Improving Kent Firefighters Human Performance Parameters Through Implementation of Various Heat Acclimation Strategies

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CERTIFICATION STATEMENT

I hereby certify that the following statements are true:

1. This paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

2. I have affirmed the use of proper spelling and grammar in this document by using the spell and grammar check functions of a word processing software program and correcting the errors as suggested by the program.

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TABLE OF CONTENTS

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ABSTRACT

The City of Kent Fire Department responds to fires in all seasons and must be prepared to operate in unexpected high-heat conditions year-round. Numerous fire service publications, including the National Fire Protection Association (NFPA) standards, specifically cite heat acclimation as a measure fire departments should use to prevent heat strain and cardiac emergencies in firefighters. Discussions within the Kent Fire Department, however, have revealed that many firefighters are not familiar with heat acclimation, one of many reasons the department has struggled to implement procedures to adequately prepare firefighters for the high temperatures they face. Without policy or a proper understanding of heat acclimation, the Kent Fire Department risks serious injury or even death to firefighters by not preparing them to operate in hot environments.

The purpose of this descriptive study was to identify and describe how the Kent Fire Department prepares firefighters for working in hot environments, what are the benefits, if any, of preparing to work in hot environments, and how other fire departments prepare firefighters to work in hot environments.

Descriptive research was utilized to answer three questions which were the foundation of this paper:

- How does the Kent Fire Department prepare firefighters for working in hot environments?
- What are the benefits, if any, of heat acclimation in preparing firefighters for working in hot environments?
- How do other fire departments prepare their firefighters for working in hot environments?

Research conducted via literature review, personal interviews, and a descriptive survey revealed both the negative impact of high heat on the physiology of firefighters, and, conversely, the positive impact of regular heat acclimation practices and proper hydration before, during, and after an exposure to high temperatures.

The pages that follow, therefore, serve to recommend that firefighters be educated in exertional heat stress, heat acclimation principles, and proper hydration practices, and that the Kent Fire Department develop specific implementation procedures for the same.

INTRODUCTION

Statement of the Problem

The City of Kent Fire Department responds to fires in all seasons and must be prepared to operate in unexpected high-heat conditions year-round. Firefighting involves heavy strenuous work while operating in a hostile environment and which activates the sympathetic nervous system, increases cardiovascular and thermal strain, and often triggers dehydration (Smith et al., 2013). In fact, while many persons assume that burns and smoke inhalation cause most on-duty deaths, cardiovascular disease (CVD) is the single most frequent cause of duty-related fatalities among firefighters in the United States (Kales & Rielly, 2013). In 2017, 53 percent of firefighter deaths were attributed to overexertion or stress, with 48 percent classified as "sudden cardiac death" (Fahy, LeBlanc & Molis, 2018). In addition, in a review performed by the National Fire Protection Association (NFPA) over five years, findings indicate that there are approximately 25 non-fatal line of duty cardiac events for every fatal cardiac event (Smith et al., 2013). It is clear that exertional heat strain and the lack of acclimatization have been found to be highly associated to cardiovascular risk factors that lead to these cardiac injuries and deaths. These risk factors include increased lipids, obesity, and the increased percentage of body fat for firefighters (Kales & Riley, 2013). This descriptive study addresses how the City of Kent Fire Department can mitigate serious exertional heat injuries that could result in death to firefighters as the result of operating in high heat environments.

Acclimatization is defined as the process of adapting one's body to environmental extremes (Horn et al., 2010). Since acclimatization is synonymous with acclimation, and for simplicity, this paper will use the term acclimation. from this point forward, O'Hara (Appendix B). Acclimation has specifically been noted in numerous fire service standards and studies as a

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vital measure to prevent heat strain and cardiac emergencies in firefighters (NFPA, 2012). As such, one might assume firefighters understand this process and its benefits. This misconception, however, is the crux of the issue and the impetus for this paper. Many firefighters don't understand acclimation or how to train to acclimate to high-heat conditions they typically experience in the field and do not have the knowledge or programs necessary to properly acclimate themselves through various structured physical training programs. Without policy or a proper understanding of heat acclimation, the Kent Fire Department risks serious injury or even death to firefighters by not preparing them to operate in hot environments.

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Purpose of the Study

The purpose of this descriptive study is to identify and describe how the Kent Fire Department currently prepares firefighters for working in hot environments, the benefits, if any, of preparing to work in hot environments, and how other fire departments prepare firefighters to work in hot environments.

Research Questions

1. How does the Kent Fire Department prepare firefighters for working in hot environments?
2. What are the benefits, if any, of heat acclimation in preparing firefighters for working in hot environments?
3. How do other fire departments prepare their firefighters for working in hot environments?

BACKGROUND AND SIGNIFICANCE

The City of Kent Fire Department is a career fire department with thirty-six uniformed personnel. Three shifts of firefighters operate out of two fire stations and serve a population of over 50,000 people, over an area of 25 square miles (City of Kent FD, 2018). The Kent Fire Department responds to over 4,000 calls for service annually, with a majority of these being emergency medical in nature (City of Kent FD, 2018). A typical house fire can reach temperatures of 1,000 degrees F at the ceiling, 600 degrees F at eye level and over 100 degrees F on the floor (U.S. Department of Homeland Security [DHS], 2018). These types of extreme conditions occur year-round regardless of outside weather conditions. What many don't consider, however, is that the average high outdoor temperature of 72 degrees F typically lasts from May 27th through September 18th, with the highest average dew points occurring between May 31st and September 22nd each year (Weather Spark, 2018). These temperatures increase the probability of Kent firefighters operating in both, hot and humid conditions prior to even entering a fire. In 2017, the City of Kent Fire Department responded to 175 fire calls between May 1st and September 30th, 42 percent of the total number of fire calls for the year (City of Kent FD, 2018).

While the Kent Fire Department, like other fire departments, has an age diverse membership that has undergone a significant turnover in the last decade, due to retirements and an increase in staffing, forty percent of its members are under the age of 35 (Appendix A). With this younger age group, the importance of acclimation, somewhat surprisingly increases, since many young firefighters do not manage the heat as well as their predecessors did (United States Fire Administration [DHS], 2008). Heat related injuries, illnesses, and deaths have been on the rise in recent years. Numerous studies attribute this to the lack of acclimation in young people

that spend a considerable amount of time in air-conditioned homes and schools (USFA, 2008). Collectively, researchers have shown that humans have drifted from their evolutionary past, when comfort was a rare treat and stress was a constant. The resultant lack of exposure to the extremes has dulled our senses, perhaps a contributing factor to the prominence of autoimmune diseases. Simply put, the under stimulated biology starts to turn on itself (Carney, 2017).

This shift from constant physical stress to near constant physical comfort and the resultant urgency for acclimation training have been a point of contention in the Kent Fire Department, (J. Tosko personal communication, July 31, 2018). The main source of contention was the adoption of a new training program. The training program mandates that full personal protective equipment (PPE) be worn during skill check offs, many which take place in the warm months (May-August). Several firefighters believe that wearing PPE, for even a short period of time, is dangerous and exposes them to further exertional heat strain, possibly leading to heat illness. Others believe that wearing PPE during these elevated temperatures better prepares them for working in the heat (J. Tosko personal communication, July 31, 2018).

The Kent Fire Department has a history of its members falling victim to heat strain while battling structure fires or conducting laborious rescue activities, such as advancement of hose lines or overhaul operations. While there have been at least four firefighters who required treatment and transport to the hospital due to exertional heat illness, no firefighters have been thus affected during training, (J. Tosko personal communication, July 31, 2018). This contrast was a significant factor in the department deciding to move forward with the training program in 2014, despite the opinions of a few fire and union officers. Since its inception, the training has been completed without one incident of heat strain. Yet, for some reason, an undercurrent of doubt still pervades the department. Some believe that it is more prudent to protect the stamina

of our firefighters by avoiding unnecessary activity outside when the temperature rises. In fact, in an attempt to prevent exposure to this heat, the thermostats at both fire stations are often set at the lowest level. This not only increases energy costs, but also makes the living quarters unnecessarily cool, (J. Tosko personal communication, July 31, 2018).

In 2014, shortly after being questioned by other firefighters about the need for a heat acclimation program, this author began an informal search of scientific literature on the subject. There are quite a large amount of literature and studies on the topics related to acclimation. As this informal search grew, it became obvious that a more formal review of the scientific, peer-reviewed, literature could prove very useful in educating the department on heat mitigation strategies and specific physical training acclimation regimens to prevent exertional heat illness in firefighters. Furthermore, it is the author's firm belief that this is information that the entire fire service can and should use to prevent heat strain in firefighters and, ultimately, to save lives.

LITERATURE REVIEW

The focus of this literature review is to examine an assortment of studies. The Illinois Fire Service Institute located at the University of Illinois, has been a leader in researching the effects of firefighting on the cardiovascular system. In 1995, at the Saving Our Own course, Dr. Denise Smith spoke to the group about the changes in blood after just the first 20 minutes in a fire. Dr. Smith specifically mentioned how plasma levels drop suddenly and take some time to return to safe levels. Dr. Smith continues to work to help firefighters. She led a study researching the clotting and fibrinolytic changes following firefighter activities, which found that platelet activity and coagulatory potential increased immediately post-firefighting and many variables reflected a procoagulatory state even 2 hours after recovery. The study indicates that the procoagulatory state exists following firefighting may provide a mechanistic link to the reports of sudden cardiac events following strenuous fire suppression activities (Smith et al., 2013).

The U.S. Fire Administration (USFA, 2008) prepared a detailed report that focuses on the impact of heat and includes multiple case studies of line of duty deaths resulting from heat strain. An entire chapter is dedicated to the impact of heat stress on the firefighter and the need for heat acclimation training is stressed repeatedly. The authors state that acquired thermal tolerance refers to cellular adaptations induced by heat exposure that protect tissue and organs from heat injury (USFA, 2008).

In a study of firefighters at the University of Illinois Fire Service Institute, Horn et al. (2010) found that even a short bout (18 minutes) of firefighting activity results in significant physiological, psychological, and cardiovascular strain (Horn et al., 2010). Heart rate and core temperature were found to be significantly elevated from baseline conditions and did not return

to baseline levels for up to 60 minutes into the recovery. Furthermore, after 120 minutes of recovery, fibrinolytic markers returned to baseline levels, but coagulation remained significantly elevated. Horn explains the potential cardiac impact of these spikes when he writes that "As many heart attacks on the fire-ground occur following fire suppression, these results suggested a possible mechanism for the increased risk" (Horn et al. 2010, p. 4). Horn also argues that on scene rehabilitation (OSR) had no effect on core temperature. In fact, depending on the type of OSR, there is a risk of significantly elevating heart rate while attempting to cool and rehydrate. The importance of preparing the body for this type of cardiac impact cannot be emphasized enough (Horn et al. 2010).

