Looking for a Few Good Women

Physical demands of combat

by Paul O. Davis

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With the stroke of a pen on his last day in office, Secretary of Defense Leon Panetta signed a directive that created nearly irreversible pressure for the Armed Forces of the United States to open direct ground combat forces to both genders, thereby squelching both the subjective lessons of millennia of history and objective scientific data. The goal was noble—advance civil rights—but the consequences for our country and those who defend it can be very, very grave. To those whose minds are open to discussion of an issue of such consequence, an examination of what both science and a parallel experience tells us about qualifications and outcomes might be illuminating.

Ergonomics

As the science behind the study of physical work, ergonomics includes analyzing job changes in the workplace that reduce the incidence of overuse injuries and mitigate musculoskeletal trauma by introducing safety and labor-saving devices. To be sure, ergonomics and material-handling equipment have dramatically reduced workplace injuries and increased manufacturing efficiencies. However, it is not true that all jobs can be reengineered so that either the applicant pool or those who are ultimately accepted for the job are assured of injury-free employment. Hand-to-hand combat warfare is one place where job reengineering is severely limited in its capability to protect the Marine.

Equal Employment Opportunity

Federal employment opportunity law proscribes discrimination in hiring decisions based upon stereotypes or factors that are unrelated to the requirements of the job. These protections extend to racial- and gender-based minorities, as well as the protected age group under the Age Discrimination in Employment Act. Because of the military's unique use of physical coercion to thwart our enemies from taking actions that are inconsistent with our national goals, the one class of employees exempt from Federal equal employment opportunity law include members of our Armed Forces.

Marines also underwent testing and evaluation at the MWTC. *(Photo by LCpl Cesar N. Contreras.)*

The critical and potentially deadly mission of close combat drives the selection criteria where the adherence to the highest of admission and retention standards increases the likelihood of combat success for the individual, as well as the battle group and, by comparison, second place is unacceptable.

Applied Research on the Marine Rifleman

In 1979, our research group, the Institute of Human Performance, was en-

gaged and funded by the Naval Medical Research and Development Command to objectively measure the physical demands of the combat Marine according to MOS 0311 (rifleman). The logic for focusing our study solely on 0311s was based upon the time-honored axiom that every Marine is first and foremost a rifleman, thereby simplifying the need for MOS-specific job standards that would provide objective criteria for acceptance or retention within MOS 0311.[1] For years the Marine Corps had been using a 3-item physical fitness test (3-mile run, pull-ups, and sit-ups) known as the physical fitness test (PFT), which was generally thought and accepted to be predictive of physical readiness. Minimum and maximum standards were age- and sex-adjusted.

Not all tasks can be reengineered to accomodate gender differences. *(Photo by Cpl Sara A. Medina.)*

The JTA—A Case Study

The first step in the development of close combat job standards is to conduct a job task analysis (JTA). The JTA identifies the essential functions that make the job unique and objectively identifies the trainable skills and abilities and the minimum capacities required in an applicant or incumbent population. The JTA included a review of military and pertinent scientific literature, observations of work performance, and, most importantly, surveys and interviews. At the initial stage of the Naval Medical Research and Development Command project, there were thousands of Vietnam combat veterans still on active duty. We convened panels of Vietnam veterans as subject matter experts (SMEs) in an attempt to develop a taxonomy of physical tasks that were: 1) frequently performed; 2) arduous (in that they required significant aerobic or muscular fitness demands); or 3) critical (i.e., if they could not be performed, injury or death would result).

Combat Veteran SMEs

Two SME panels were convened, one each at Camps Lejeune and Pendleton. Each panel spent the better part of a day creating a list of infantry tasks with objective descriptions of load-bearing tasks (including weights and distances) and a host of other physically demanding challenges related to 0311 combat activities that could be incorporated into the JTA. Clearly, not all of the complexities of combat can be fully characterized, but many important job tasks *can* be, and were. Not unexpectedly, the physical demands and the environment in which warfare takes place puts *rifleman* very high on the list of fitness capacities.

