

The Fitness Imperative:



The Why and How of Fitness for the Fire Service

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Outline



Section One – The Need For Fitness in the Fire Service

Section Two – Basic Exercise Physiology

Section Three – Developing Fitness Programs for the Fire Service

Section Four – Challenges

Section Five – Fire Service Initiatives/Resources

Section Six – Use of Technology to Support Fitness Initiative

Section One

The Need for Fitness in the Fire Service



Section One

The Need for Fitness in the Fire Service



1. High physical demand of firefighters (FF)
 - Performance
2. Evidence of poor or average fitness
 - Health
3. High prevalence of sudden cardiac events (SCE)
 - Safety

Section One

Physical Demands of Firefighting



Strenuous work

Climbing stairs

Forcible entry

Search and rescue



Heavy PPE

➤ 22 kg

↑ Metabolic work

↓ Heat dissipation

Restrictive



Hot and Dangerous Environment

Routinely over 100°C

Chaotic

Low visibility

Section One

Physical Demands of Firefighting



Summary of Physiological Responses to Firefighting

- **Cardiovascular** (Increased HR and BP, Decreased Stroke Volume)
- **Hematological** (Decreased Plasma Volume, Hemoconcentration)
- **Thermoregulatory** (Elevated Core Temperature, Dehydration)
- **Respiratory** (Increased Breathing Rate and Oxygen Consumption)
- **Metabolic** (High Oxygen Cost, Increased Lactate, Fatigue)
- **Immune/Endocrine** (Increased Leukocytes and Hormones)
- **Nervous** (Sympathetic Surge and Increased Adrenaline)
- **Muscular** (Increased Oxygen Use and Heat Production)

Section One



Physical Demands of Firefighting

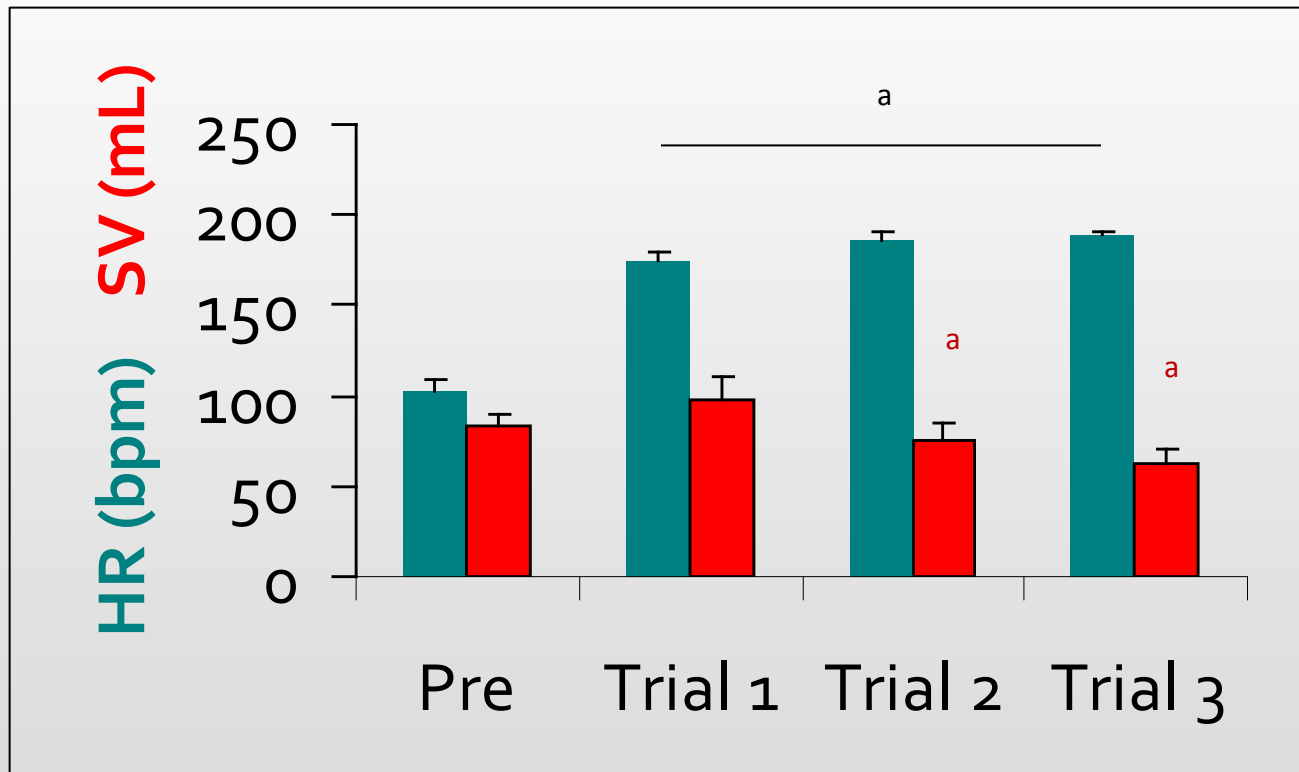
- Fitness demands of firefighting
- High Aerobic Capacity
 - $\text{VO}_2\text{max} > 44 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ as the minimal acceptable value for FF
Gledhill and Jamnik, 1992
- High Anaerobic Capacity
 - Firefighting activity requires high levels of anaerobic system of energy expenditure
Lemon and Hermiston, 1977; Barr et al., 2010
- High Muscular Strength/Endurance
 - Needed for forcible entry, hoisting of hose, chopping tasks, and victim rescue
Sothmann et al., 1990; Clark, 2002