Dr. Michael N. Sawka is a research scientist who spent 32 years at the US Army Research Institute of Environmental Medicine (Sawka, 2011). He focused his research on the physiology of upper body exercise, blood volume and its impact on thermoregulation and performance, hydration and its impact on thermoregulation and performance, and heat stress physiology adaptation, maladaptation, and performance (Sawka, 2011). Most impactful to firefighters could be Dr. Sawka's findings of increased blood plasma levels after heat acclimation is complete. Due to his extensive research, Sawka is seen by many as the leading expert in heat acclimation strategies for the US Military, O'Hara (Appendix B). In 2011, near the end of his career, he wrote an extensive review of the scientific literature on heat stress, citing much of his own work (11 of his own studies were referenced). The work (Sawka, Leon, Montain, & Sonna, 2011) is extremely detailed and offers a wealth of information to any looking to educate themselves on heat stress and, specifically, heat acclimation.

Kales and Riley (2013) continued the International Fire Fighters Association's focus on acclimation in preventing heat strain by studying the effects of heart disease in the fire service.

This study names lack of heat acclimation a significant factor in cardiovascular disease (CVD) in firefighters. In short, there is a synergistic effect when CVD is combined with heat strain, thus posing a constant risk to firefighters. The author states, "fire fighters experience thermal strain from the heat of the fires, as well as the heat generated by metabolic activity while performing these tasks, which acts as a cardiovascular stressor" (Kales & Riley, 2013, p. 21).

A group of Finnish researchers (Laukkanen, Khan, Zaccardi & Laukkanen, 2015) showed significantly lower death rates from CVD, stroke, and all-cause mortality events in men who regularly exposed themselves to higher temperatures by frequently using a sauna. The authors noted that, "the higher frequency of sauna bathing was related to considerable decreased risk of sudden cardiac death (SCD), fatal coronary heart disease (CHD), fatal CVD, and all-cause mortality events independently from conventional risk factors" (Laukkanen et al., 2015, p. 546). Increased cardiac function is directly related to increases in body temperature due to sauna bath exposures, which could help firefighters ameliorate risk of exertional heat stress when fighting fires. This relationship with heat exposure and the prevention of CVD is very promising, in mitigating exertional heat illness in firefighters.

Investigating the teachings of Dutch fitness guru, Wim Hoff, Scott Carney reported key findings regarding the human body's immense ability to acclimate to various temperature extremes (Carney, 2017). The lessons noted in his personal case-studies have even been used successfully by fitness leaders across the world to test the limits of human endurance in extreme environments, such as those involving extreme heat and cold. Although much of the research focuses on adapting to cold exposure, the book details the positive effects of acclimating to the heat. The author participated in these intense regimens, personally reporting that, indeed, the body can adapt to both extreme hot temperatures and to extreme cold in austere environments.

Critically, however, Carney (2017) notes in his book that the human body must be overloaded often enough that adaptation will occur. Having the body constantly remain in a relatively stable equilibrium (e.g., homeostasis) is unhealthy. The author reiterates this point by stating, "our bodies are just not ready for a world so completely tamed by our desire for comfort. Without stimulation, the physiological responses that were designed to fight environmental challenges don't always lie dormant. Sometimes they turn inward and wreak havoc on our insides" (Carney, 2017, p.28 of the introduction). He further notes that an entire field of medical research conducted on subjects who have autoimmune diseases may suggest that there is a disconnect between the outside world and an under stimulated biology.

Hunter et al. (2017) concluded that exposure of firefighters to extreme heat and physical exertion activates platelets, increases thrombus formation, impairs vascular function, and promotes myocardial ischemia and injury in otherwise healthy firefighters. Additionally, these researchers reported that pathogenic mechanisms may explain the association between fire suppression activity and acute myocardial infarction in firefighters (Hunter et al., 2017). This highlights not only how firefighters are adversely affected physiologically, but also why firefighters must be better prepared through proper physical training programs to better prepare for hot and humid heat environments.

Each year, the National Fire Protection Association (NFPA) collects data on all firefighter fatalities in the United States. The data collected provides the number of injuries or illnesses that occur in firefighters while on-duty. Data from 2017 showed that sudden cardiac death continues to be a leading cause of death of firefighters (Fahy et al., 2018). The report states that "sudden cardiac death has consistently accounted for the largest share of on-duty firefighter deaths since the NFPA began this study in 1977" (Fahey et al., 2018, p. 4). This

report, along with the many other of cardiac related studies for firefighters, clearly show the need to better prepare firefighters for the rigors of their job, including adapting to heat stress.

Collectively, the research referenced here has repeatedly shown how stressful firefighting can be on the body, often manifesting itself in serious cardiac issues, both during and after a firefighter is exposed to extreme heat. The amount of research indicating the benefits and need for acclimation is overwhelming. This author could find no medical professionals or researchers who disagree. Sauna use, as it pertains to heat adaptation, and regular heat exposure through training are tools that could be used to acclimate firefighters to extreme heat conditions, so they are prepared when they face an actual firefight (Appendix B). The research completed has shown a clear direction to further focus on heat acclimation strategies and training techniques, and how these are implemented in the fire service.

PROCEDURES

Research information for this paper was collected from three sources: literature research, personal interviews and a descriptive research survey. As previously noted, this formal research was started with informal investigation into heat stress, specifically addressing methods to prevent exertional heat illness in firefighters. Much of this informal research centered around six fire service articles, which were later used to locate original research and studies on the topic of heat strain.

Most research was gleaned from scientific literature and the Internet. Almost all the literature used in this paper is readily available on-line, with only a few papers requiring a fee or login information. The availability made the information regarding exertional heat stress very easy to obtain. Other sources included word of mouth from outside experts in the areas of heat stress. When others were made aware of the nature of the paper, many sent links to known research sites regarding heat stress. Specific protocols and procedures, however, were obtained from accredited, scientific, literature or field experts.

The personal interviews were found to be the most beneficial source of information for this work, particularly a podcast (Rush, 2016) with Dr. Reggie O'Hara. To have the opportunity to speak directly with an expert, actively researching in this field, was an honor. Dr. O'Hara, a U.S. Air Force Research Lab Research Physiologist and endurance athlete, spoke of treating heat strain and the use of heat acclimation to prevent heat strain in special forces operators. Dr. O'Hara has personally been involved in numerous studies on acclimation and hydration and is one of the leading experts in the military on these topics. The podcast led to further inquiry and, eventually, direct communication with Dr. O'Hara via a contact in the Air Force. After receiving an email describing in detail the intended research, Dr. O'Hara quickly replied and expressed his

enthusiasm in assisting the fire service in any way that he could. Dr. O'Hara offered a phone interview and an in-depth discussion was conducted on July 13th, 2018. The interview lasted over 1.5 hours, followed by a second interview on September 18th to cover additional inquiries made after discussions with other firefighters. Each interview was recorded, with Dr. O'Hara's permission, to ensure accuracy, and combined and transcribed into one complete interview (Appendix B). To ensure that the information transcribed was accurate, the interview document was emailed to Dr. O'Hara for his review and correction. Dr. O'Hara's review did involve multiple corrections and additions. The corrected version was submitted as Appendix B. Dr. O'Hara reinforced the need for heat acclimation in firefighters, adequately answering research question two: what are the benefits, if any, of heat acclimation in preparing firefighters for working in hot environments?

A convenience sample survey was used to gather information on physiological training methods that can reduce heat stress in firefighters. In order to obtain the most accurate representation of the widest sample, a survey was administered openly to as many firefighters as possible. To complete this task, the type of survey chosen was a convenience survey. Unlike exploratory, or casual research, convenience sampling relies on data collected from individuals or organizations who are available – in other words, all subjects are invited to participate (Dudovskiy, 2016). This made it possible to gather information quickly from individuals with relevant data. The survey was shared in numerous fire service Facebook group pages and was sent via to the Ohio Fire Chief's Association "eblast" that included all 215 Ohio Fire Executive Alumni and 20 current class participants. The survey remained open and active from July 11th, 2018 until September 18th, 2018, resulting in 280 total respondents. One hundred percent of the survey takers completed the survey. Responses were received from firefighters all over the

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United States and one firefighter from Canada. The following are the questions asked in the survey and a brief description of information gained from each question:

1. *What fire department are you representing (Please include your State)?* All 280 respondents answered this question, making a statistical redundancy less likely and providing a detailed map of areas of the Country represented. Responses were received from all across the United States and included one response from Canada. The large distribution on Facebook, likely provided this diverse representation.
2. *What is your rank?* All 280 respondents answered this question. This question gave the author an understanding of the rank and the responsibility of each respondent within their own departments.
3. *Numerous fire service studies have suggested that the lack of acclimating (the process of adapting one's body) to the heat, increases a firefighter's risk of having a heart attack, which is one of the leading causes of firefighter line of duty death each year. How familiar are you with this process as it relates to you as a firefighter?* Out of 280 total respondents, 275 respondents answered this question. The results related directly to the hypothesis posed by the author in the Background/Significance section of this paper.
4. *As far as you know, does your fire department have a guideline or procedures for acclimating to the heat?* Out of 280 total respondents, 275 respondents answered this question. If a respondent answered "yes", their survey response was examined for a department name and/or further contact information that would help to locate departments with guidelines or procedures, answering Research Question #3 (How do some other fire departments prepare their firefighters for working in hot environments?).

Information gained from this question led to the interview with Battalion Chief Pat Martin (Appendix C), detailed later in this section.

5. *How does your department PREPARE for operating in the heat, what specifically do you do?* Out of 280 total respondents, 277 answered this question in their own words. Out of a variety of responses, the general consensus was this information was useful when searching for an achievable acclimation plan, likely to be implemented by firefighters across the board.
6. *Have you or anyone on your fire department ever been treated for a heat injury (heat cramps, heat exhaustion or heat stroke) while operating on an emergency scene?* All 280 respondents answered this question. Verifying the prevalence of exertional heat illness in firefighters and the importance of heat acclimation practices.
7. *Please include the following contact information if you do not mind being contacted if your answers promote further questions.* Of the total 280 respondents, 216 left some type of information (i.e., e-mail, cell phone number). This was used to locate fire departments with heat acclimation guidelines and make further inquiries. This author also plans to send a link to this paper when finalized.

The survey was conducted by using the SurveyMonkey app and by purchasing the PRO FEATURE, to provide an in-depth report of each response. The entire report was too large to share with this document, but a specific answer report for each question was added into Appendix D.