Warfare Simulation—Fire Team Integration

To further a better understanding of the position, over the next 4 years, the Institute of Human Performance team was integrated into Marine Corps fire teams that participated in training missions including amphibious, desert, jungle, and high-altitude/cold weather operations.[2] [3] [4] Essential Marine Corps tasks were observed, measured, and classified, including load carriage, climbing, swimming, and weapons training.[5]

High-Altitude/Cold Weather Theater

The cold weather theater was clearly the most physically demanding environment of all. This was primarily because of the loads carried (≥100 pounds) and the relatively high energy costs of performing such tasks in the cold at altitudes over 6,000 feet with the added challenge of locomotion on snow.[6] For the purposes of validating fitness standards in different environmental conditions, logic dictates that performing satisfactorily in the hardest environment meant that a Marine would likewise be capable of performing satisfactorily in all other less demanding environments.

Contingencies

As a nation, we have rarely had the luxury of choosing the place or timing of our next conflict. Women are already serving in combat with valor. However, recent counterinsurgency warfare has erased the memories of many as to the difficulties of urban warfare such as that seen in Fallujah, where violent house-to-house close combat required the absolute best we can muster. War *has* changed in the theaters of Iraq and Afghanistan, but are we willing to bet the country's security that this premise will hold for the next conflict? In his last speech as Secretary of Defense, Robert Gates stated, "When it comes to predicting the nature and location of our next military engagements our record [since Vietnam] has been perfect. We have never gotten it right."[7]

Physiological Baseline

To improve our understanding and interpretation of individual outcomes, as well as relative and absolute performances, each Marine underwent physiological testing as well as the PFT at the Naval Health Research Center in San Diego prior to their deployment

for the month-long training exercise at the Marine Corps Mountain Warfare Training Center (MWTC) in Bridgeport, CA. Measures included aerobic capacity, muscular strength, and endurance, as well as body composition (lean body weight and percent body fat). We added a 300-meter "hill dash" to obtain a power predictor.

Research Methodology

To obtain objective data on how the PFT and other physiological parameters predicted combat performance, we created a simulation of a day in combat at the MWTC. Two battalions participated in the study. One hundred Marines from each battalion (2d Battalion, 9th Marines, and 3d Battalion, 5th Marines) were randomly chosen by age, PFT score, and MOS and assigned to the study groups. Sticks of 20 Marines were flown via CH–46s to the "laboratory" and area of operations, approximately 9000 feet above sea level. They were provided an orientation and instrumented with a heart rate monitor. Each Marine's standard issue M16A2 weapon was rezeroed to the trajectory of a laser instead of the normal 5.52 round.

Each Marine then fired his weapon and was scored for 20 rounds at a known distance. Following the baseline shooting, they embarked on a series of connected tasks that included an ALICE pack hump weighing 45 pounds on a packed trail, ahkio sled pull (150 pounds) on snowshoes, digging a fighting hole, and performing a 50-meter resupply shuffle. A postevent shooting scenario incorporating another 20 rounds (as with the baseline) followed this series of tasks. The time for completion of the four tasks plus the pretest and posttest shooting scores were recorded for each Marine, and they were correlated with PFT and other physiological/fitness parameters.

Ratings of Perceived Exertion

During the simulated combat course, we obtained from each Marine a rating of perceived exertion. This rating of perceived exertion scale ranged from 1 (not hard) to 10 (extremely hard). Scores on this scale were correlated to actual arduousness based on the heart rate data we collected. Based upon these arduousness perceptions and an interpretation of the actual laboratory heart rate data, we found that a reasonable estimate of the aerobic and caloric demands of combat in this arena would be classified as "very high."

Lean (Fat-Free) Body Mass

Almost none of the Marines had fitness levels or arduousness perceptions that would compromise mission accomplishment. However, Marines whose total body weight was less than 130 pounds were more significantly challenged both in perception and heart rate data. This is understandable because the load carriage represented a significantly high percentage of their body weight. Most load carriage studies ideally suggest an external load of not more than 40 percent of body weight. This axiom is routinely violated. The practical implication is that smaller individuals must have a higher relative fitness level than their larger counterparts.

In the world of close combat, physical work can and does involve moving more than one's own body weight. The single most arduous task expected of a Marine other than hand-to-hand combat is moving a downed Marine. In a perfect world, all Marines would come in the same size. If this were the case, the expectation is that everyone would be capable of rescuing each other. However, it is an indomitable law of nature that physical size dominates performance.

