

## **SSE Roundtable #28: The Industrial Worker: A Different Breed of Athlete**

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### ROUNDTABLE

#### THE INDUSTRIAL WORKER: A NEW BREED OF ATHLETE

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#### **Introduction**

The industrial worker, whose occupation requires various degrees of physical effort for sustained periods of the work day, is a unique breed of athlete. The ability of this individual to perform physically may have direct bearing on the productivity and competitiveness of the worker's company, much like the success of an athlete's team. The stakes of life or death situations faced by some workers can elicit physical and psychological stresses that are greater in magnitude than those faced during world-class athletic competition. Our panel of experts discusses the physical and mental stress faced by industrial workers to expand our insights into occupational physiology.

1. To familiarize our readers with the types of stress and sources of injury faced by working, please describe the various environmental stresses that may be encountered on the job in industry.

T. Bernard: Among the workplaces with which I am most familiar, clearly high environmental heat and clothing requirements are the biggest problems. The environmental heat comes in the form of high workplace temperatures and humidity along with significant amounts of

radiant heat on occasion. A person's capacity for balancing the heat stress by evaporative cooling is truly remarkable. But in most workplaces, the standard clothing will limit the rate of evaporative cooling. When special purpose clothing is worn to prevent burns or chemical contamination of the skin, the rate of evaporative cooling is reduced even further.

G. Bates: The operations in Australia mining, where I work, offer some examples of the type of environmental stress that Dr. Bernard mentioned. Some mines in the far north have temperatures in the mid 40's °C; (113°F) and reasonably high humidity (>70%). Most, however, operate in above 40°C dry bulb with humidity between 30 and 70% during the summer. The very high wet bulb temperatures are made worse in underground operations by the large volumes of water used to reduce dust. The daily environmental temperature at one mine I have recently visited had on average a daily dry bulb of 40-45°C, but people working in the copper smelter plant are exposed to temperatures of around 50°C. The most stressful exposure I have witnessed is that of bricklayers who repair furnaces while they are in operation. The dry bulb temperature reaches >90°C (>194°F). It's so hot that the worker's shoes can catch fire, and maximum exposure is limited to 15 minutes.

H. Bilyk: Firefighters, the workers with whom I consult, face temperature extremes of anywhere from below freezing to in excess of 300°C (>570°F), and in many cases these extremes occur within minutes of each other. They are continuously exposed to various chemical and physical hazards, one of which is the microclimate that is created by the protective gear that they wear. The protective barrier of the gear also prevents the body from properly cooling itself. The heavy physical labor that firefighters must perform can result in heart rates of 88±6% of the predicted maximum. The generation of internal body heat and the inability to dissipate heat are further compounded by the weight of the gear (bunker suit, helmet, and self-contained breathing apparatus), which approaches 24 kg (53 lb.). Add to this that the firefighter must be able to transport various pieces of equipment that can weigh over 35 kg (77 lb.) while still in full gear, in a dark, smoky environment, with limited visibility.

S. Gieske: Based on experiences in our food research plant, which would be representative of many other plants or factories located in the U.S., the main stresses are noise, hot temperatures during the warm months, hot pipes, a large variety of movable machinery and psychological stresses. Psychological stresses evolve out of a constantly changing environment, both with jobs and machinery, with organizational changes in the company, and with job insecurity. Noise can vary depending on the section of the plant, with levels reaching above 85 decibels when the machinery is in operation. At times, some plant workers are covered in protective gear, like the firefighters. Generally, workers face a pretty tough heat challenge in warm seasons because the plants can not be air conditioned for logistical reasons.

2. Relative to the tasks performed on the job, what physical attributes or types of fitness are required by your workers to fulfill their daily duties?

G. Bates: Although the precise requirements differ for each site, the heavy work on some mine schedules (12 h shifts for 14 consecutive days) in a hot/humid environment generally requires both muscular strength and cardiovascular endurance. Just as athletes develop great coordination for specific movements through daily training, workers are very efficient at specific tasks from years of experience in performing their work, which is intermittently repetitive. This adaptation or training effect is generally referred to as work hardening, and takes some months to acquire. As a result the workers do not necessarily have high maximum oxygen uptake ( $V_{O2max}$ ) values. This motor efficiency allows them to sustain a task without fatigue whereas a less experienced person could suffer an overuse injury.

They are also fully acclimatized to working in the heat, more so than the acclimatization that occurs during the 2 week period that is classically recommended. It may take the miners

months rather than weeks, before they feel somewhat comfortable working in very hot conditions for long daily durations.