As mentioned above, one survey respondent provided contact information for Battalion Chief Pat Martin of the Glendale, Arizona Fire Department. When asked to share more information on his department's heat acclimation program, the respondent shared a PowerPoint

presentation and a procedure that the Glendale Fire Department uses. Chief Martin's contact information was provided on the last slide. Upon contacting Chief Martin, a date for a phone interview was scheduled. The interview (Appendix C) was then completed on October 17th, 2018 and recorded with Chief Martin's permission. The interview was transcribed into a document that was then sent to Chief Martin for his approval and corrections. Chief Martin returned the document with corrections and the interview was added to Appendix C of this paper. Included with the interview (with Chief Martin's approval) in Appendix C is also the Glendale Fire Department PowerPoint presentation on heat acclimation and the procedure that they follow for operating in the heat.

Definition of terms

Acclimation: The process of adapting to environmental extremes (USFA, 2008).

Atherosclerosis: A disease of the arteries caused by deposition of cholesterol plagues on the inner lining of the arteries causing narrowing and altering of blood flow through the artery (Kales & Riley, 2013).

Autoimmune Disease: A condition in which your immune system mistakenly attacks the body (Watson, 2017).

Coronary Heart Disease (CHD): The narrowing of the coronary arteries from atherosclerosis (Kales & Riley, 2013).

CVD: Cardiovascular Disease (CVD) are those diseases affecting the cardiovascular system. CVD is the single most frequent cause of duty-related fatalities in the fire service annually (Kales & Riley, 2013).

Hemostatic Balance: The balance between blood clot formation (coagulation) and blood clot breakdown (fibrinolysis). Hemostasis is carefully regulated to keep blood fluid under

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normal circumstances and to promote the rapid formation of a blood clot when necessary (Horn et al., 2010).

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Heat Stress: The net load to which a firefighter may be exposed from the combined contributions of metabolic heat, environmental factors, (i.e., air temperature, humidity, air movement, and radiant heat), and personal protective clothing requirements (USFA, 2008).

Heat Strain: The overall physiological response resulting from heat stress (USFA, 2008).

Hypercoaguable State: A condition in which there is an abnormally increased tendency toward blood clotting (coagulation) (MedicineNet, 2019).

Incident Rehabilitation (Rehab): The process of providing rest, rehydration, nourishment, and medical evaluation to responders who are involved in extended and/or extreme incident scene operations. To restore or bring to a condition of health or useful and constructive activity (Kales & Riley, 2013).

Myocardial Ischemia: The lack of oxygen in the myocardial cells (Kales & Riley, 2013).

Limitations of Study

Oddly enough, the biggest challenge of the study is the abundance of information available on heat acclimation. With so many different entities taking advantage of the benefits of heat acclimation, it can be time consuming to sift through the information and find what is relevant to firefighters. A protocol developed for a high school football team, for example, relates much less than that of a solder preparing for duty in a hot environment.

There were also many heart studies related to the fire service, some of which are not included, to avoid repetition. The most recent and pertinent studies were prioritized first. While

some studies were difficult to read, due to medical terminology the interviews with Dr. O'Hara helped to translate the vital components of these studies and how each relates to the fire service.

A missing component of acclimation research is the specific ramifications for firefighters. Most acclimation studies are derived from the military, involving young, fit soldiers. Hardly the average demographic of firefighters.

The survey, while providing a wealth of information, also had its limitations. Using Facebook users that frequent fire service pages did raise the question if they were actual firefighters. The author believes most who use these pages are firefighters as they provided specific department information that only a person involved in the fire service would know. Each of the 280 surveys were individually reviewed and appeared genuine. Multiple participants from the same department skewed slightly the percentage of fire departments that do not have acclimation policies or procedures. All responses were included, however, in an effort to garner as many respondents as possible. The responses to this question took priority to knowing how many departments had acclimation policies. Furthermore, since the number of departments who have these policies are so few, redundancy was rare.

The role of biases cannot also be discounted. Cognitive biases are errors in reasoning, evaluating, remembering, often occurring as a result holding onto one's preferences and beliefs regardless of contrary information (Ching, 2016). Cognitive biases can affect both researchers and the participants. Starting with the participants, it is realistic to think that some firefighters, unaware of heat acclimation may say that they are aware, to save themselves the embarrassment of not knowing a subject related to fire service studies. Participants can also sense where a study is going and will answer following this perception, to be included in the larger group. This type of bias is termed as the *bandwagon effect* (Ching, 2016). Admittedly, the author could easily

have been swayed by a bias termed as *anchoring*. Anchoring bias is the human tendency to rely too heavily on the first piece of information offered when making decision (Ching, 2016). The author identified this bias personally early into the research process and made it a point to find research that challenged the information initially found in the informal research investigation.

Since this topic could involve for more research and time than what can realistically be covered in this paper. I hope this research is just a launching point for continuing research involving firefighters and heat acclimation, due its importance in preventing heat related stress and deaths.

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RESULTS

The following information has been compiled to summarize the results gathered from literature, personal interviews, and a survey, as it pertains to three research questions.

Research Question One- How does the Kent Fire Department prepare firefighters for working in hot environments?

This question is best answered by reviewing Kent Fire Department policies and procedures, both past and present. A personal interview with Fire Chief John Tosko was particularly helpful, providing some specific information. Unfortunately, the Kent Fire Department has no formal procedure to prepare firefighters for working in hot environments and most firefighters are unfamiliar with heat acclimation practices.

Departmental policies and procedures have no reference to preparing for working in hot environments. Formal day-to-day operations involve no consistent preparation for firefighters to work in the heat. A few members take it upon themselves to exercise or train in the heat, with an intent to better adapt to hot and humid weather, but this is inconsistent, as it followed no accepted protocols. This inconsistency could be problematic and dangerous to the well-being of firefighters. Conversely, some firefighters avoid any exposure to the heat and may spend much of their shift in air-conditioned buildings with the temperature set low, (J. Tosko personal communication, July 31, 2018).

The Kent Fire Department is not alone in their unfamiliarity with heat acclimation, their lack of a heat acclimation procedures, and the inconsistency of their firefighter's approach to operating in the heat, (J. Tosko personal communication, July 31, 2018). The following results of four survey questions demonstrate this predicament.

First, only thirty percent of 275 respondents (Appendix D) said they felt very familiar with acclimation, as it pertains to the fire service. Twenty five percent of the respondents said that they were either minimally or not at all familiar with acclimation.

Secondly and perhaps even more telling, less than seven percent of the 275 respondents answered that their departments had guidelines or procedures for how firefighters can train to acclimate to the heat (Appendix D).

Thirdly, nearly 80 percent of the 280 respondents answered that they were aware of at least one firefighter from their fire department who had been treated for a heat injury (heat cramps, heat exhaustion or heat stroke) while operating on an emergency scene (see Appendix D, pg. 6).

Lastly, given that we can safely assume the Kent Fire Department is in the same situation as the majority demonstrated above, it is harrowing to consider the severe disadvantage at which firefighters are placed. If they lack enough knowledge of the benefits of heat acclimation and do not know how to implement heat acclimation strategies in their training regiments, firefighters will continue to suffer from heat strain, heat illness, and, worst of all, cardiac events. This stark realization necessitates continued research and illuminated the important lessons that this research can provide to fire departments across the United States.

Research Question Two- What are the benefits, if any, of heat acclimation in preparing firefighters for working in hot environments?

The amount of proven literature about acclimation is abundant, multi-faceted, and includes, but is limited primarily to studies from the US Military and sports fitness experts. In part, this research explores exertional heat stress illness, hydration principles, the effects of firefighting on the cardiovascular system, and the correlation of each with the benefits of heat

acclimation. The interview conducted with Dr. O'Hara (Appendix B) is particularly helpful in putting these scientific and medical phrases in layman's terms, for both author and reader. Dr. O'Hara's knowledge was not only a primary resource for this paper, but also serves as an impactful voice in recommending improved strategies in all fire departments.

Simply put, there are many benefits of heat acclimation for the firefighter. Heat acclimation induces biological adjustments that reduce the negative effects of heat stress. These adjustments or adaptions include: improved thermal comfort, submaximal aerobic exercise performance, and maximal aerobic exercise performance (Sawka et al., 2011). Essentially, when exposed to a hot environment, the firefighter will likely be more comfortable and able to maintain expected physical performance.

These improvements are achieved by integrated thermoregulatory, fluid-electrolyte, metabolic, cardiovascular, and acquired thermal tolerance adaptations. Let's break those terms down. Thermoregulatory adaptations refer to reduced core temperatures at rest and during exercise, lowered skin temperatures, improved sweating, and improved skin blood flow. Fluid electrolyte adaptations refer to improved fluid balance, reduced sweat electrolyte losses, increased total body water, and plasma volume. Lowered whole body metabolic rate, lowered lactate threshold, reduced muscle lactate, muscle glycogen sparing and increased skeletal muscle force generation constitute metabolic adaptations. Cardiovascular adaptations include increased stroke volume and cardiac output, improved cardiac efficiency and ventricular compliance, improved cardiac pressure generation, and improved cardio protection. Lastly, the improved acquired thermal tolerance is due to an increase in heat shock protein (HSP) basal levels and altered HSP expression patterns (Sawka et al, 2011).

These benefits can be more generally described, and more easily understood, under the umbrella of the four markers of heat acclimation. They are as follows: lower heart rate, reduced core temperature, higher sweat rate, and improved aerobic exercise capacity during heat stress (Sawka et al, 2011). To better understand how these markers benefit the firefighter, it is important to understand the dangers of exertional heat stress, the urgency of acclimating a firefighter to the heat, the role hydration plays in that acclimation and, finally, the intense cardiovascular stress incurred by simple firefighting operations.

Environmental heat stress increases the requirements for skin blood flow and sweating to dissipate body heat. When the environment is warmer than the skin, the body absorbs this external heat, thus increasing the amount of heat that needs to be dissipated. Muscular exercise, similarly, increases metabolic rate above resting levels and, thus, increases the rate at which heat must be dissipated. So, while muscular exercise in and of itself can require a high cardiac output to support metabolism, when combined with environmental heat stress, the cardiovascular system may be pushed to its limit. It is too taxing to simultaneously support the competing thermoregulatory demands for skin blood flow and metabolic demands of the contracting skeletal muscles. This competition can degrade performance and induce serious heat illness (Sawka et al., 2011). It is under these arduous conditions that a firefighter must operate when faced with the high heat and humidity of firefighting. Dr. O'Hara specifically notes that muscle contractions will create 20 times the heat the body normally produces in a given setting (Appendix B). This extra heat is created by the actively contracting muscles which is transferred directly to your blood, then to your core, which in turn induces hyperthermia. Add to this the strain inflicted by wearing protective clothing or firefighter turnout gear. The additional layers

increase the likelihood of reduced physiological and cognitive performance, even during very light work (Caldwell, Patterson & Taylor, 2012).