Section One

Physical Demands of Firefighting



Heart rate (HR) and stroke volume (SV) responses to firefighting

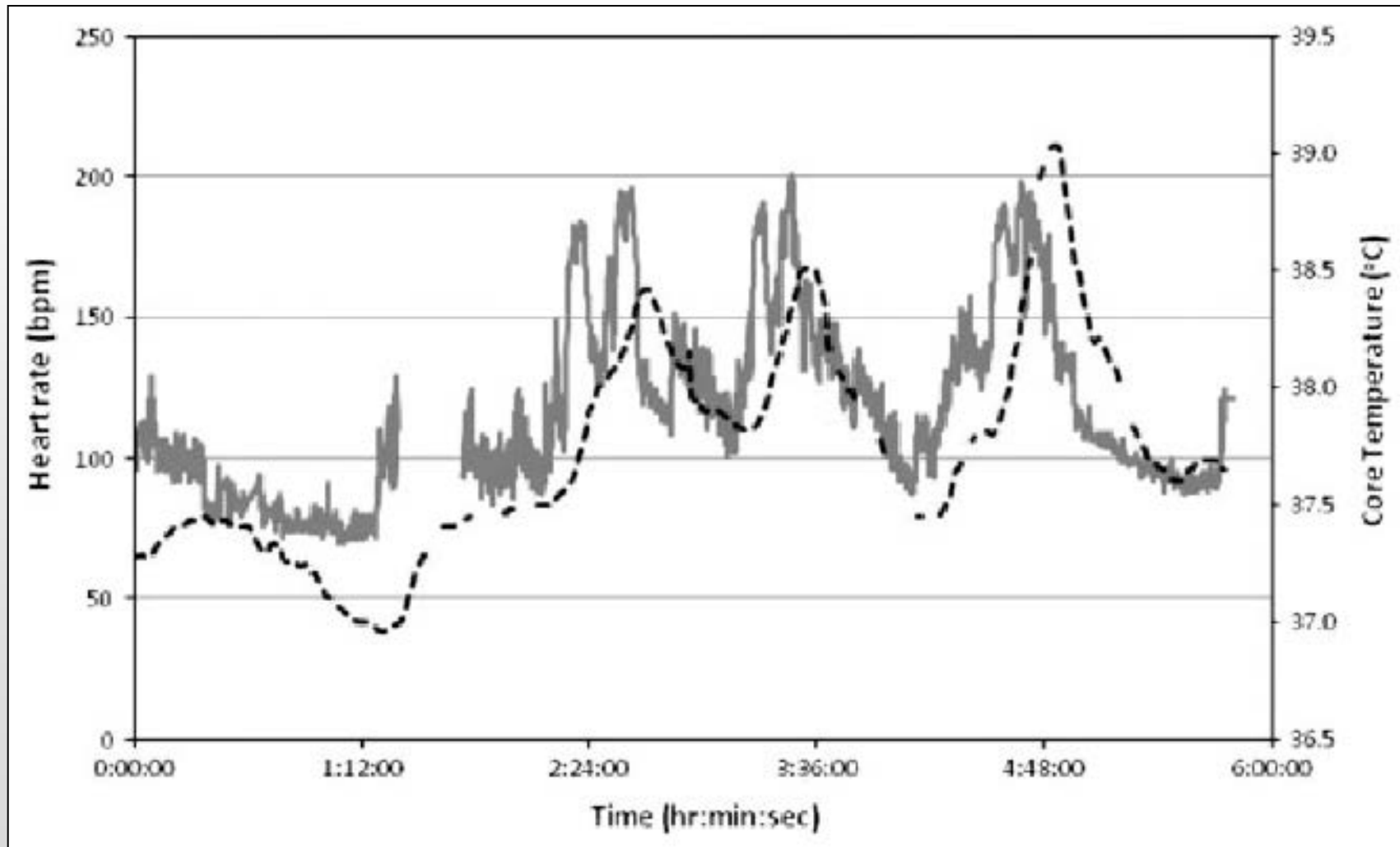


a $p < 0.05$ vs Trial 1

a $p < 0.05$ vs Trial 1

Section One

Physical Demands of Firefighting



Section One

Physical Demands of Firefighting



Cardiac responses to firefighting

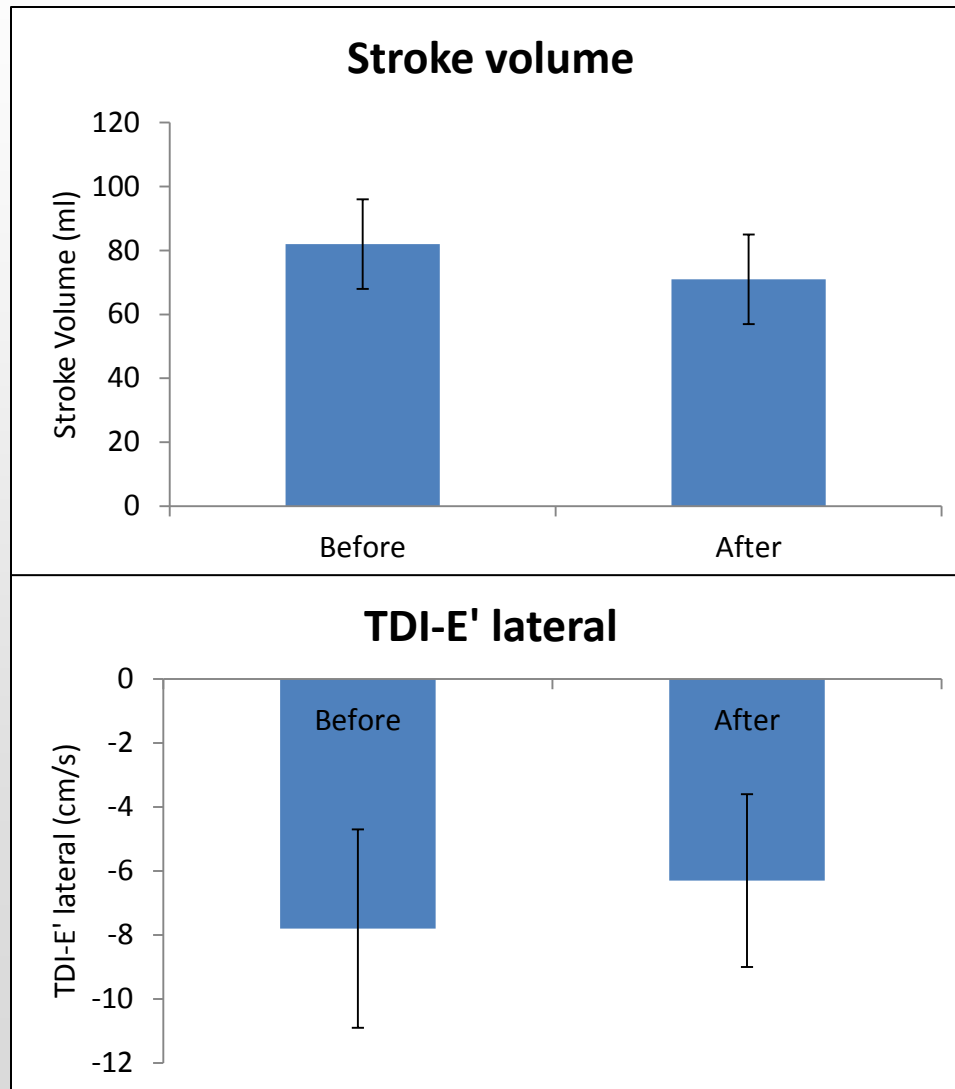
Table 1: Echocardiographic variables before and after firefighting (n = 40)

	Before	After
Left ventricular shortening fraction (%)	33.0 (6.4)	28.6 (6.0)*
Ejection fraction (%)	60.3 (9.2)	54.3 (9.5)
Stroke volume (ml)	82 (20)	71 (22)*
mitral E (cm s ⁻¹)	81 (14)	71 (14)*
Mitral A (cm s ⁻¹)	45 (9)	45 (14)
TDI-E' lateral (cm s ⁻¹)	-7.8 (3.1)	-6.3 (2.7)*
TDI-S lateral (cm s ⁻¹)	4.4 (1.4)	4.0 (1.4)
TDI-E' septal (cm s ⁻¹)	-4.5 (2.0)	-4.2 (1.8)

* $p \leq 0.05$ for before-after comparison

Section One

Physical Demands of Firefighting





Evidence of Poor or Average Fitness

US Firefighters - Profile

- Generally do not have CV risk profile that differs from general population (Drew-Nord, 2009)
- Recruits – 35 ml/kg/min (Roberts et al., 2002)
- High Prevalence of obesity
 - 87% - BMI > 25 34% > 30 (Kales et al., 1999)
 - 77% - BMI > 25 33% > 30 (Tsismenakis et al., 2009)
 - 75% - BMI > 25 25% > 30 (Fahs et al., 2009)

Section One



Evidence of Poor or Average Fitness

Effects of obesity on cardiovascular health

Variable	Body Mass Index (kg/m ²)		
	<25.9 (Group 1)	25.9-29.5 (Group 2)	≥29.5 (Group 3)
Intima-media thickness	0.44 (0.01)	0.46 (0.01)	0.52(0.01)*†
Aortic pulse wave velocity	5.9(0.1)	6.4(0.2)*	6.8(0.1)*
β Stiffness	4.6(0.2)	5.1(0.2)	6.2(0.4)