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Study Conclusions and Results

Compared to the normative fitness levels of the general population within their age group, the Marines were a highly fit group. The variability in Marine fitness from the youngest (18 years) to oldest (43 years) was insignificant. In other words, there was more variance within different MOS categories than there was in age.

We found no scientific basis for scoring the PFT based on age when in fact, all Marines could be expected to perform the same combat tasks to the same level of proficiency across age levels. If women were expected to perform in this environment, gender-based proficiency levels would be equally inappropriate.

The high energy cost of travel, wearing snowshoes, and carrying heavy loads exacts a toll that can be measured and replicated. Estimates of rate of travel for infantry operations are severely impacted in this environment. These laws of physics are immutable. The energy costs of the Marines' test activities were roughly equivalent to that of running a half marathon.

Marines in the study group within the 0311 MOS had the lowest degradation in shooting performance. The PFT did predict with statistical significance performance in this simulated environment.

Power, the ability to perform work (mass x distance ÷ time) is a very important variable and cannot be overstated as a critical construct in combat. The hill dash provided valuable information in predicting work performance. In fact, if forced to choose one attribute for Marines, power would head the list. This finding was corroborated by an Army-sponsored research project.[8]

The Pull-Up

The inclusion of the pull-up in the PFT battery has long been considered by most as a good surrogate measure for upper body strength. A three pull-up minimum is presently a cut point for consideration of integration of women Marines into combat MOSs. Of course, there are also practical implications for the ability to do a pull-up itself. This capability can be very useful in extricating

oneself from water or getting through a window or over a parapet that is above head-height.

The average number of pull-ups performed by this cohort of Marines was 10. Because Marines are a homogeneous group, the pull-up did not have the predictive value of the hill dash.

Multiple repetitions of the pull-up add information about muscular endurance. Increasing body weight results in fewer numbers of maximum repetitions because the cross-sectional area of the bicep does not increase in proportion to the mass being moved. The addition of body armor or load-bearing equipment has a draconian effect on performance. Women are capable of performing pull-ups, and smaller women are at an ergonomic advantage over larger women for scoring higher on this test. However, we found that pull-up capacity did not add any predictive value in our combat simulation at MWTC and therefore needs to be interpreted for its intended use only: relative fitness. In related research, this author and others have reported the predictive value of the pull-up in work performance and barrier-surmounting.[9] [10]

Applications

Battlefield combat comes in an infinite variety of presentations and there is no definitive "finish line." By contrast to the civilian employment sector that is driven by the "minimum" requirements of the job, the very nature of combat precludes a minimalist approach to desirable standards.

To the contrary, Marines have traditionally focused on maximum sustainable brute force and fighting capability. The maximum model will always trump minimum acceptable requirements on the battlefield. Further, efforts directed at maximizing those attributes, abilities, and capacities significantly reduce the risk of failure. And, unlike most civilian occupations with physical demands, failure in combat can result in death. Attempting to see how close we can get before failure is not a protocol for dominance.

Research From the Army

The U.S. Army's current research for establishing minimum standards for combat arms is following a paradigm not unlike that of the minimum hiring criteria for civilian employees for the postal service—very much driven by the tenets of "equal opportunity employment." What the Army is doing now is a marked departure from their very excellent research done decades ago.[11] This body of knowledge is still very relevant today, as human physiology has not changed in the last millennium.