This is why heat acclimation practices are essential. Heat acclimation develops through repeated heat exposures that are sufficiently stressful to elevate both core and skin temperatures and provoke profuse sweating (Sawka et al., 2011). In fact, many studies suggest that acclimation requires a daily heat exposure combined with aerobic exercise. The physiologic strain induced by the same exercise-heat stress condition decreases with each day of heat acclimation. Most of the improvements in heart rate, core temperature, and sweat rate are achieved during the first two weeks of daily exercise in a hot climate. Heart rate reduction develops most rapidly in 4 to 5 days. After 7 days, the reduction in heart rate is virtually complete. The thermoregulatory benefits from heat acclimation are usually complete after 10 to 14 days of exposure, though, improvements to physiological tolerance may take longer. Heat acclimation, however, gradually disappears if not maintained by consistent heat exposure (Sawka et al., 2011).

Firefighters can lose significant bodyweight while conducting firefighting operations, due to dehydration, core temperature rise, lactic acidosis, and leukocytosis (Smith et al., 2013). Dr. O'Hara further confirms that maintaining proper hydration levels reduces overall physiological strain on the body while operating in hot and humid environments (Appendix B). Dehydration leads to a rapid decline in blood plasma volume, the liquid part of the blood. This decrease of blood plasma in turn lowers the hematocrit level, making the blood thicker. Dr. O'Hara relates that hydration plays a specific role in how well and how long a firefighter can perform under physical exertion, especially in a high heat environment.

In sum, firefighters experience thermal strain from the heat of fires, as well as the heat generated by metabolic actives of the musculature while performing tasks, which act as a cardiovascular stressor. Additionally, insulated personal protective equipment (PPE) limits heat evaporation (Kales & Riley, 2013). The much greater risk of a firefighter suffering a cardiac event following fire suppression activities compared to physical activity alone, suggests that multiple stressors (i.e., exercise, heat, psychological stress) may cause an exaggerated hemostatic response. Firefighting involves heavy strenuous work while operating in a hot and humid environment. Leading to an activation of the sympathetic nervous system, increased cardiovascular and thermal strain, and eventual dehydration. Catecholamines stimulate platelets and several coagulatory factors suggesting that sympathetic stimulation may lead to a hypercoaguable state that increases the risk of thrombus formation (Smith et al., 2013). There are multiple factors that increase the risk of heat illness and cardio events in firefighters, including obesity, low levels of physical fitness, lack of acclimation, dehydration and prior episode of heat illness (Kales & Riley, 2013).

Research Question Three- How do other fire departments prepare firefighters for working in hot environments?

The convenience sample survey (Appendix D) was helpful in answering this question by clearly showing that most fire departments do nothing to prepare their firefighters for operating in the heat. Each survey response helped differentiate the different activities or procedures that fire departments rarely use to prepare for working in the heat. The few departments that have acclimation procedures were contacted using the e-mail addresses provided in the survey, one of which was Battalion Chief Pat Martin with the Glendale, Arizona Fire Department. The information that Chief Martin shared was very helpful in forming the recommendations for this paper. Without the use of this survey it would have been very difficult to locate fire departments with acclimation protocols since they are so rare. Chief Martin granted access to the Phoenix Regional Standard Operating Procedures section for Heat Stress Management, one of the protocols employed by the Glendale Fire Department. The Glendale Fire Department also graciously permitted the inclusion of the PowerPoint presentation they developed to train their staff on Heat Acclimation. This presentation is also included in Appendix D.

DISCUSSION

Research and scientific data on the benefits of heat acclimation are abundant, time tested and largely without refutation. As Dr. O'Hara stated in his interview (Appendix B), while some studies on acclimation have tested different variables through the years, none argue that acclimation does not work, examples of these variables are: duration of acclimation and characteristics of the blood to further show that acclimation to the heat cannot be discounted. Sawka et al. (2011) references 437 pieces of work that speak to the performance, adaptation and maladaptation to heat stress, the culmination of his distinguished career as a researcher of heat acclimation. Researchers have moved beyond proving the basic benefits of heat acclimation, now going as far to link it with the treatment of brain injuries (Umschweif et al., 2014). This massive amount of research pointing to the merits of heat acclimation is likely the reason that Kales & Riley (2013), NPFA 1403 (2012) and USFA (2008) specifically referenced heat acclimation in their documents to the fire service. Even in the face of this evidence, however, firefighters are not well educated in heat acclimation strategies and most fire departments do not implement a heat acclimation program for their firefighters, the impetus for this research.

As stated above, the benefits of heat acclimation are vast and could be positively impactful to a firefighter, but the process is time consuming and requires strict adherence. Not only must fire departments commit to providing training regimens, but the individual firefighter must commit his or her time and energy to the program. It is, however, achievable. It is with sincere hope that the recommendations in this paper will help fire departments implement heat acclimation strategies and exercise programs that help firefighters adapt better to high heat. It must be cautioned though, that most persons used in the heat acclimation studies were young and fit. Fire departments must implement heat acclimation strategies appropriate to all age and

fitness levels. General guidelines can be followed, but there must be specific allowances for firefighters to find the amount of exertion that they are comfortable with. Another requirement is for the firefighter to wear the level of PPE that they would be wearing while fighting a fire; this includes breathing from an SCBA (self-contained breathing apparatus). The level of PPE can be slowly added along with the amount of exertion. Wearing the gear is essential for the benefits of acclimation to be optimized during training exercises. Many disagree and argue that firefighters should not wear their full PPE on a hot day unless on an actual fire or rescue response. This author has been involved in similar disagreements with department members. They suggest the activity is hurtful to the firefighter. While PPE may cause some strain as discussed by Caldwell, it is the recommendation of Dr. O'Hara for firefighters to wear PPE while conducting heat acclimation strategies (Appendix B) as this is, in part, what will prepare their bodies for the more intense heat of a fire (Caldwell et al., 2012). He recommends a firefighter to begin with an 8-minute segment of heat exposure wearing PPE while completing a light to moderate workload. If a firefighter is unable to complete light to moderate work for 8 minutes, additional questions should be asked of that firefighter regarding their overall health and oxidative fitness level.

Humans are extremely adaptable to the environment they are exposed to (Carney, 2017). At the very least, firefighters should expose themselves to heat whenever they are able to. This could include working outside on their days off or using a sauna. Many firehouses have purchased saunas as part of cancer initiatives. As referenced before, these saunas could provide extra opportunities for heat training as shown by Laukkanen et al. (2015). This work showed a drastic disparity in cardiovascular and all-cause mortality events between people who used a sauna once a week and those who used a sauna three times a week. The survey (Appendix D) also demonstrated a vast disparity in how firefighters approach working in the heat. Some

firefighters avoid heat at all cost, unless they are required to operate in it. They spend much of their day in the air conditioning. Others seek out work and exercise in the heat, while reducing exertion and carefully monitoring how they feel. The latter approach has been proven more beneficial and less negatively impactful on the body, especially the cardiovascular system (Kales & Riley, 2013).

The most sobering information obtained by researching this subject was the impact of firefighting on the cardiovascular system of the firefighter. Kales & Riley (2013) reported a definitive culmination of the scientific evidence of the cardiac risk to firefighters. Recent research shows that even short bouts of firefighting activity in high heat is likely to dramatically change the blood chemistry of a firefighter and put them at high risk for acute myocardial infarction (Hunter et al., 2017). Decades worth of similar conclusions highlight a major risk to firefighters of all ages. To understand the severity of this risk, one needs to look no further than the tragic fatality rates in firefighters, the leading cause of which is CVD (Kales & Riley, 2013). While many of these deaths may have been attributed to the lack of heat acclimation, dehydration, a far more manageable risk, is also a contributing factor and, therefore, leaves departments without excuse. Fire departments must act to adequately prepare their firefighters.

Researchers have reported that blood plasma volume decreases immediately in firefighters following firefighting activities (Smith, Petruzzello, Chludzinski, Reed & Woods, 2001). Blood plasma is the liquid part of blood, O'Hara (Appendix B). Most recent studies have shown that, along with the decrease of blood plasma there is an increase of platelet count, creating a hypercoaguable state in the blood of firefighters (Hunter et al., 2017). A specific benefit of heat acclimation that may aid in protecting the firefighter is the probable increase of blood plasma in the acclimated person (Sawka et al., 2013). Beyond the benefits of acclimation

this researcher also found that hydration may play a key role in preparing a firefighter for the cardiovascular shock that firefighting unfortunately provides. Dr. O'Hara asserted in his interview (Appendix B) that proper hydration is vital before, during, and after working in the heat, as it reduces the overall physiological strain on the body and may allow the firefighter to work more effectively in a hot environment. A firefighter can easily monitor their own hydration and work to maintain a healthy state of hydration throughout their shift. These simple adjustments will likely provide them a great deal of added protection. There is disparity between sports drinks available to firefighters for hydration purposes. Rice-based electrolyte and rehydration drinks may offer benefits greater than commercial sports drinks. These benefits include increased water retention for maintenance of blood plasma volume (Moore & O'Hara, 2016). The maintenance of blood plasma, specifically, can be of great benefit to a firefighter. Dr. O'Hara recommends drinking a rice-based sports drink ad libitum throughout the day or micro-hydrating by taking small sips every 20 to 30 minutes. While it is not the main focus of this research project, the importance and potential benefit of proper hydration in the firefighter is intricately important to their ability to function in high heat, as it works hand in hand with acclimation.

This descriptive study indicates that heat illness is prevalent among firefighters operating in high heat environments and that they are susceptible to cardiac emergencies. However, much of the research has focused on military populations and a variety of heat mitigation strategies were incorporated. Several of these heat acclimation strategies used by the military and other outside resources, however, could be implemented in a firefighting community such as the Kent Fire Department. Additionally, the exertional heat stress created by working strenuously while

wearing PPE makes the benefits of heat acclimation important all year long. Furthermore, heat acclimation should not be viewed as a practice that only benefits during the heat of the Summer.

This research could impact the Kent Fire Department in a few ways. First, it demonstrates irrefutably the benefits of heat acclimation. Second, it offers achievable steps to properly prepare firefighters for working in the heat. Third, it offers solutions to arguments over wearing PPE while training in the heat. By educating firefighters on the topics outlined here and by practicing the steps explained in this paper, the Kent Fire Department will not only improve the stamina of their firefighters, but also reduce their risk of dying from a heart attack.

RECOMMENDATIONS

In order to better prepare firefighters for operating in high heat, the following are four recommendations for both the Kent Fire Department and other fire departments as well.