* Different from group 1 (p<0.05)

† Different from group 2 (p<0.05)

Values are Mean ± SD

N=110 firefighters

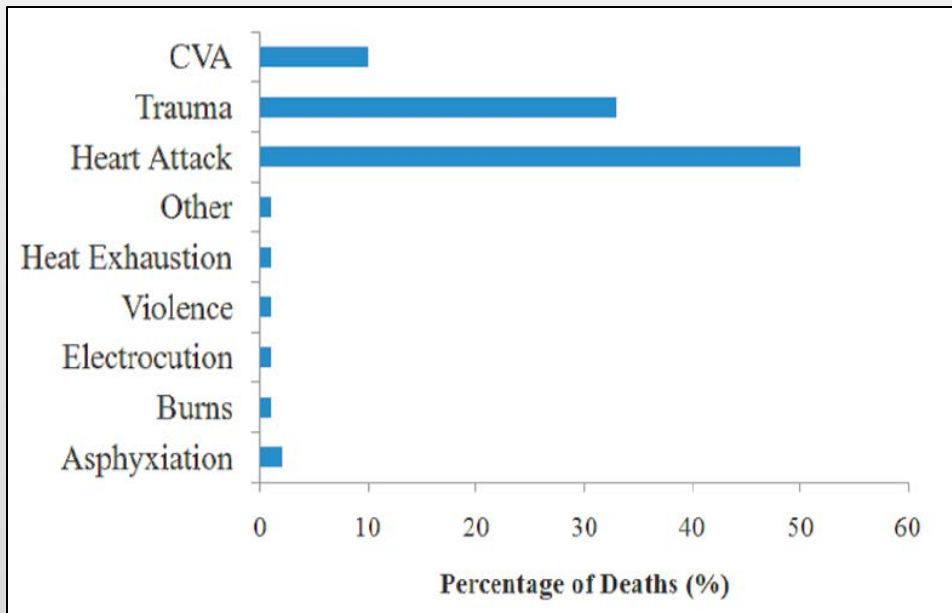
Age= 29.7±8.0 years

Section One

Prevalence of Sudden Cardiac Events



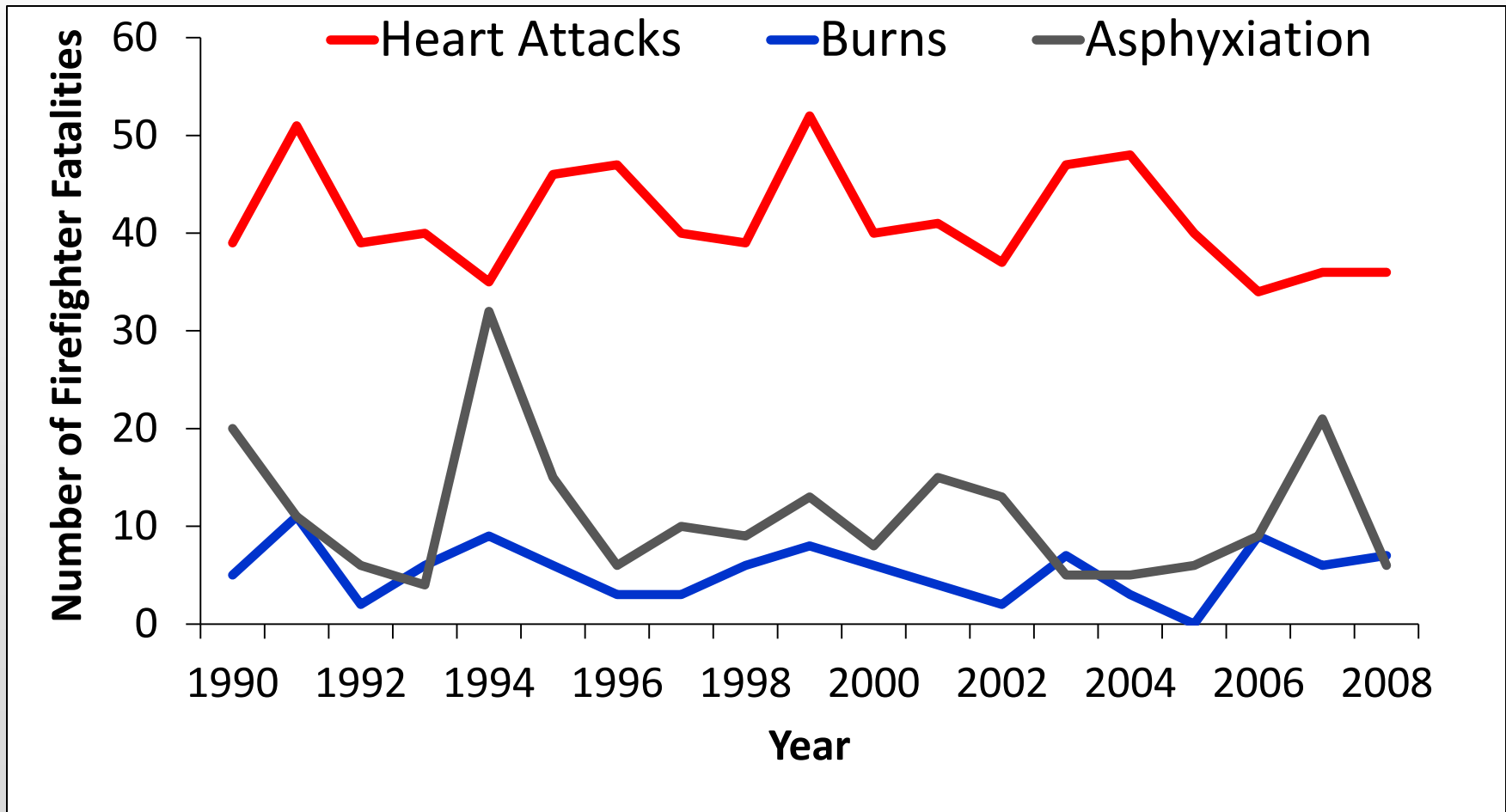
- High Prevalence of Sudden Cardiac Events (SCE) – Safety (USFA, 2009)