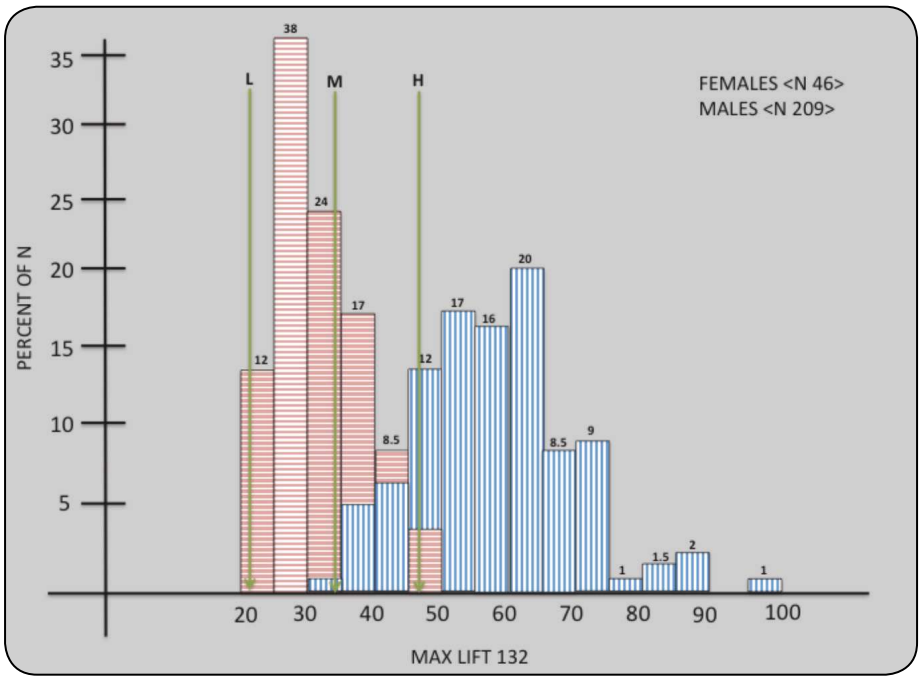

Figure 1. Maximum lift in kilograms to 132 centimeters.

In the early 1980s, a Department of Defense ad hoc committee proposed selection criteria for enlisted personnel at the Military Entrance Processing Station based upon MOS demands. The more than 300 MOSs were characterized from the more sedentary to the most physically demanding. The combat arms (infantry, armor, artillery, and engineers) were classified as high endurance (aerobic power) and high strength. To reduce the risk of failure, top-down selection criteria of the top 20 percent would be eligible for these jobs.

The frequency distributions of some of these criteria are shown in Figures 1 and 2. These plots graphically demonstrate the significant gender differences (women in red shading; men in blue shading) that exist, and the associated problems with integration of women into combat units where physical prowess dominates the landscape. High (H), median (M), and low (L) values for aerobic capacity (in liters of oxygen per minute) and maximum lifting capacities in kilograms for the various MOS clusters are noted.

These frequency distributions (stacked columns) display the overlap of women and men in the applicant populations. These distributions suggest

By contrast to the civilian employment sector that is driven by the "minimum" requirements of the job, the very nature of combat precludes a minimalist approach to desirable standards.

that 99 percent of the women applicants would be rejected versus 15 percent of the men. Hiring from the top down would result in no male rejections. To increase the presence of women in close combat MOSs would require a significant lowering of standards in order to accommodate any eligible women.

Figure 1 (a frequency distribution chart) shows the overlap, or lack thereof, of women (as red, horizontally striped stacks (columns) and men (blue, vertically striped stacks). The vertical axis shows the relative percent of each sex. Atop each column are the number of people within each subgroup, representing 5 increments for maximum lifting capacity to the height of 132 centimeters, the distance from the ground to the tailboard of a military truck. The vertical lines (in green) designate the minimum requirements for a specific MOS, where "L" would be the lowest strength requirement, to "H" for the highest for close combat. The "N" stands for number of subjects by sex.

Figure 2 (a frequency distribution chart) shows the overlap, or lack thereof, of women (as red, horizontally striped stacks) and men (blue, vertically striped stacks). The horizontal axis shows the relative percent of each sex. Atop each column are the number of people within each subgroup as the aerobic capacity values on the horizontal axis progresses from low to high. Close combat MOSs require a minimum fitness level of ≈3 liters of oxygen per minute. "N" refers to the numbers of men and women in the study.