1. Educate
2. Acclimate
3. Hydrate
4. Future studies

Education

The Kent Fire Department should develop a training program covering exertional heat stress and the treatment of heat illness, the cardiac impact of firefighting hydration principles, and the benefits of heat acclimation. This training should be offered on an annual basis and made available to all department members as specifically recommended by Battalion Chief Martin of the Glendale Fire Department (Appendix C). As guidelines and procedures are developed for each of the training topics, they too can be added to the training curriculum. The Glendale Fire Department PowerPoint presentation on Heat Acclimation (Appendix C) serves as a good model for such training.

Acclimate

The Kent Fire Department should develop heat acclimation guidelines in accordance with the interview (Appendix B) with Dr. O'Hara. Following this recommendation, the author drafted a guideline (Appendix E) for the Kent Fire Department and other fire departments to consider. Once guidelines are established and approved by the Fire Chief, the department should provide opportunities for firefighters to complete heat acclimation, while they are on duty as well as off duty at the fire station. Perhaps one tangible way to achieve this is to identify trainer cadre

comfortable and familiar with heat acclimation principles. This cadre could lead heat acclimation exercises and offer direction to firefighters while they complete their acclimation training. An approved training cadre also insures that safe practices will be followed as firefighters acclimate themselves to the heat.

Hydrate

The fire department should also make proper hydration a primary focus for safe operations. Hydration begins before the firefighter arrives at work, must be maintained while they are working, and sustained after they complete a rigorous operation. To aid in this important endeavor, a departmental guideline (Appendix F) has been developed for consideration, using the recommendations put forth by Dr. O'Hara in his interview (Appendix B). A simple tool to help firefighters monitor their daily hydration are urine color charts that can be installed in departmental restrooms. The Kent Fire Department should also consider switching to a rice-based sports drink. This would be in addition to the bottled water that the fire department provides its members. The department would then discontinue the purchase of commercial sport drinks and discourage their use by firefighters while on-duty.

Future Studies

Future studies on this subject could greatly benefit the American fire service. A heat acclimation study specifically focusing on firefighters of all ages is of first importance. Most of the heat acclimation studies involved in this research represented military personnel who were young and in good fitness. An independent study of current heat acclimation practices would determine if alterations are necessary. Examining vital signs, blood work and hydration levels of firefighters before and after heat acclimation, could provide impactful information.

Secondly, the studies involving the cardiac impact of firefighting largely drew upon young and fit firefighters, and rarely included any preventative measures for those who don't fit this description. It may be highly beneficial to the fire service for future studies to involve a more diverse selection of participants (young and old, fit, and out of shape subjects) and that steps to reduce the cardiac impact could be scientifically tested. Heat acclimation and proper hydration are two steps firefighters can implement, that may reduce the negative effects of heat stress during firefighting on their cardiovascular system and maintain or even improve human performance.

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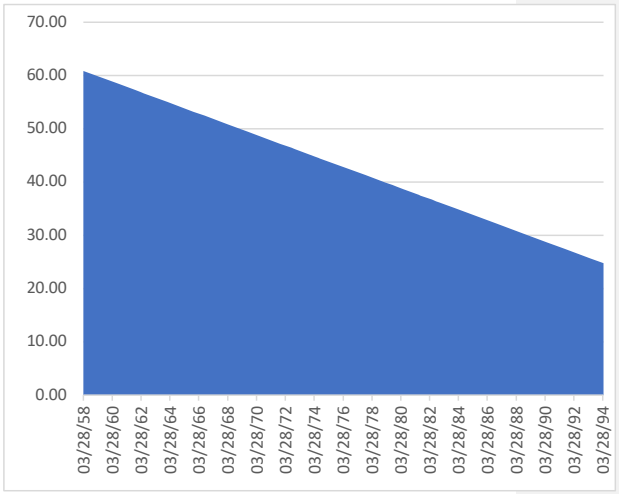
APPENDIX A – KFD BIRTHDATE LIST

Kent Fire Department Birthday Spreadsheet (names omitted for privacy)

	Birthday	1/17/2019
FF1	03/28/58	60.85
FF2	08/14/60	58.47
FF3	10/09/61	57.31
FF4	03/12/62	56.89
FF5	06/02/62	56.67
FF6	01/26/64	55.01
FF7	11/11/65	53.22
FF8	08/23/66	52.44
FF9	01/13/68	51.05
FF10	04/12/68	50.80
FF11	08/10/69	49.47
FF12	11/16/71	47.20
FF13	08/23/72	46.43
FF14	11/18/72	46.19
FF15	12/11/73	45.13
FF16	01/11/74	45.05
FF17	03/08/74	44.89
FF18	07/27/74	44.51
FF19	08/14/74	44.46
FF20	10/16/77	41.28
FF21	02/28/79	39.91
FF22	08/24/79	39.43
FF23	12/24/79	39.09
FF24	05/25/80	38.67
FF25	06/27/81	37.58
FF26	08/16/81	37.45
FF27	05/23/82	36.68
FF28	09/13/82	36.37
FF29	11/23/82	36.18
FF30	12/18/83	35.11
FF31	11/19/86	32.18
FF32	12/25/88	30.08
FF33	05/22/90	28.68
FF34	07/18/91	27.52
FF35	05/17/93	25.69
FF36	04/17/94	24.77



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APPENDIX B – DR. O'HARA INTERVIEW

The following interview was completed with Dr. Reginald O'Hara on July 13th, 2018 at 10:00 hrs.

What is the most proper term, heat acclimation or acclimatization?

They are synonymous, but acclimation is the term that you will want to use.

What happens to one's body when they operate strenuously in the heat without being acclimated? Especially when that person is a firefighter who is not physically fit and is overweight.

The cardiovascular impact is the most important component and it is directly impacted by the heat. When you are working strenuously in the heat, as you would be in firefighting, your muscle contractions will create 20 times the metabolic heat that you would normally. This heat, created by the actively contracting muscles is transferred directly to your blood, then to your core. This rapid buildup of heat creates hyperthermia which raises both, your heart rate and blood pressure. The blood plasma, which is the fluid in blood, is dramatically decreased. This in turn lowers your hematocrit level, making your blood thicker.

Your sweat rate will also increase, as your body attempts evaporative cooling to lower your body temperature. The gear a firefighter wears is problematic though, as it will inhibit evaporative cooling almost entirely. Plus, the PPE automatically increases your workload and the metabolic rate goes way up.

To summarize, this firefighter would be put in a very dangerous cardiovascular state while losing blood plasma volume through high sweat rates. It is also important to point out the heat strain is

cumulative, so the next fire that shift will be much harder on a firefighter, likely making them more susceptible to exertional heat illness.

What would the benefits be to a firefighter who was properly acclimated to the heat?

After completing heat acclimation training, firefighters may enhance overall physical fitness physical fitness. For example, enhanced physical fitness would allow firefighters to more effectively manage high cardiovascular demands further induced by exposure to high heat conditions. Second, acclimation increases the amount of blood plasma that constitutes your overall blood volume. Subsequently, heart rate and blood pressure will remain within safe parameters. An acclimated person may also have a more effective sweat response and sweat response will occur early on contributing to an overall rise in core body temperature, especially when operating in hot and humid environments. Subsequently, firefighters would be able to operate longer in firefights without overheating and may recover faster prior to the next fire.

So, hydration plays a big part of how well a person is acclimated?

Proper hydration is vital; before, during and after working in the heat. Being well hydrated reduces overall physiological strain on the body. Additionally, proper hydration plays a specific role in how well and how long one can perform under physical exertion, especially in high heat conditions. I would expect that many firefighters show up to work in a semi dehydrated state compared to the normal population.

What are your recommendations for maintaining proper hydration for a 24 hour shift?

First, begin drinking water as soon as you wake up. If your urine color is dark, it is suggested that you consume at least 12 to 16 ounces of water 2 to 3 hours before the start of your shift. If your urine color is light, then it is recommended you consume between 10 -12 ounces of water. It's also advisable to drink 2 liters of water 4 hours before any known strenuous work in high heat (e.g., training fires). I also recommend eating a breakfast high in carbohydrates (CHO) (e.g., 70-80%), but you must earn that meal at some point during the day by participating in high intensity or low intensity high duration physical activities. If you don't fight a fire, then it is recommended that you participate in some form of aerobic activity up to 60 minutes at a moderate to vigorous intensity.

During normal work hours, I recommend drinking a rice-based sports drink ad libitum throughout the day. For example, the operational definition of this is 'micro-hydration.' This simply means you take periodic (every 20-30 minutes) sips to maintain your hydration through your normal shift.

For fires or any other strenuous activity, I recommend to pre-hydrate en-route. For example, take a couple of sips of your sports drink while responding. This will help you maintain hydration during the first stressful minutes. Additionally, I recommend you hydrate every 20 to 30 minutes while on the emergency scene, drinking an 8ounce bottle of a rice-based sports drink. Immediately after, the recommendation is to drink 500 ml of a rice-based sports drink followed by 20 ounces of water. To aid in proper absorption and to prevent gastrointestinal issues, it is recommended to sip the sports drink verses drinking a large bolus (e.g., too much all at once).

Back at the firehouse and the hours after, it is important to eat a full meal along with drinking 2 liters of water. Doing so will greatly prepare your body for the remainder of the shift and help to maintain safe blood levels and hydration. Additionally, your energy levels will be restored through replenishment of your skeletal muscle, liver and kidney glycogen stores.

Why the rice-based sports drinks and not the commercial sports drinks?

The commercial sports drinks are high in sugars (fructose, sucrose) and can quickly cause spikes in your glucose levels, causing spikes in your blood sugar levels. The rice-based sports drinks may help maintain healthy blood glucose levels and blood plasma levels. This maintains total hematocrit. These drinks may also help maintain healthy levels of potassium and sodium. Additionally, it's important to point out that drinking water alone works well for activities lasting up to 60 minutes but not longer than 90 minutes. Additionally, it's prudent to pre-hydrate with water. However, once a firefighter is exposed to high heat conditions, he may benefit from drinking a rice-based sports drink to mitigate exertional heat illness, maintain blood glucose levels, and reduce core body and skin temperatures. Overall, the consumption of a rice-based sports drink may also maintain physical and cognitive performance while fighting fires and in some cases ameliorate heat stroke.

How should a firefighter acclimate themselves to the heat?