Section One



Prevalence of Sudden Cardiac Events



Section One

Prevalence of Sudden Cardiac Events



Relative risk of different firefighting activities



**Line of Duty Deaths - CHD related
N=449, 1994-2004**

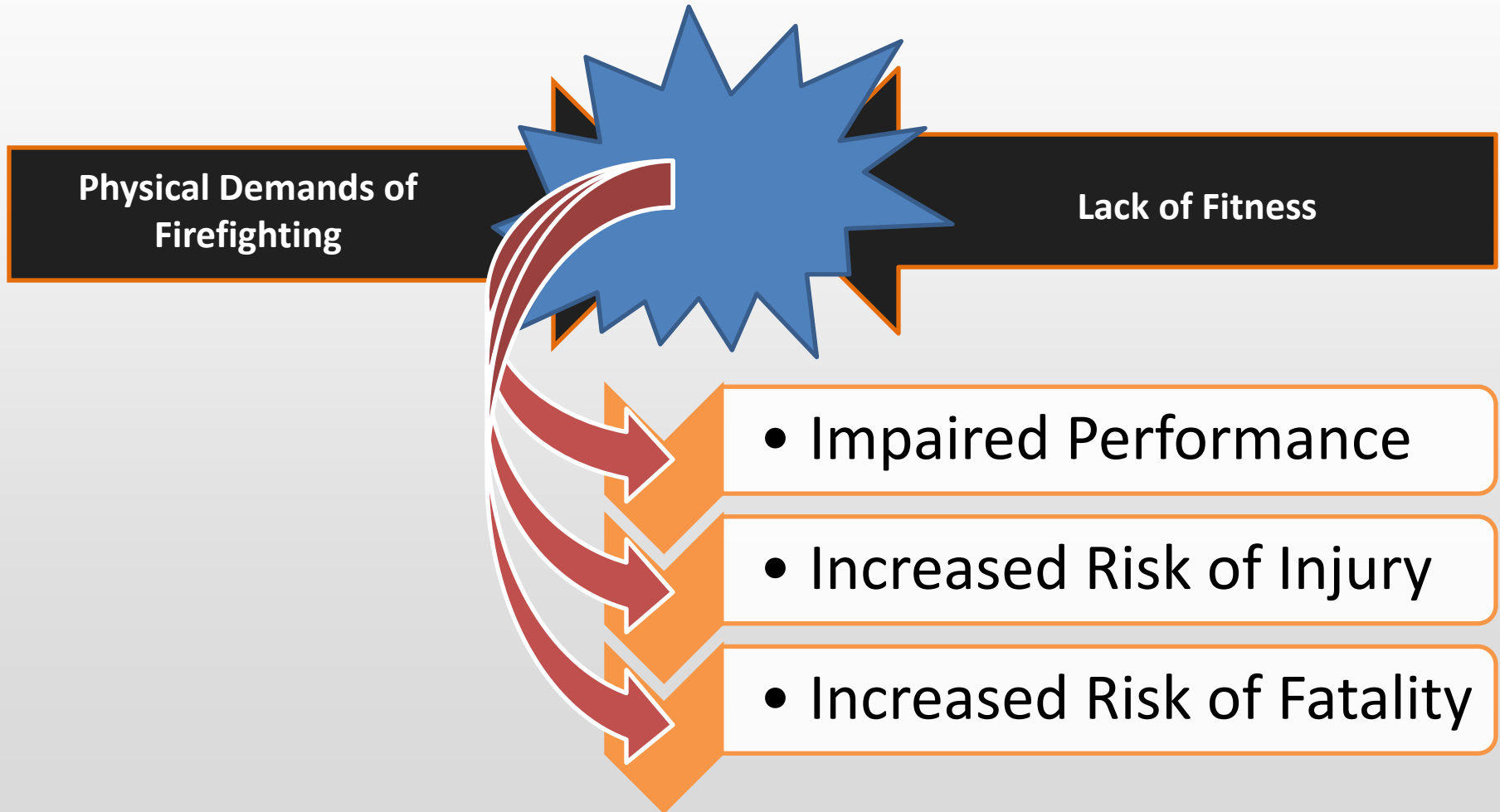
	Time Spent (%)	Fatalities (%)	Odds Ratio
Fire Suppression	1%	32.10%	136
Response to Alarm	4%	13.40%	14.1
Return from Alarm	7%	17.40%	10.5
Physical Training	8%	12.50%	6.6
Nonfire emergencies	15%	9.40%	2.6
Nonemergency duties	65%	15.40%	1

Section One



Prevalence of Sudden Cardiac Events

Creates a mismatch with bad outcomes



Section Two

Exercise Physiology for Firefighters



- Integrated response
- Principles of training
- Benefits of a fit firefighter

Section Two

Integrated Response



Neuroendocrine-Immune System

- Maintenance of homeostasis
- Regulation of body's response to exercise and adaptation to exercise

Cardiovascular-Respiratory System

Circulation:

- Transportation of oxygen and energy substrates to muscle tissue
- Transportation of waste products

Respiration:

- Intake of air into body
- Diffusion of oxygen and carbon dioxide at lungs and muscle tissue
- Removal of carbon dioxide from body



Metabolic System

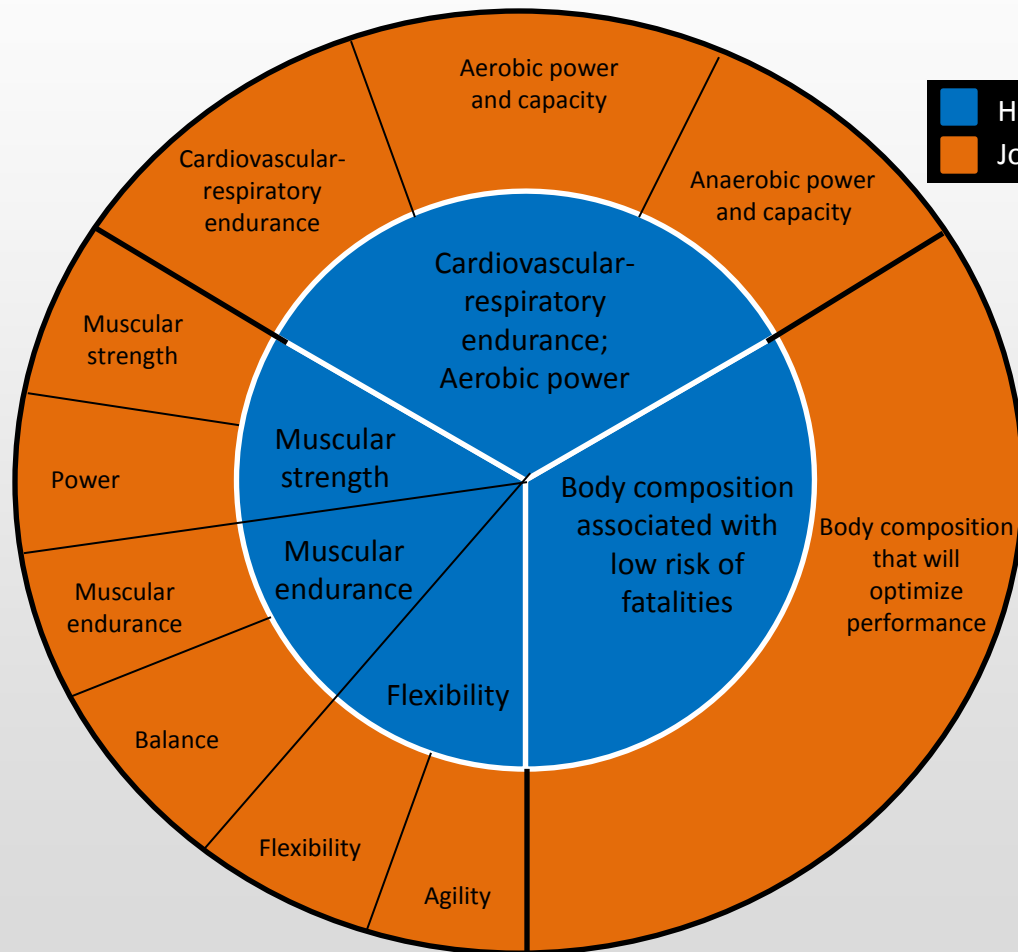
- Production of energy
- Balance of energy intake and output for body composition and weight control

Neuromuscular-Skeletal System

- Locomotion (exercise)
- Movement brought about by muscular contraction (under neural stimulation acting on bony levers on skeletal system)

Section Two

Physical Fitness



Section Two

Principles of Training



- Specificity
- Overload
- Rest/recovery/adaptation
- Progression
- Retrogression/plateau/reversibility
- Maintenance
- Individualization