H. Bilyk: Research shows that most firefighters fall into the sedentary range of physical fitness. This is misleading, though, because firefighters must go from a sedentary lifestyle to a sudden, very physical, high-stress situation that requires them to be able to perform duties as needed. Firefighters must be able to lift and hold for extended periods of time various pieces of equipment that may weigh in excess 35 kg (>77 lb.). They're also required to ascend ladders in full gear, while carrying additional pieces of equipment of various weights. Therefore, strength or muscular endurance would be of utmost importance to the firefighter.

S. Gieske: The work in our pilot plant requires a moderate degree of fitness and the performance of fairly predictable activities that are somewhat similar to those of the firefighters. These include climbing ladders, stooping, kneeling, pushing and pulling. The workers are also frequently required to do lifting, pushing, and pulling such as lifting a 23 kg (50 lb.) bag of ingredients. Good vision, manual dexterity and alertness is also required given the proximity of overhead bars, moving machinery and hot and electrical connections. These jobs require a certain endurance because once a project is started it must be followed through carefully to completion, which may be several hours before the worker can completely rest.

T. Bernard: We like workers to have good aerobic capacity because these individuals tend to be the most heat tolerant. Usually, this means good cardiovascular and pulmonary health as well as normal physiological functioning of other organ systems. Like the others here, we work with adults between the ages of 18 and 65 years who are in generally good health and qualified by a physician. There is also some self-selection of workers into the more demanding jobs. Because performance screening tests are not sufficiently reliable, we can not use them to select workers; they can only be used to counsel workers about possible heat tolerance.

3. Are there specific injuries that your workers risk incurring? What precautions are taken to reduce the chances of such risks?

S. Gieske: Our most frequent injuries are cuts and lacerations of the hands, burns related to hot steam lines and back strains. Work-related illnesses have included a hearing impairment. Heat stress is a potential illness source as well.

To prevent these problems, the workers themselves have been trained to complete a written job-hazard analysis of the tasks and machinery. They identify possible causes of injury, for example, cuts and lacerations, and list the required protective equipment and gear needed to eliminate the risks. Job-hazard analysis is applied to identify risks of back strain, too. Training sessions on proper lifting techniques are given to those at risk, and instruction on exercises to strengthen muscles, including consultation with physical therapists, and risk assessment for the back are offered free to all employees. Hearing loss is minimized by requiring each exposed worker to attend annual training on hearing conservation, to obtain a free audiogram with feedback, and to wear ear plugs while machinery is running. All areas in the plant are marked as high noise areas. Through posters displayed to alert workers to heat stress, and passing the word to drink more when the temperature gets to critical levels, we've fortunately avoided cases of heat illness.

G. Bates: To elaborate on the heat stress, after a few hours of work in the heat, dehydration can reach levels that impede heat dissipation and compromise cardiovascular function and work capacity. If the normal signs of heat stress, such as thirst, tiredness and visual disturbances, are not heeded, the result can be a series of disabling complications such as heat cramps, heat exhaustion, and heat stroke. Surprisingly, the incidence of reported heat

illness at work sites in these harsh environmental conditions is unexpectedly low. One possible reason for this may be that as heat-induced hypohydration impairs mental and physical performance, workers may suffer muscle fatigue or a loss of concentration, which then leads to accident and injury. A large number of injuries may be caused by mental and physical decrements as a consequence of poor hydration; however, the primary cause (dehydration) is misdiagnosed.

Methods of preventing heat stress vary, but the most successful intervention includes education. I know of a number of work sites where the incidence of heat illness has been significantly reduced by educating the work force on the importance of fluid replacement during work. Where this type of strategy has been introduced, the men have a greater daily fluid intake than their less informed counterparts in other companies. There is no doubt that adequate fluid intake is the greatest single factor that minimizes the risk of heat illness in industry.

T. Bernard: I agree. The most frequent illness among workers exposed to heat stress through environmental conditions and/or clothing requirements is heat exhaustion, which is most likely due to dehydration. Some workplaces will also report frequent occurrence of muscle cramps. To reduce the risk of heat disorders, a strong emphasis is placed on heat-stress hygiene practices. These include self-limitation, adequate fluid replacement, eating a good, well-balanced diet, monitoring health status, and allowing for acclimation to the heat. The workers must be aware of what they can do to lower their individual risks for heat disorders, and the employer must do those things that are reasonable to encourage these practices.