The goal is to workout in the environment that you wish to acclimate to, while wearing the PPE that they would operate in. So, they should begin in their PPE with a light to moderate workload for 8-10 minutes in the environment that they wish to acclimate to. Remember, that by wearing your gear in the heat, your workload is increased, and you do not want to push it. A good rule of thumb that I have gained over my 23 years of professional experience is to limit your workout by 50% if the temperature is equal to/or greater than 90 degrees F and the humidity is equal to/or greater than 40%. To be safe, I would have the firefighter start with wearing just their turnout gear then slowly work up to wearing the SCBA and finally breathing air. The general idea is to increase your workout time by 10% each day while increasing your PPE. These workouts should be conducted daily and last a minimum of 10 to 14 days, preferably longer if they are not in great shape. Again, I would err on the side of caution in regard to the intensity of the workout. Start slow and ramp up only when you feel comfortable and capable. This rule should also be followed when working out in a group, each individual must monitor their own workload. Once completed, the firefighter would likely be acclimated while being in better physical fitness and weighing less, great benefits all around. To be physically fit, a person should exercise cardiovascularly 300 minutes a week. Just to maintain their current fitness, they would need to exercise 150 minutes a week. They should also do resistance training 2-3 times a week.

Acclimation can be quickly lost if you stop working in the environment intended, so it is imperative to make these workouts a regular event for as long as you want the protection from acclimation.

Are firehouse saunas effective in acclimating to the heat?

Although they lack the humidity, they can be very helpful in heat acclimation. I would recommend that the physical activity being done in the sauna is relative to the work that a firefighter does, like doing steps, but any physical activity will work. The firefighter should start in shorts and a shirt for 10 minutes then add pieces of their PPE gradually over 3-4 weeks until they are fully encapsulated. Once they achieve this level, they can then increase the time in the sauna by 10 percent each week. This would greatly enhance their fitness and their acclimation to the heat.

Are there any studies that you know of that show that acclimation does not work or is ineffective?

No, you are not going to find such studies because they don't exist. What you will find is the duration of acclimation may change from study to study, but acclimation cannot be discounted. The older research lacked the critical variables that have found today. That is, that hematocrit and hemoglobin levels have proven to be critical to determine the hydration level and the ability to acclimate that a person has.

APPENDIX C – GLENDALE INTERVIEW, PROCEDURES AND PRESENTATION

The following interview was completed on October 17th, 2018 with Battalion Chief Pat Martin from the Glendale Fire Department (Arizona). This appendix also includes guidelines and a PowerPoint presentation (created by Dennis Dorrance) on heat acclimation currently used by the Glendale Fire Department.

How did you start your program?

We started this program after we had a firefighter go down with dehydration during one of the hottest days of the year. As the health and safety officer of our department I had to submit to OSHA the required paperwork needed after the member was treated for an overnight stay at the hospital. One of the questions that OSHA asked was "What was the last time the department had trained on heat related illnesses?" At that time, we did not regularly cover heat related illness and the prevention of heat injuries with our department. As a result, we created a PowerPoint program to we presented to the entire department and now annually present at the beginning of our hottest season. We also have standard operating procedures and heat alerts to remind the importance of hydration. All of which reiterate the importance of heat acclimation to our personnel.

Were the benefits of heat acclimation well known before you started your program?

Yes, as a native of Arizona I have been raised to aware of the heat and to the dangers of the extreme heat we see. As a firefighter, the only way to operated effectively in the heat while wearing gear is to acclimate yourself to it! I am an avid bike rider and I ride throughout the year. As I have gotten older, I have found that I need to be more cautious in the heat. I do not respond

the same way I did when I was younger. All of us stay active outside because we see the importance of acclimating to the heat. We also remind our personnel to stay hydrated and not to use the sugary drinks. The energy drinks are also not recommended.

What has your department found helpful to monitor the hydration of your people?

We have posted the urine gauges (or color charts) in our restrooms to help remind our folks about how well hydrated they are. We have found that these gauges have been very helpful in keeping our personnel aware of their hydration. I drink a lot of water and everyone who lives here does much of the same. Rhabdomyolysis is a big concern here when our people are exerting themselves in the heat and once you have felt the effects of rhabdomyolysis you don't want to repeat it. That truly makes our staff very cognizant of our hydration to prevent rhabdomyolysis. We even had one member who could not transfer to another department because of his susceptibility to getting Rhabdomyolysis and he could not get medically cleared. So, it is a very serious condition that can affect you for the rest of your life, since once you have rhabdomyolysis you are more likely to have it again.

Do you require your personnel to complete acclimation exercises?

It is strongly recommended. A lot of the officers will work with their shifts to maintain a good fitness level, but we do not have a fitness requirement. We provide gyms and allow people to work out on duty. During the hot days we just remind our people that today is not the day to your personal best or to do a PR (personal record). In fact, the last firefighter we had have a heat injury admitted that he worked out too hard just prior to a fire. Because of that we tell our people to not go over your 80% on those days. Before that injury, we had gone a year without one. We do see it an important facet to work out in your turn out gear. We do complete fitness

evaluations that provide each member with a MET score and this evaluation is given annually when the member reaches the age of 40. We tell our people that just improving by one MET decreases your risk of a cardiac issue by 15%. So, any improvement is huge and we have found this evaluation vital in keeping our people aware of their fitness level.

What other practices do you find important in relation to operating in the heat?

We have found the importance of providing proper REHAB to our personnel after they have been operating in the heat. It must be more than just removing your turn out gear, that is only passive cooling and your body temperature will actually continue to rise. The quicker you get your core temperature down, the quicker your body will put back the fluids that you are sweating out. So active cooling is imperative and an example of that is submersing the arms in cold water. Mist fans and cooling hoods are also other examples of active cooling. We have found that maintaining a REHAB areas so important that we assign either an ALS engine company or squad to run the area. This provides the manpower and focus to do it properly. We train our officers and use SOP's to understand the jobs required when providing REHAB as a company. The SOPs also cover health parameters for allowing firefighters to leave the REHAB area, pulse and blood pressure being two of these areas we monitor. All of these measures provide consistent REHAB operations for our people.

What is a key competent of keeping your crews safe while operating in the heat?

The first is getting enough resources there where you can rotate crews out to REHAB after they have worked. We cannot keep beating our crews up. Another thing is that REHAB is becoming part of our culture now. Our members see how important it is for their safety and productivity.

Even officers are now asking that their crew go to REHAB, that did not happen in the past. We also applaud those that ask for help when they are not feeling well. We relate it to calling MAYDAY. No one wants to make that call, but if you are not feeling well you must ignore your ego and ask for help.

What do you use for rehydration?

We do use Gatorade, but we often cut it half with some water. Many of our younger people are very cognizant of carbs and do not prefer the sugary drinks. I have used electrolyte replacement tablets that have made a big difference in my own fitness.

Field Code Changed

PHOENIX REGIONAL
STANDARD OPERATING PROCEDURES

HEAT STRESS MANAGEMENT

M.P. 206.13 10/15-R 06/18-SR

The purpose of this procedure is to establish guidelines and responsibilities for minimizing the effects of heat stress to department members.

PROCEDURE

The following directives are to be implemented effective June 1st to September 30th of each year or at the discretion of the on-duty Shift Commander.

1. Dispatch and Deployment shall provide an additional ALS Engine Company and Rehab Unit to any working fire incidents.
2. Each member will be responsible to:
   a. Maintain proper rest/nutrition regimen
   b. Observe appropriate work/rest cycles
   c. Hydrate before, during, and after each shift (minimize coffee, tea, and cola products)
   d. Inform supervisor of any ill effects due to heat
3. In addition to the above, Company Officers are responsible for monitoring and managing:
   a. Cardiovascular activity (i.e., tennis, racquetball, running, etc.) shall be limited to a maximum of 30 minutes
   b. A minimum of 64 ounces (2 quarts) of fluid should be consumed during the 24 hour shift
   c. Work/rest cycles, request a relief company and assignment to rehab after crew has consumed two bottles of air
   d. Company activity and request additional resources as necessary
4. During emergency operations the Incident Commander is responsible for the following:
   a. Consider the establishment of a Rehab Sector/Division/Group on all working fires
   b. Assign companies to Rehab Sector/Division/Group as needed or requested (companies shall remain in rehab for a minimum of 20 minutes)
   c. Utilize the practice of first company in, first company out routine
   d. Request additional resources as necessary

Field Code Changed

Offensive Strategy on Cardiovascular Health

With the recent drastic and sudden surge in high temperatures we must pay close attention to the next two modifiable elements that the Regional Wellness Committee identifies as most applicable for our Offensive Strategy tactics on Cardiovascular Health:

Hydration

Firefighting requires strenuous work in hot environments while wearing heavy and restrictive clothing and carrying heavy equipment. The average 200-pound firefighter assigned to interior operations at a typical structure fire could easily lose two percent of their body mass within 30 to 60 minutes, depending on work intensity and environmental conditions. The decrease in muscle strength and reduced ability to concentrate from this loss of body mass will affect fire ground performance. Per NFPA 1584, every member on scene must participate in rehab, maintain their own hydration, advise their company officer when their performance is affected, and maintain an awareness of the status of other members on scene. Firefighters are often significantly dehydrated.

Recommendations:

1. Fire Departments should ensure that adequate hydration/re-hydration, rest cycles and medical monitoring is provided for at all training and fire ground operations. This can be part of a formalized rehabilitation process or an informal crew based process as is determined to be appropriate.

2. Maintain hydration daily

- Consume half your body weight in ounces of water
- Limit alcohol consumption the day prior to reporting for duty.
- Avoid high level caffeine products during your duty day.
- Post urine color charts in restrooms as a self-evaluation tool.

3. Prior to Fire Ground Training, Operations or Physical Training

- Drink at least 16 oz. of water an hour before operations/exercise to ensure proper fluid levels.

4. During Fire Ground Training, Operations or Physical Training

- Drink cool (40 degrees F) diluted fluids at a minimum rate of at least 8 oz. every 15 minutes
- If exercising longer than 90 minutes, drink 8–10 oz. of a sports drink (with no more than 8% carbohydrate) every 15–30 minutes.

5. After Fire Ground Training, Operations or Physical Training

Field Code Changed

- If the exercise (fire ground activity) lasts for less than an hour, the body should have sufficient electrolyte and carbohydrate supplies to maintain optimal performance. Therefore, for short periods of exercise, water is just as good as sports drinks. If exercise (fire ground activity) lasts for more than an hour, use a sports drink with electrolytes and carbohydrates along with water to rehydrate the body.