Section Two

Principles of Training

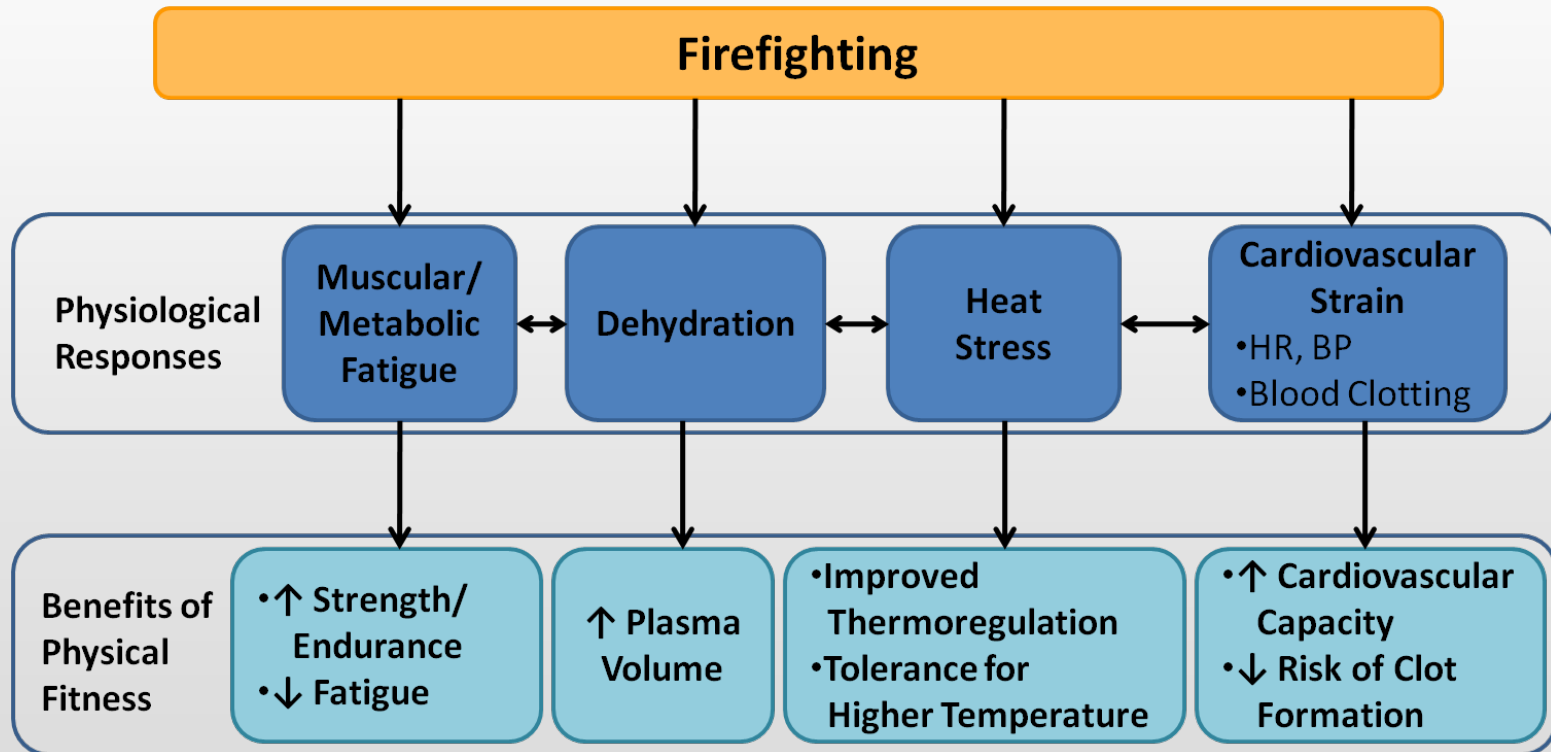


- Fitness prescription for firefighter health and safety
- Cardiovascular training
- Strength training
- Functional training
- Nutrition



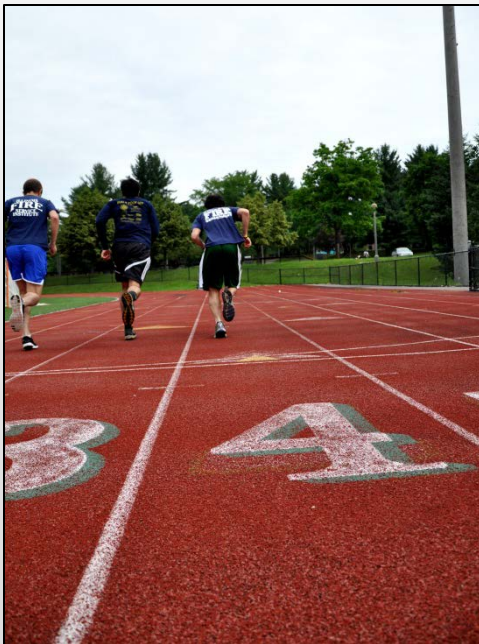
Section Two

Benefits of Fitness for Firefighters



Section Three

Developing Fitness Programs for Individuals



- Cardiovascular training
- Strength training
- Functional training

Section Three

Fitness Prescription for Firefighter Health & Safety



- Needs to address the demands of firefighting
- Needs to recognize the current diversity in fitness (and health) status of firefighters
- Needs to recognize unique structure and culture of volunteer and career departments

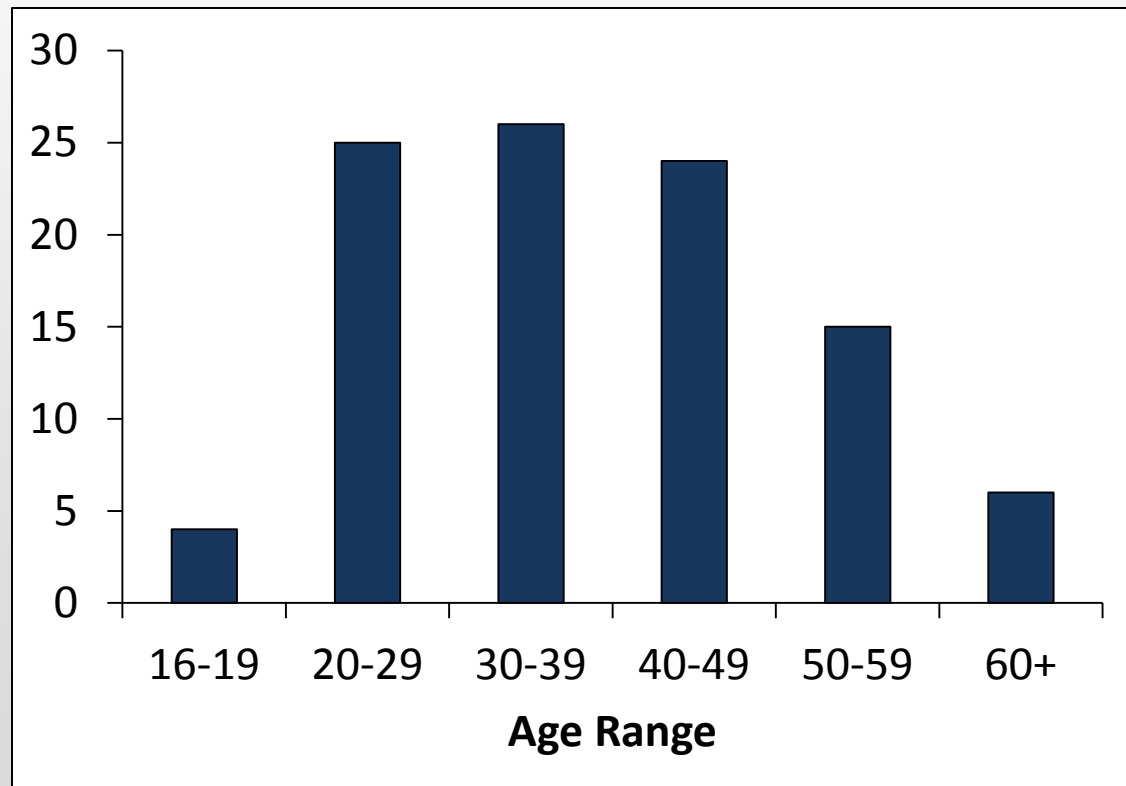


Section One

Diverse Needs



- U.S. Firefighter demographics
 - 1,148,850 total
 - 25% career
 - 75% volunteer
 - Rural vs. Metro
 - 3.7% Career FF Females
 - Wide age range