H. Bilyk: Interestingly, almost 50% of firefighter fatalities on duty are not from direct fire related injuries but from heart attack and stroke. Direct injuries that occur to firefighters include heat illness related to dehydration, smoke inhalation, burns, sprains, and other traumas to the musculoskeletal system. Chronically, firefighters experience a high incidence of knee injuries, usually due to prolonged, physical stress on the joints. Most scenarios in which the injuries occur cannot be changed, but the procedure on how to prevent each injury can. Firefighters, in general, should receive training and in-service education on nutrition, which could help prevent the leading causes of death among these workers. Nutrition classes, taught by a Registered Dietitian, have had a direct, positive effect on helping firefighters achieve adequate fluid intake for better hydration, and in reducing the total caloric intake and the grams of fat consumed each day. Regular exercise that includes aerobic and anaerobic training, can be used as another "precaution."

4. What are the chronic health risks, physical or mental, that your workers face? What actions do you or other health professionals take to attenuate these risks?

T. Bernard: Because of the competition for blood flow during exposures to heat stress, there is some risk of ischemic digestive system disorders. My real concern, however, is the opportunity risk for serious accidents associated with heat stress exposures. As mentioned earlier, the frequency of unsafe behaviors, poor decisions, accidents, and injuries increases with increasing levels of heat stress. Therefore, the longer a person is working under conditions of heat stress, the more likely he or she will suffer an injury. These opportunity risks are managed the same way that we manage the acute exposures to heat stress. That is, good heat-stress hygiene practices are encouraged, and the exposures to heat stress are controlled through changes in the level of stress, administrative controls on the amount of work time and rest periods, and use of personal cooling systems in extreme cases.

G. Bates: The most obvious chronic health risk in those with whom I work is renal calculi (kidney stones). The high degree of employee turnover in many of these industries makes it difficult to demonstrate a direct link between renal stones and prolonged exposure to heat. Nonetheless, some data exist to support this relationship. Skin cancers in above-ground

operations are another common problem especially in northern Australia, which has the highest incidence of melanoma in the world. Other medical problems that arise in mining operations are burns, lead exposure, silicosis and back injuries. There are also a number of life-style health problems that are common in these remote towns, with alcoholism being the most prevalent. The culture of these towns is based upon a work-hard, play-hard philosophy, so most people not only drink, but drink significant quantities of alcohol. This can also be a problem in the heat because of the diuretic effect of alcohol. I strongly suspect that many people turn up for work in a hypohydrated state, which could have long-term consequences.

S. Gieske: The type of chronic problems I see relate fairly directly to risks, such as high cholesterol levels, poor diet habits, physical inactivity, and to a lesser extent, smoking, alcohol use and high blood pressure. Hypertension management involves identification and monitoring of blood pressure when the employee is on a medication. Back problems often are related to body weight and lack of exercise. Sprains and strains can be related to a lack of fitness. Upper respiratory diseases and other diseases where the body's immune system is compromised by stress and poor self care are common. Depression and generalized anxiety are the general types of mental health conditions often seen.

H. Bilyk: Generally, the chronic physical risks that firefighters face include being overweight or obese, or possibly having cardiovascular disease or osteoarthritis in the knee. They also face a considerable amount of mental stress. Most firefighters are on duty for 24 hours, then they are off for 48 hours. During this time they live at the fire station. Since there is never a "planned emergency," they are always anticipating the alarm. It's similar to being on a roller coaster. Once the alarm sounds there is an automatic adrenaline "rush" and an increase in their heart rate, before they even get to the fire. Combine the emotional stress of this with the health stresses of being overweight and having low cardiovascular fitness, and the physical stress of fighting the fire, and you have a candidate for a heart attack. Practical instruction on fluid intake, food portion control, and food label reading is beneficial. Education has made an impact, and results in positive changes, if the information is modified to meet the specific lifestyle and needs of the specific occupation with which you consult.

5. What is the typical diet pattern among your workers? Is there a belief among your workers that sound nutrition habits can enhance their performance on the job or lengthen their years in the work force?

H. Bilyk: Firefighters are concerned about their diets. They want to lower their fat intake and improve their overall nutritional status. They also feel that nutrition has an effect on their ability to perform. But like the general population, firefighters need instruction on the correct way to make these changes. They, too, are subject to misinformation about making lifestyle changes. Typically, their diet remains high in animal protein, and below the recommended serving amounts for fruits and vegetables. Their fluid intake is sporadic and high in caffeine content, both of which when combined with the high temperature work environment can result in a life-threatening situation. This is critical because the health of each individual firefighter affects that of all members of the firefighting team.