- If no water was consumed during exercise (fire ground operations), aggressively rehydrate at a rate of 16 oz. of fluid every 15–20 minutes

Heat Stress

In 2007, Orange County Fire did a study with 100 participants, of all fitness levels, wearing full PPE for a 30-minute work cycle simulating five-fire attack drills. After the 30-minute work cycle, the average firefighters core temp was 101.8F, with 44% over 102.1F. After five minutes of rest, the average core temperature continued to rise, and after 15 minutes of rest with no intervention, the average core temperature was still 101.1F. These findings show that on average almost all firefighters are experiencing heat stress after one work cycle in full PPE. Rehab sector is established to help cool firefighters off to a safe level before they work another cycle. The study found that active cooling was 50-60% more effective than passive cooling. Passive cooling included removing gear lowered temps 0.75F, and a misting fan lowered temps 0.88F. Active cooling includes using a cold wet towel on head & neck lowered temps 1.18F and forearm immersion in ice water lowered temps 1.22F (Dodson, 2016).

Recommendations:

1. Utilize Full Rehab Sector after each work cycle

2. Participate in Passive and Active Cooling

   - Remove all protective clothing, including boots, to allow for maximal cooling and utilize a misting fan where appropriate. Cold wet towels on head and neck and or forearm immersion in ice water buckets are both inexpensive and highly effective options.

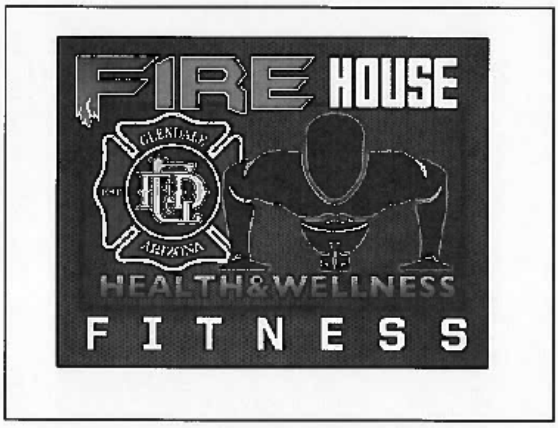
3. Acclimatization (train in turnouts and include safe outdoor activities to slowly acclimate)

4. Hydration – noted in prior section

Although we don't often correlate Hydration and Heat Stress Management as risk factors for cardiovascular health problems, it is the position of the Regional Wellness Committee that we take an active approach to modify these factors to mitigate our risk. This is crucial to us year around, but especially in times of daily high heat temperatures and often habitual dehydrated states. Set yourself up for success and stay active and hydrated! It's almost summer and we are still offensive!

Field Code Changed

1/20/201



Effects of Heat Stress on Firefighters

- The most common heat illnesses among athletes are heat cramps, heat syncope, and heat exhaustion.
- Heat exhaustion is the most commonly diagnosed form of heat illness among athletes, despite the fact that its symptoms are often vague and differ greatly from one situation to another.
- Clinical descriptions include various combinations of headache, dizziness, fatigue, hyperirritability, tachycardia, hyperventilation, diarrhea, hypotension, nausea, vomiting, syncope, heat cramps, as well as "heat sensations" in the head and upper torso.

Field Code Changed

1/20/201

Effects of Heat Stress on Firefighters

- The three aforementioned heat illnesses all involve either fluid-electrolyte balance, extracellular volume and tonicity, or cardiovascular adaptation.
- This emphasizes the importance of (a) ample dietary intake of NaCl and fluids, and (b) fluid-electrolyte hormone regulation during heat acclimatization.

How to Become Acclimated for Firefighter Performance

- Complete heat acclimatization requires up to 14 days
- Physical exercise in the heat is required to achieve optimal heat acclimatization for that exercise intensity in a given hot environment.
- For firefighters it is important to include exercise under working conditions (wearing turnouts!)

Field Code Changed

1/20/201

How to Become Acclimated for Firefighter Performance

- During the acclimatization process the body chemistry changes as it learns to conserve minerals normally lost through sweat and urine.
- Sweating response becomes earlier and greater.
- Better cooling is achieved as blood flows closer to the skin.

How to Become Acclimated For Firefighter Performance

Total Benefits of Heat Acclimatization include:

- Improved thermal comfort
- Improved exercise/work performance
- Reduced core temperature
- Earlier and greater sweating
- Earlier skin blood flow
- Lower body heat production
- Lower heart rate
- Reduced salt losses

Field Code Changed

1/20/20:

Training Suggestions for Heat Acclimatization

- Individuals with a high VO2max exhibit superior heart rate and rectal temperature responses, and usually reach a stable heat acclimatization state faster, when compared to those with a low VO2max.
- Numerous studies show that you can increase your VO2max by working out at an intensity that raises your heart rate to between 85 and 95% of its maximum for at least 20 minutes three to five times a week.

Training Suggestions for Heat Acclimatization

Training Suggestions:

- At least once a week train in turnouts for at least 20 minutes.
- Includes Skills Course, Stair climbing, Hose Lays, etc....
- Find person with "most room for fitness improvement" on crew and focus training toward them reaching and maintaining acclimatization?

Field Code Changed

1/20/201

Training Suggestions for Heat Acclimatization

- This assures all crew members are acclimated and have acceptable firefighter fitness levels.
- Other shifts during the week concentrate on P.T. centered around intensity levels reaching 65% to 85% max heart rates.
- Examples are circuit weight training/interval cardio training.
- Emphasize hydration, nutrition, core temperature regulation pre/post exercise.

Stay Constantly Vigilant!

- The benefits of heat acclimation are lost quite rapidly when an individual stops exercising in heat conditions.
- In general, with each two days of abstaining from heat exposure, one day of acclimation is lost.
- Thus, after three to four weeks without heat exposure, an individual should be considered un-acclimated.

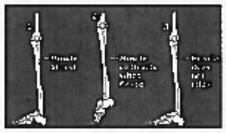
Field Code Changed

1/20/201

Heat Cramps

You can usually treat heat cramps by drinking water or fluids containing electrolytes, resting and getting to a cool spot, like a shaded or air-conditioned area

Heat cramps are caused by initial exposure to high temperatures or physical exertion



Signs and symptoms usually include

- Excess sweating
- Fatigue
- Thirst
- Cramps, usually in the stomach, arms or legs

Heat Exhaustion

A result of the body overheating

Symptoms may Include

- Cool, moist skin with goose bumps when in the heat
- Heavy sweating
- Dizziness
- Fatigue
- Weak, rapid pulse
- Low blood pressure upon standing
- Muscle cramps
- Nausea
- Headache

Without prompt treatment, heat exhaustion can lead to heatstroke

Causes of heat exhaustion include exposure to high temperatures, particularly when combined with high humidity, and strenuous physical activity

Field Code Changed

1/20/201

Heat Stroke

EMERGENCY

Heatstroke is caused by prolonged exposure to high temperatures or by doing physical activity in hot weather.

Patients are considered to have heatstroke when the body temperature reaches 104 F (40 C) or higher

- Heatstroke occurs if the body temperature continues to rise.
- In a period of hours, untreated heatstroke can cause damage to the brain, heart, kidneys and muscles.
- These injuries get worse the longer treatment is delayed. Increasing the risk of serious complications or death.

Heatstroke Symptoms Include

A body temperature of 104 F (40 C) or higher is the main sign of Heatstroke

- **A lack of sweating**
- Nausea and vomiting. Patients may feel sick to the stomach or vomit
- Flushed skin. Skin may turn red as the body temperature increases
- Rapid breathing. Breathing may become rapid and shallow
- **Racing heart rate**
- **Headache**
- **Confusion**. Patients may have seizures, hallucinate, or have difficulty speaking or understanding what others are saying
- **Muscle cramps or weakness**. Muscles may feel tender or cramped in the early stages of heatstroke, but may later go rigid or limp.
- **Unconsciousness**

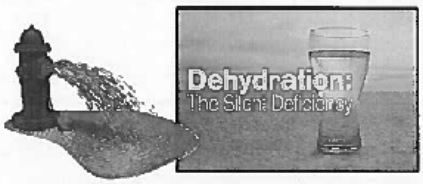
Field Code Changed

1/20/201

Heatstroke Treatment centers on cooling of the body to a normal temperature to prevent or reduce damage to the brain and vital organs.

- Use evaporation cooling techniques.
- Apply ice packs to the groin, neck, back and armpits
- If any treatments to lower your body temperature causes the patient to shiver, you may patch for a muscle relaxant, such as a **benzodiazepine.** Shivering increases your body temperature, making treatment less effective

Dehydration



Dehydration occurs when the body loses more fluid than it takes in, and the body doesn't have enough water and other fluids to carry out its normal functions.

Field Code Changed

1/20/201

Levels of Dehydration

Depending of the severity of dehydration, the course of action will be drastically different

Mild – 0-5% loss of body water
- Dry sticky mouth
- Sleepiness or tiredness
- Decreased urine output
- Dry skin
- Headache
- Constipation
- Dizziness or lightheadedness

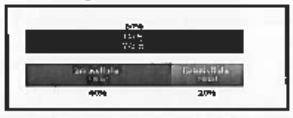
Moderate – 5-10% loss of body water

Severe – 10-15% loss of body water
- Extreme thirst
- Very dry mouth
- Dry skin
- Lack of sweating
- Little or no urination
- Sunken eyes
- Poor Skin Turgor

Go any further than 15% of body water loss, and the situation becomes life-threatening. It is at this point that dehydration gets its reputation for being fatal.

Water is the most important and fundamental need of our body

It's for that reason that understanding dehydration is so vital



Generally, our bodies are hydrated when our body water is at normal levels. A normal body water level is 60% of body weight. Of that body water, 2/3 is Intracellular Fluid (body water within cell membrane) and 1/3 is Extracellular Fluid (body water outside of cell membrane: blood, interstitial fluid, etc.).

Field Code Changed

1/20/201

Hyponatremia

Is a condition that occurs when the level of sodium in the blood is abnormally low.

This type of dehydration much less common (5-10% of cases), but much more severe. Hyponatremic dehydration is an electrolyte imbalance in that more salt is lost in relation to water.

Signs and Symptoms May Include

- Nausea and vomiting
- Headache
- Confusion
- Loss of energy
- Fatigue
- Restlessness and irritability Muscle weakness, spasms or cramps
- Seizures
- Unconsciousness
- Coma

A Normal Sodium Blood Level is Between 135 and 145 MilRequivalents Per Liter (mEq/L) of Sodium. Hyponatremia Occurs When the Sodium in the Blood Falls Below 135 mEq/L.

1

1/20/2

Battalion Chief Pat Martin

Health and Wellness Division
Glendale Fire Department
Office (623)772-7192
Cell (623)451-8532

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APPENDIX D – SURVEY MONKEY DATA

The following is the data report provided by SurveyMonkey©

Q1 What fire department are you representing? (Please include your State)

Answered: 280 Skipped: 0

Q2 What is your rank?

Answered: 280 Skipped: 0

Q3 Numerous fire service studies have suggested that the lack acclimating (the process of adapting one's body) to the heat increases a firefighter's risk of having a heart attack, which is one of the leading causes of firefighter line of duty death each year. How familiar are you with this process as it relates to you as a firefighter?