Fitness and Injuries

Research conducted by the military shows a correlation between higher levels of fitness and reduced musculoskeletal injuries. This is analogous to attempting to use a forklift to move 5,000 pounds with a maximum lifting capacity of 3,000 pounds. Army data show that women who work in jobs largely populated by men incur a reportable injury that can range up to twice that of their men counterparts.[12]

Specialized Training for Women

Clearly the physical work capacity of any person can be improved with the application of the principles of progressive overload. In two studies involving women recruits, dramatic improvements in fitness were observed. However, the improvements did not rise to the level required to meet close combat and essential damage control tasks.[13] [14]

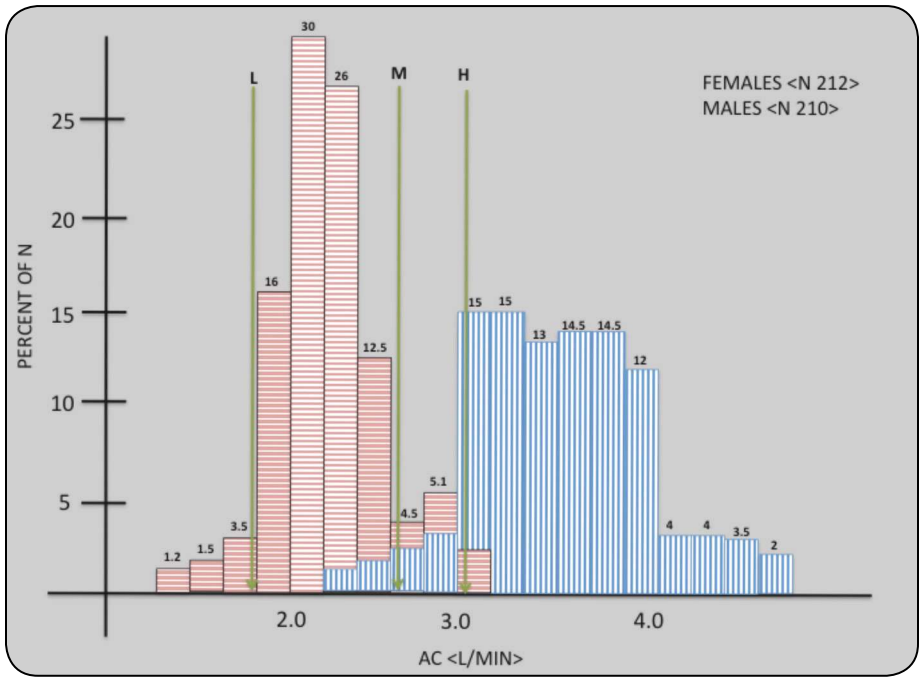

Figure 2. Maximum aerobic capacity (liter/minute).

Firefighters and Marines

Firefighting has been the subject of interest by the military, particularly during peacetime where the overlay of combat was unavailable for study of the physical and psychological responses to danger.[15] Proponents of advancing career opportunities for women within the military frequently cite the firefighting profession as a good example of success.

A couple of decades ago when the Navy proudly announced that they had added a woman to one of their fire departments, they also mentioned that they had not reduced the number of firefighters on the fire engine. Today that practice would be widely criticized by both sides of the issue of using social engineering practices to redress employment imbalances within occupations that have traditionally been all male.

Combat, as the term is employed in the fire service, applies to those firefighters who are assigned to "line" or

Variable	USMC	Fire Service
Organizational Structure	Military	Paramilitary
Active Duty (uniformed)	204,153	307,000
Organic Organization	Worldwide	Fragmented (city/county)
Tooth: Tail (T3R:Combat: Admin)	40 percent	90 percent
Hiring Criteria	Medically cleared	Merit based to no standards
Basic Training Grad, Criteria	Male/female standards	Gender neutral
Percentage Females	6.62	3.5
Work-Task Stimulus	Offensive or defensive	Offensive or defensive
Consequences of Failure	Injury or death	Injury or death
Retention Criteria	Fitness test	Nearly nonexistent
Retirement	20 years	20+ years
Load Equipment Carriage (wt)	100+ plus	75+ PPE (50 pounds)
Billeting	Area of operations	Fire station
Strength Requirement (peak)	Very high (lift/carry Marine)	Very high (lift carry victims)
Peak Strength Demand	Carry Marine unknown distance	Rescue victim/firefighter <100 feet
Aerobic Demands	Very high (miles)	Moderate (flights of stairs)
Incident Rehab	Incident dependent	Manpower Dependent
Duty Cycle	No finish line	24-hour shift
Employee Association	None	IAFF

Table 1. Comparison between the Marine Corps and fire service.

suppression operations versus the gamut of administrative functions. In the military, close combat is carried out with direct fire weapons supported by indirect fire, air delivered fire, and nonlethal engagement means. Close combat defeats or destroys enemy forces or seizes and retains ground.[16] Table 1 displays 19 comparisons and similarities between the two organizations.