S. Gieske: Our employees are fairly knowledgeable about diet, partly because of the annual screening for cholesterol levels. There have been a number of nutrition intervention programs offered free at the work site and frequent communications on the risks of being over-weight, having high cholesterol, and consuming too much fat. Those employees who have switched to healthier eating and have lost weight-have generally been motivated by maintaining their edge in a competitive sport or because they have reached age 40 and realize that they cannot eat with disregard to their body weight. Losing weight increases their self esteem, and they like their new appearance. The motivation is less, if at all, from realizing increased job performance or to lower their health risks. We have made some progress in cholesterol lowering but no progress in weight management over the past years in spite of education and

other interventions. We are constantly trying to find innovative and successful strategies.

T. Bernard: With respect to diet, most workers follow a pattern that is typical of most Americans. They are not likely to link overall diet with productivity. They are encouraged to eat a sound, well-balanced diet and to avoid a weight-loss diet that is not under the direction of a physician. On the other hand, they will clearly link fluid intake and work performance. Through both personal experience and worker education efforts, they will understand the need to drink at regular intervals to replace fluid lost through sweating.

6. Is the incidence of injuries on the job linked to a time of day when workers might be fatigued, experiencing low blood sugar, or be dehydrated? What recommendations might minimize or prevent conditions that might be linked to the injuries?

G. Bates: One of my recent studies offers some insight. At one particular work site, about 80% of the accidents occurred in the late morning. Because, the workers lived on the site, we could study the living behaviors that might explain the injuries. Commonly, workers skipped breakfast and started work without food; either they were not hungry at 5:00 am or they chose sleep over food. Some employees did not eat for almost 18 hours if the previous evening meal was also missed. By sleeping in and missing breakfast, workers went from midday to midday with no substantial nutrition. This might produce fatigue that occurs between 10:00 am - 12:00 p.m. on the job, and may cause the more serious accidents at that time of day. So far, though, the blood sugar levels of the workers have been within the normal range, so hypoglycemia does not seem to be the culprit. Possibly, hypohydration may result in falsely high glucose levels, or some individuals may experience sufficient drops in blood glucose over a shift to induce mental changes. It would be premature at this point to state that hypoglycemia is not involved in worker fatigue. Other factors promoting fatigue and injuries are poor hydration compounded by the large volumes of alcohol consumed the prior evening, and circadian rhythms, which could affect energy level, hydration status, or the ability to concentrate mentally.

S. Gieske: Our injuries occur late morning or early afternoon, and our worst injuries seem to occur in the spring and at the beginning of the holiday season. Injuries also seem to occur when the employees work long hours. Complicating the situation is the fact that our workers may have a second job that is also physical.

H. Bilyk: One of the most important concepts that I stress is the importance of continuous fluid consumption. Due to the fact that a firefighter never knows when they will be called to a fire and that they should not rely on their thirst mechanism, it is important that they drink appropriate fluids throughout their entire shift.

T. Bernard: We do know that unsafe behaviors, accidents and injuries increase with increasing heat stress exposures. Self-limitation and fluid replacement are two things that the individual should always be thinking about during the job. Management will do what it can to reduce the level of heat stress through engineering controls and adjustments in work practices, especially the planning of rest breaks, and providing fluids for replacing sweat losses. Many of the jobs that I've observed are paced by the production requirements, so productivity improvements are more difficult to show. After careful analysis of the heat stress demands and reallocation of work in an aluminum smelter, production was maintained by fewer people. Also, there was a decrease in the reported number of heat-related disorders as well as a decrease in reportable injuries, in general. An important feature of the changes in work practices were enforced breaks for recovery and rehydration. Another plant provides one-quart insulated containers that are filled with a commercial fluid replacement drink and carried along by the workers so that they can comfortably drink small amounts frequently during the periods of highest activity.

## **Summary**

The demands, both physical and emotional, in industrial settings require a novel type of fitness in the worker. Environmental stress compounds the physical challenges faced by these individuals. Preventative measures such as maintaining proper hydration, acclimatization, being aware of the source of hazards, changing dietary patterns, performing exercise on a routine basis, and controlling of weight and adiposity, can assist in reducing risks presented in the work place.

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