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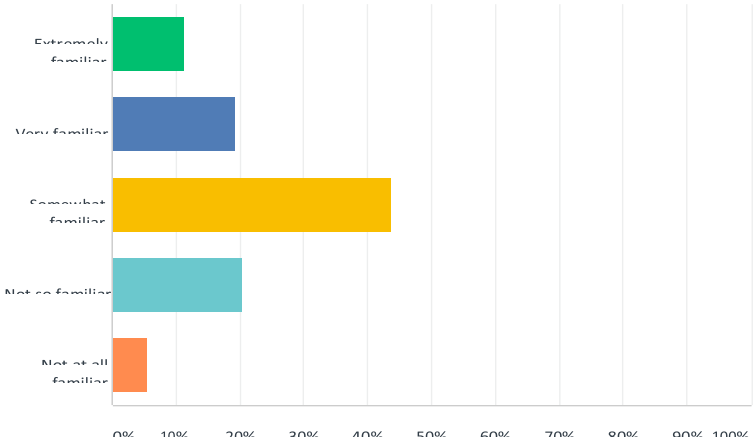
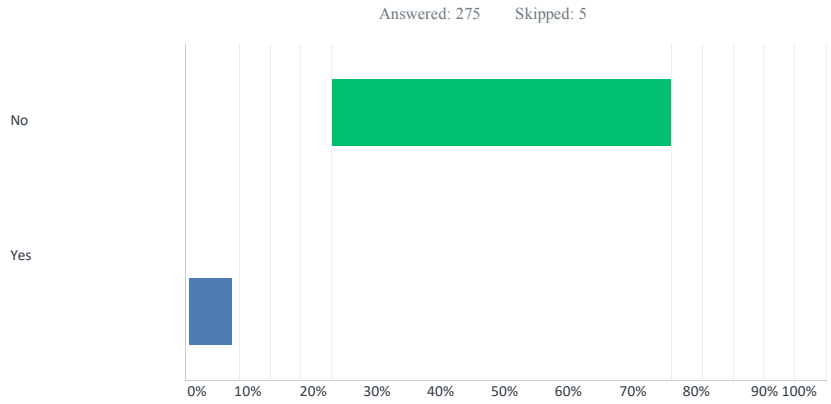
Answered: 275 Skipped: 5



ANSWER CHOICES	RESPONSES	
Extremely familiar	11.27%	31
Very familiar	19.27%	53
Somewhat familiar	43.64%	120
Not so familiar	20.36%	56
Not at all familiar	5.45%	15
TOTAL		275

Q4 As far as you know, does your fire department have an guidelines or procedures for acclimating to the heat?

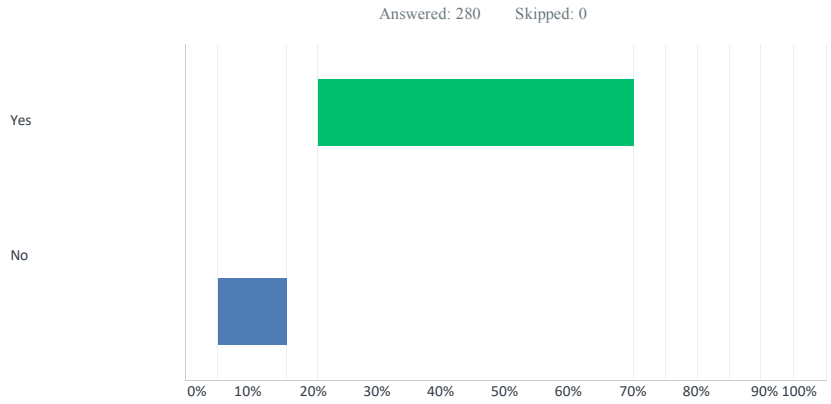


ANSWER CHOICES	RESPONSES	
No	93.09%	256
Yes	6.91%	19
TOTAL		275

Q5 How does your department PREPARE for operating in the heat? What specifically do you do?

Answered: 277 Skipped: 3

Q6 Have you or anyone on your fire department ever been treated for a heat injury (heat cramps, heat exhaustion or heat stroke) while operating on an emergency scene?



ANSWER CHOICES	RESPONSES	
Yes	79.29%	222
No	20.71%	58
TOTAL		280

Q7 Thank you for taking the time to complete this survey! Please include the following contact information if you do not mind being contacted if your answers promote further questions:

Answered: 216 Skipped: 64

ANSWER CHOICES	RESPONSES	
Name	100.00%	216
Company	0.00%	0
Address	0.00%	0
Address 2	0.00%	0
City/Town	0.00%	0
State/Province	0.00%	0
ZIP/Postal Code	0.00%	0
Country	0.00%	0
Email Address	97.22%	210
Phone Number	84.26%	182

APPENDIX E – PROPOSED HEAT ACCLIMATION GUIDELINES

Kent Fire Department Policies, Procedures and Guidelines

000.00 HEAT ACCLIMATION

I. PURPOSE

To provide a guideline on how to properly acclimate to the heat. Research has shown that heat acclimation training may allow firefighters to more effectively manage high cardiovascular demands further induced by exposure to high heat conditions. Subsequently, hear rate and blood pressure will remain within safe parameters. An acclimated firefighter may be able to operate longer without overheating and may recover faster prior to the next operation.

II. POLICY

1. The fire department will provide training on heat acclimation principles and will review this guideline annually with the entire department.
2. The fire department will make providing time and opportunity for members to conduct heat acclimation training a priority each shift day. The fire department highly recommends and encourages each member to maintain a high level of physical fitness.

III. GUIDELINE

The following is a guide for the member to follow who wishes to get acclimated to the heat. The goal is to in the environment that you wish to acclimate to in the level of personal protective equipment (PPE) that you would expect to operate in.

A. Begin the first workout in full PPE

1. Conduct a light to moderate work load for 8-10 minutes.
2. It is important to remember that by wearing full PPE your workload is automatically increase, you do not need to do much to get benefit when you first start.
3. To not push the body, a good rule of thumb is to limit your workout or work load by 50 % if the temperature is equal to/or greater than 90 degrees F.

4. These workouts should be conducted daily and to increase the workout time by 10% each day.
5. It is recommended to start slow and ramp up ONLY when you feel comfortable and capable. This rule should also be followed when working out in a group, each individual must monitor their own work load.
6. Workouts should last a minimum of 10-14 days, preferably longer when a firefighter lacks physical fitness.
7. The acclimated firefighter while being in better physical fitness and weighing less, will also likely have an increased amount of blood plasma. Thus, greatly protecting their cardiovascular system.
8. Acclimation can be quickly lost, so it is imperative to make these workouts a regular event for as long as you want the protection from acclimation.

B. Normal shift operations during high heat temperatures

1. Firefighters are recommended not to avoid the heat, but rather, invite light workloads (training, chores) during the heat of the day.
2. It is also recommended to not lower air conditioning to cold temperatures. A more normal operating temperature (68-70 degrees) limits the shock to the firefighter when exposed to high heat conditions.

C. The use of saunas to acclimate to the heat

1. Saunas can be very beneficial to the firefighter in acclimating to the heat. Research has even shown that regular sauna use can significantly lower a person's risk of sudden death.
2. If/when the fire department purchases a firehouse sauna, the following guideline can be followed to assist the firefighter in attaining and maintaining heat acclimation throughout the year:
    A. The firefighter conduct light physical activity (step ups or on bicycle) in shorts and shirt for 10 minutes.
    B. The firefighter adds pieces of the PPE gradually over 3-4 weeks until they are fully encapsulated. PPE must be clean, so not to contaminate the sauna.
    C. Once they are fully encapsulated, the firefighter can then increase the time in the sauna by 10% each week.
    D. Completing this training will greatly enhance the fitness and heat acclimation for the firefighter.

APPENDIX F – PROPOSED HYDRATION GUIDELINE

Kent Fire Department Policies, Procedures and Guidelines

000.00 HYDRATION

I. PURPOSE

To establish a guideline on how to maintain proper hydration before reporting to work, while operating at a physically demanding emergency scene and after returning back to quarters. Research has shown that being well hydrated reduces overall physiological strain on the body. Additionally, proper hydration plays a specific role in how well and how long one can perform under physical exertion, especially in high heat conditions.

II. POLICY

A. The fire department will make it a priority to provide annual training on proper hydration techniques and review this guideline with all department members.

B. The fire department will post urine color charts in every department restroom to help members to determine their level of hydration.

C. The fire department will provide bottled water and a rice-based sports drink (Cerasport EX1) as hydration drinks to aid in healthy maintenance of hydration and rehydration. The fire department recommends that members avoid excessive caffeine ingestion while on-duty. If a commercial sports drink is the only option available, it recommended that the member mix the drink with 50% water.

III. GUIDELINE

D. BEFORE reporting to work begin drinking water as soon as you can and evaluate your urine color :

1. 1. If your urine is dark in color, it is suggested that you consume at least 12-16 ounces of water before the start of your shift.
2. 2. If your urine is light in color, it is recommended that you consume 10-12 ounces of water before the start of your shift.

3. 3. A breakfast high in carbohydrates is also recommended, especially if high heat or intense activity (i.e., training fires) is expected. If you do not fight a fire or an equivalent activity, then it is recommended that you participate in some form of aerobic activity for up to 60 minutes to earn that breakfast.

E. DURING normal work hours:

1. It is recommended to drink water or the provided rice-based sports drink (Cerasport EX1) ad libitum throughout the day. The operational definition of this is 'micro-hydration'. This simply means that the member takes periodic (every 20-30 minutes) SIPS to maintain hydration through the shift.

2.

F. DURING fires or any other strenuous activity:

1. It is recommended to pre-hydrate en-route by taking a couple sips of the provided rice-based sports drink (Cerasport EX1). This will help to maintain hydration during the first stressful minutes.
2. It is recommended to hydrate hydrate every 20-30 minutes while on the emergency scene, by drinking an 8 ounce bottle of the provided rice-based sports drink (Cerasport EX1).

A. AFTER a fire or any other strenuous activity:

1. Immediately after, the recommendation is to drink 500 ml of the provided rice-based sports drink (Cerasport EX1) followed by 20 ounces of water.
2. To aid in proper absorption and to prevent gastrointestinal issues, it is recommended to sip the sports drink versus drinking a large bolus.
3. Back at the firehouse and during the hours after, it is important to eat a full meal along with drinking 2 liters of water. Doing so will greatly prepare the body for the remainder of the shift and help to maintain safe blood levels and hydration. Additionally, your energy levels will be restored through replenishment of your skeletal muscle, liver and kidney glycogen stores.

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