Offensive operations in the fire service are attacking the fire with an expectation of suppression. Defensive tactics are protecting exposures with the expectation of total loss of the burning structure.

Some Lessons From the Fire Service

Looking at the civilian sector, 40 years after the first female was appointed as a career firefighter, the percentage of women in the U.S. fire service workforce is 3.4 percent of the total. A target number for inclusion of women as a percent of the total workforce has not been established, absent any agreement on a methodology for acceptance. All the while, claims and counterclaims regarding the lowering and raising of standards continues, including charges of workplace harassment.

All women hired as firefighters have a common pathway through the academy and into a line (combat) assignment, after which migration to light duty or administrative positions affords more longevity and less potential for a career-ending injury. It is not known how many women spend their careers assigned to a combat unit. Unpublished data from Montgomery County, MD, reportedly suggest that women firefighters, who are 10 percent of the department, are injured at a rate of 400 percent of their male counterparts and represented 40 percent of the total costs.[17] This comports with injury data from Los Angeles County and the relationship to muscular strength.[18]

Like the Marine Corps, the lack of physical ability in the firefighting profession can have disastrous consequences. In a tragic fatal firefighting training exercise, a female recruit was unable to self-rescue by pulling herself up and over a window ledge.[19] The subsequent inquest faulted the Baltimore City Fire Department for lax hiring standards.

The Firefighter Combat Challenge

For over 23 years, this author has been the founder and director of a worldwide competition for firefighters known as the Firefighter Combat Challenge. The elements that comprise this competition are based upon a JTA that yielded a taxonomy of frequently performed, arduous, or critical combat tasks, including: 1) climbing 5 stories under load (42 pounds) while wearing the personal protective ensemble, including self-contained breathing apparatus (≈50 pounds), 2) hoisting to 45 feet a 49-pound donut roll of hose, 3) driving a 160-pound beam 5 feet with a shot mallet, 4) dragging a charged hose line 75 feet, and 5) "rescuing" a 175-pound mannequin a distance of 106 feet.

Although women's records for timed sports events such as running are typically within 10 percent of men's values, there are some sports where a woman's performance nearly mirrors that of men (such as shooting.) By contrast, if there were no gender-specific categories for women in sports that require power, strength, or endurance (e.g., mixed martial arts, wrestling, boxing, football), women would rarely, if ever, medal in competition against their male competitors.

The timed performance on the Firefighter Combat Challenge is directly related to anaerobic power, an essential construct of combat performance. Once again, there are notable women who can perform at levels achieved by the average male. These data (Figure 3) graphically illustrate how sex differences are markedly increased where there are expectations for load bearing—exactly like combat operations.

The Firefighter Combat Challenge competitors are self-selected and in many cases have a fitness profile of elite

