution or avoidance may be appropriate.

Third, departments should define exposure boundaries that establish reasonable safety parameters. Research protocols commonly define temperature ranges, exposure durations, and rest intervals to maintain controlled heat exposure conditions. While fire station environments differ from laboratory settings, departments still benefit from establishing general boundaries that guide safe use. These limits function as safety guardrails rather than performance targets and help prevent excessive exposure durations or unsafe temperature conditions.

Fourth, governance must consider operational readiness. Firefighters must remain capable of responding immediately to emergency calls while in the station environment. Sauna use therefore requires consideration of response procedures, rapid exit capability, and proximity to apparatus or turnout gear. Policies should emphasize that operational readiness always takes precedence over sauna exposure and that use should never interfere with response capability.

Fifth, policy should address timing relative to fireground activity and physical exertion. Firefighters may already experience significant thermal strain during structural firefighting operations. Adding passive heat exposure immediately following intense suppression activity may compound physiological stress if adequate cooling and hydration have not occurred. Governance should therefore encourage consideration of recovery time, hydration status, and individual readiness before entering a sauna environment.

Finally, departments should establish oversight, maintenance, and documentation practices. Equipment inspection, maintenance responsibilities, and incident reporting procedures should be clearly defined. Written participation acknowledgments may also be appropriate to ensure firefighters understand both the voluntary nature of sauna use and the personal responsibility associated with monitoring their own health status during exposure.

Together, these elements form the foundation of responsible sauna governance within the fire station environment. Without clearly defined expectations, sauna use may vary widely across shifts and stations, increasing the potential for inconsistent safety practices and unnecessary operational risk.

For this reason, departments that choose to integrate sauna use into the station environment benefit from implementing a structured Fire Station Sauna Standard Operating Procedure (SOP).

A written SOP translates governance principles into operational practice by defining exposure parameters, participation expectations, safety considerations, documentation practices, and maintenance responsibilities. By establishing these elements in advance, departments can ensure that sauna use supports firefighter health while remaining aligned with operational realities and risk management standards. For departments seeking guidance in developing these policies, consultation and SOP development resources are available to support safe and consistent implementation.

Operational Translation: What This Means for Firefighters

- Many fire departments exploring sauna use quickly discover that the challenge is not installing equipment, but establishing clear expectations for safe and operationally appropriate use. Questions often arise regarding exposure duration, temperature limits, hydration practices, post-fire use, and maintaining response readiness while members are inside the sauna.
- These issues are most effectively addressed through a written Fire Station Sauna Standard Operating Procedure (SOP). A structured SOP translates research findings and governance principles into clear operational guidance that can be consistently applied across shifts and stations. Establishing these expectations in advance helps departments support firefighter recovery while maintaining alignment with operational readiness and risk management practices.

About the Author

Dr. Daniel Higuera is a professor of kinesiology and a researcher specializing in firefighter health, human performance, and occupational physiology. His work focuses on translating scientific research into practical strategies that support the long-term health, safety, and operational readiness of firefighters.

Dr. Higuera holds a PhD in Health Science with an emphasis in human and sport performance and has conducted extensive research examining the physiological and occupational stressors faced by firefighters, including sleep disruption, cardiovascular health, workload, and recovery. His research has explored how factors such as emergency call volume, fitness, body composition, and psychological stress influence autonomic nervous system activity and overall firefighter health.

In addition to his academic work, Dr. Higuera regularly works directly with over 25 fire departments conducting physiological testing, health assessments, and educational programs focused on improving firefighter health outcomes. His work emphasizes evidence-based approaches that align with the operational realities of the fire service.

Dr. Higuera's broader mission is to help the fire service better understand the physiological demands of the profession and to translate scientific research into practical policies and strategies that improve firefighter health, performance, and career longevity. Dr. Higuera also advises fire departments on the development of health and recovery policies that align emerging scientific research with the operational needs of the fire service.

Dr. Daniel Higuera's Sauna SOP

Dr. Daniel Higuera's Instagram

Firefighter Sport Science

Sauna at the Fire Station: Research, Risk, and Operational Realities

This document is intended for educational and informational purposes only. It synthesizes current scientific literature related to sauna exposure and firefighter physiology. It does not constitute medical advice or departmental policy.