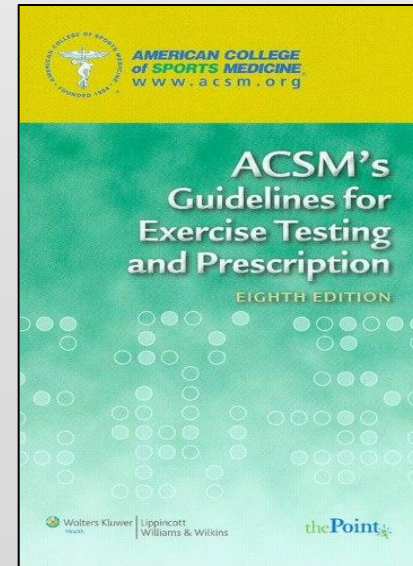


Section Three

Low to Moderately Fit – Firefighter Exercise Prescription



- Must include individual and progressive programs to meet individual needs from low-fit to highly-trained
- Emphasize weight loss and improved cardiovascular health
- ACSM Guidelines for general population:
 - ≥ 30 min. moderate aerobic activity 5+ days/week
 - ≥ 20 min. vigorous aerobic activity 3+ days/week
 - 8-10 ST exercises for 8-12 reps each, 2x week



Section Three

Lifestyle Modifications



Create a cultural change within the Fire Service:

- Develop a social support system, leadership, incentives
- Must set short & long-term goals that are realistic, measureable
- Easy to implement within constraints of space, equipment and other duties



Section Three

Trained Firefighters: Emphasize Overload and Specificity



**Aerobic
Exercise**



Aerobic Base

Include:

- High Intensity Intervals – stress anaerobic system
- Stair climber
- Job Specific Training (upper body)

Section Three

Trained Firefighters: Emphasize Overload and Specificity



Strength
Training



Strength Training

Include

- Heavy Loads
- Muscular Endurance
- Whole Body Work
- Job Specific Training (upper body)

Section Three

Trained Firefighters: Emphasize Overload and Specificity



Strength Training

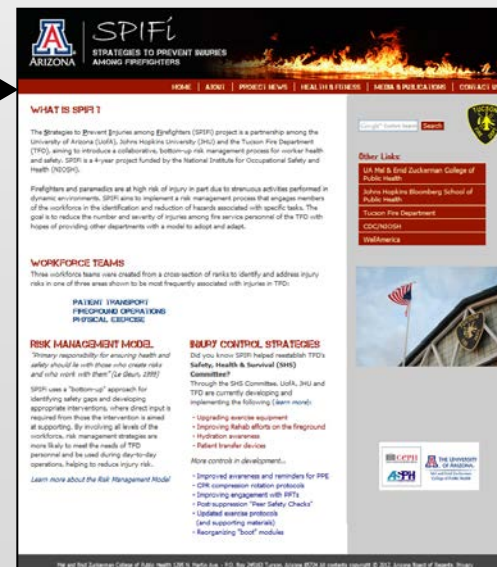
Strategies to Prevent Injuries among Firefighters (SPiFi)

- Links to job specific exercise plans

Pike Pole



This movement is a pike pole. Begin by positioning feet in a staggered stance while grasping the loop. Lift and straighten arms overhead while maintaining a secure foot anchor. Return to start position and repeat.

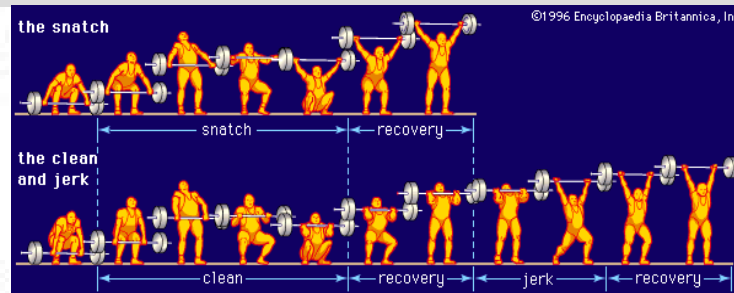
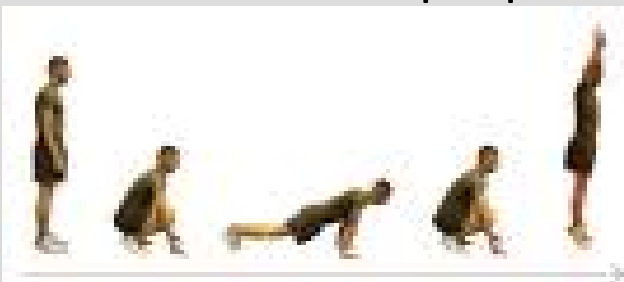


Section Three

High Intensity Functional Training



- Mimics the high intensity demands of firefighting
- Gaining popularity in progressive departments
- Whole body circuit example:
 - 45sec-1min intervals (ex. 45 on, 45 off):
 - Sledgehammer or kettlebell swings
 - Burpies
 - Clean and Jerk (Strength)
 - Kettlebell Snatches (or dumbbell)
 - Hill sprints with shoulder press (dumbbells, pipe, etc)
 - Jump squats



Section Three

Cross-Fit Workouts



- Specific type of HIFT
- Emphasizing Strength and Conditioning
- Scale load, intensity

“Cross-Fit is not a specialized fitness program, but a deliberate attempt to optimize physical competence in each of ten recognized fitness domains: Cardio-respiratory Endurance, Stamina, Strength, Flexibility, Power, Speed, Coordination, Agility, Balance, and Accuracy (CrossFit Foundations, 2002).”