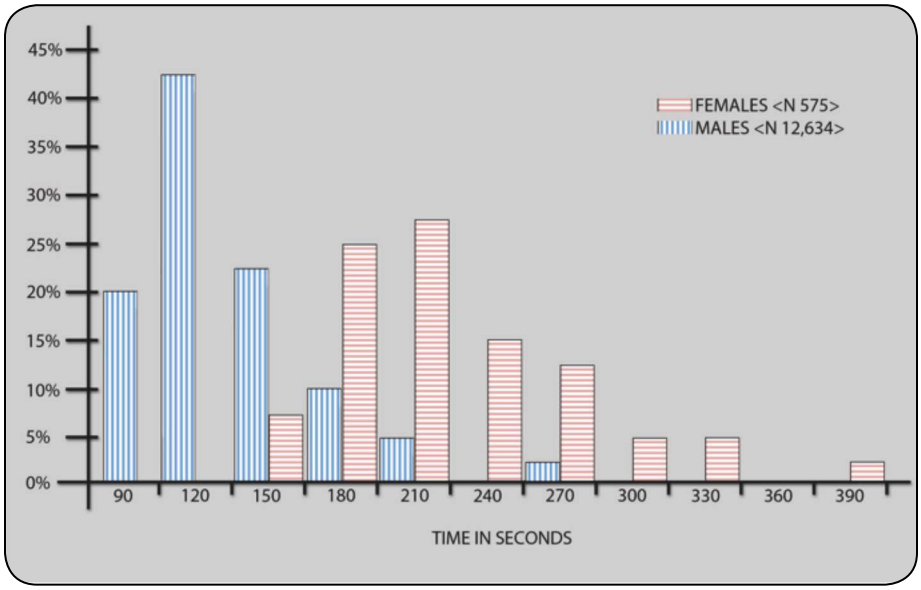

Figure 3. Men and women's results: Firefighter Combat Challenge.

world-class athletes. For the purpose of better understanding how performance of arduous tasks under load and under a timed condition varies by sex, we analyzed the data from our last 7 years of competition. We have data only for finishers (n≈13,209). All age groups have been combined. The percentage of women (4.4 percent) participating in this competition exceeds their numbers for all career firefighters (3.4 percent). We believe this cohort to be among the most motivated and best fit, with many coming from the ranks of scholastic sport. However, even in this elite group, the mean differences between men and women are highly significant. Approximately 7.5 percent (n=43) of the women can complete the course in 2 and a half minutes, while 72 percent of the men are above this time.

Figure 3 (a frequency distribution chart) shows the overlap, or lack thereof, of women (as red, horizontally striped stacks) and men (blue, vertically striped stacks). The vertical axis shows the relative percent of each sex. On the horizontal axis, elapsed time to completion is expressed in 30-second increments, from 90 (1:30) to 390 (6:50).

In Summary

- The current initiative of revisiting the subject of women in combat has seemingly ignored the large body of evidence-based science that suggests significant differences between men and women.
- Ergonomics can greatly enhance our understanding of the reasonable versus wishful thinking.
- The military, for the obvious reason of being the absolute best it can be, is exempt from Federal employment law and free from the civilian employment sector's minimalist mentality.
- The Navy-funded JTA research focused on the most arduous combat environment; this logic is based upon the premise that success in the most difficult theater predicts success in less arduous settings.
- While all Marines are highly fit, the 0311s were the most fit and had the least performance degradation (as measured in shooting accuracy) following a day's simulated combat performance in the high-altitude/cold weather environment.
- Performance under load is highly influenced by lean body mass and muscular power.
- Smaller Marines are at a distinct disadvantage when required to carry heavy loads.
- The pull-up has face validity in the performance of those tasks that require manipulation of one's body over barriers.
- Our ability to choose the time and place of our next military threat does not neatly fit into any preconceived paradigm.
- Combat frequently presents situations where there is no finish line, with events being driven by the enemy and his capabilities.
- Counterinsurgency operations are not a worst-case scenario; the battle to take Fallujah is more reminiscent of war. High-altitude/cold weather combat likely exceeds the capabilities of many men.
- The Army's data, based upon a low-risk assignment and selection criteria, took the top 20 percent for the combat arms.
- With high aerobic and strength standards, the rejection rate for women is 99 percent, and for men, 15 percent.
- There are strong similarities between the Marine Corps and U.S. fire service. Injury rates among women working in this industry are similar to those reported in military settings where the incidence is four times that of their male counterparts.
- Lack of critical physical abilities carries a risk for injury or loss of life.
- The performance of women and men on a timed course of essential tasks shows that women on average take 50 percent more time to complete the same tasks.
- Women can train up to standards; staying there results in overuse injuries disproportionate to their numbers. Attempting to perform like-duties at similar intensities exacerbates the musculoskeletal system, resulting in four times the frequency (and costs) of injuries.
- The body of military performance research literature dating back scores of years is still relevant today, as human physiology has not changed, nor have the laws of physics. The caloric costs of burning oxygen is the same for both sexes and gravity still exerts a downward force of 32 feet per second squared.
- The mission comes first. Nothing should interfere with obtaining our objectives.

Notes

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Military and civilian Defense Department leaders are choosing to ignore significant differences between men and women. *(Photo by PFC Christopher Johns.)*

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