- Popular example – P90X
- Specificity
 - Cross-fit Inferno Team
 - Specific exercises designed for firefighters using equipment routinely found in fire house
 - http://inferno.typepad.com/my_weblog/basecamp-workouts.html

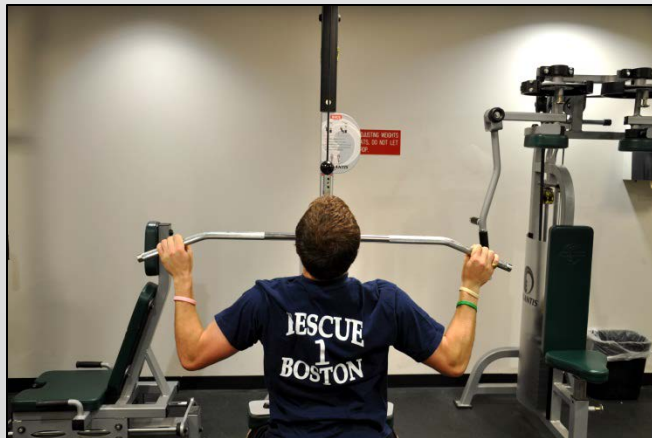


Section Three

Benefits of Fit Firefighters



- Improved Public Safety
 - ↑ mobility, energy, endurance
 - ↑ ability to perform job duty efficiently & safely
- Improved Firefighter Health and Safety
 - ↓ risk of sudden cardiac event
 - ↓ risk of injuries



Section Four

Challenges



Section Four

Challenges



- Funds
- Time
- Administration
- Union
- City
- Culture
- Leadership

Section Four

Fire Service Initiatives/ Resources



- Existing initiatives
- Benefits
- Changes necessary
- Importance of leadership

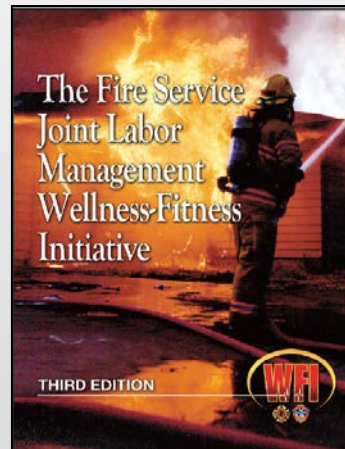
Section Four

Fire Service Initiatives/Resources



- **IAFF/IAFC/ACE Peer Fitness Program**

- Dept. member to lead in Wellness/Fitness Initiative (WFI)
- Design, Implement, Oversee programs



WFI Resource

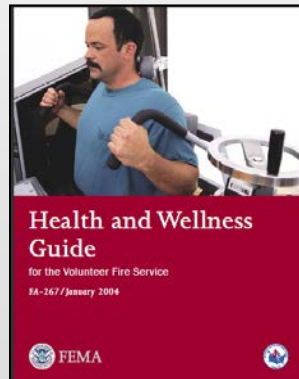
<http://www.iaff.org/HS/wfiresource/Fitness/Exercise.html>

Section Four

Fire Service Initiatives/Resources



- **National Volunteer Health and Wellness Guide**
 - National program dedicated to saving America's firefighters and EMS personnel from their leading cause of death: heart disease.



“The Heart-Healthy Firefighter Program gives firefighters the tools they need to face the dangers of heart disease and lead healthier, longer lives.” – Erron Kinney

<http://www.healthyfirefighter.org/files/documents/2005resourceguide.pdf>

Section Four

Fire Service Initiatives/Resources



- **Firefighter Combat Challenge**

- Mimics firefighting tasks – performed in full PPE
- Department competition
- 5-event physical challenge
 - Stair climb with High Rise Pack
 - Hose Hoist
 - Forcible Entry
 - Hose Advance
 - Victim Rescue (175 lbs)

www.firefighter-challenge.com



Section Five

Use of Technology for Fitness Initiative



- Physiological Health Assessment System for Emergency Responders

Christopher Cooper, MD, PhD
UCLA David Geffen School of Medicine

Bruce Verner
Chief, Sana Rosa (retired)

Maxim Batalin, PhD
UCLA Wireless Health Institute

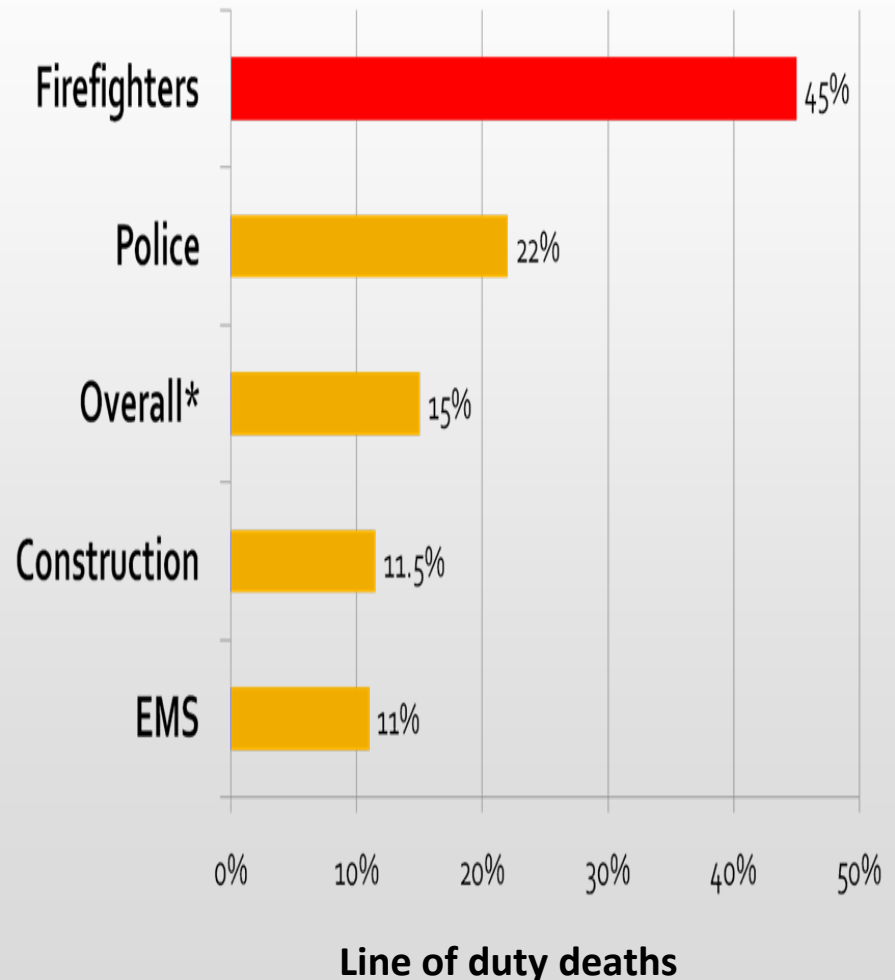
Denise Smith, PhD
Skidmore College Health and Exercise Sciences

Section Five

Primary National Objective

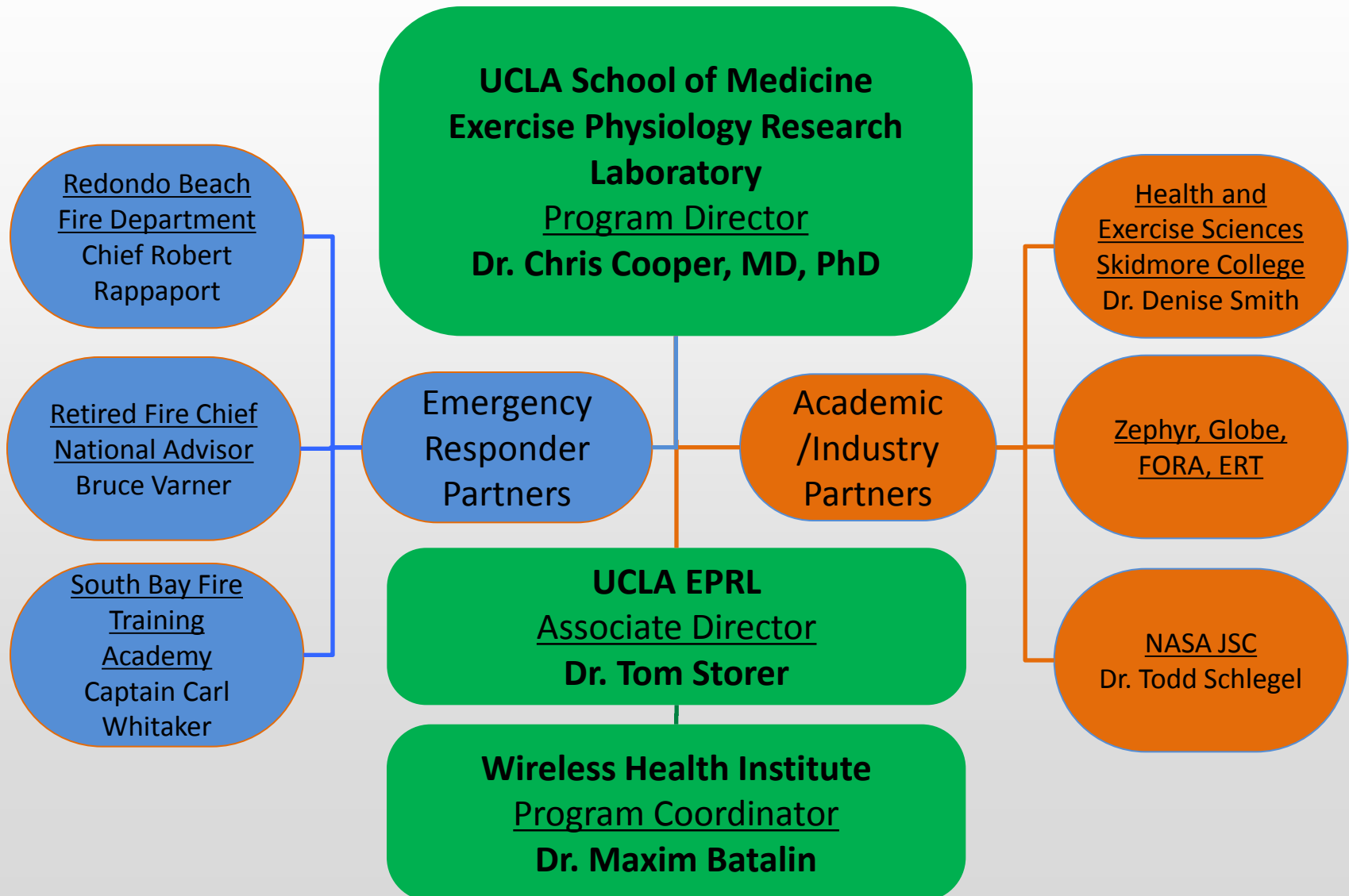


- Firefighters have the highest occupational rate of line of duty deaths (LODD) due to sudden cardiovascular events (eg, heart attacks and strokes).
- US Fire Administration Goal is to decrease firefighter LODD by 25% in 5 years and 50% in 10 years.
- A primary national objective is to develop of a breakthrough in assuring health and safety for the emergency responder community
- Requires state-of-the-art approach combining medical science with technological innovations
- PHASER is the first national program of its kind, led by UCLA and focused on development of systems and approaches to ensure health and safety of emergency responders



Section Five

PHASER: Organizational Chart



Section Five

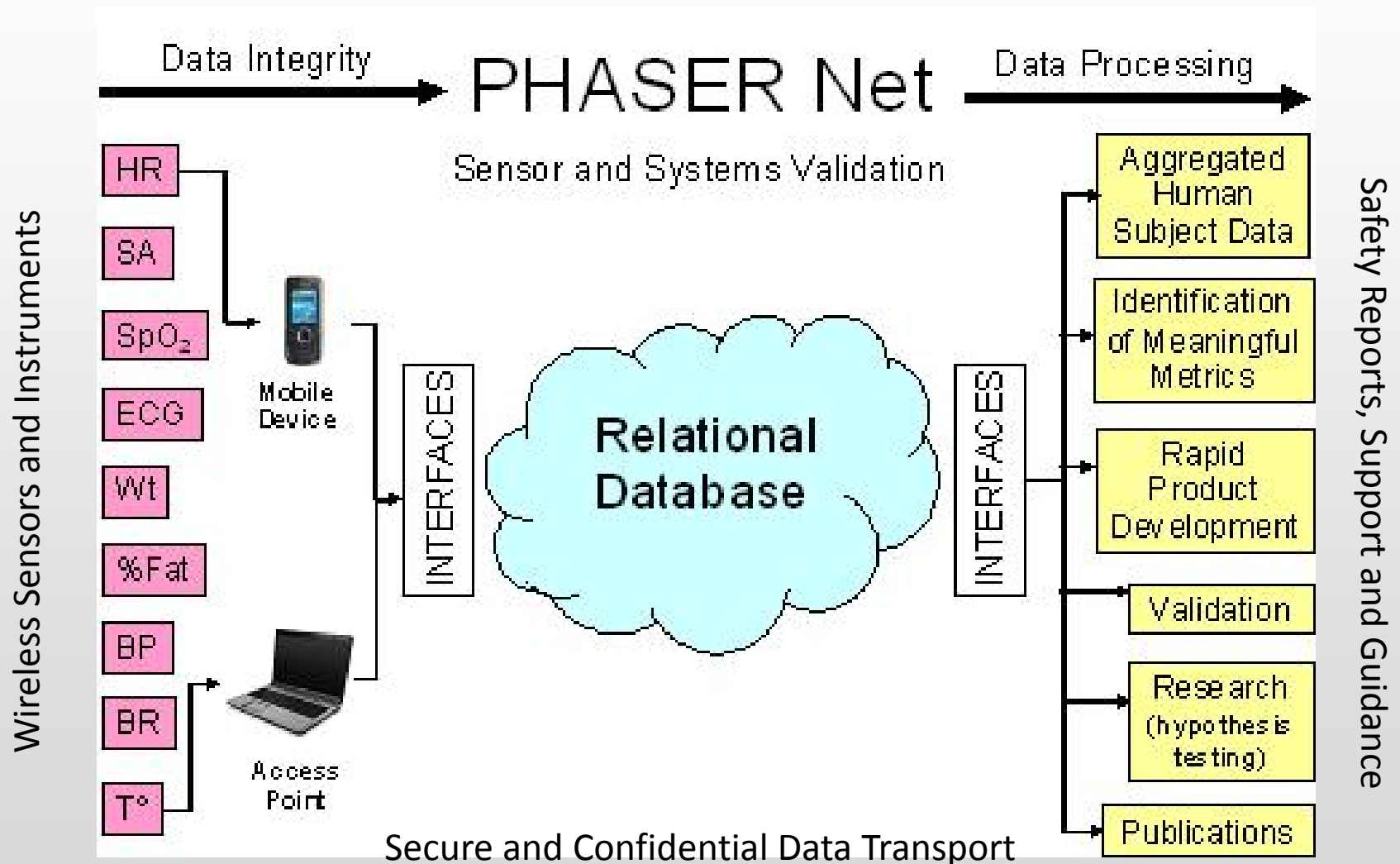
PHASER Specific Aims



- Comprehensive risk identification and prioritization
- Sensor selection and evaluation
- Laboratory-based physiological experiments
- Field-based monitoring and risk stratification
- Implementation of a low-cost networked system for physiological monitoring and intervention
- Outreach to emergency responders, the public, academic institutions, industry and other government agencies

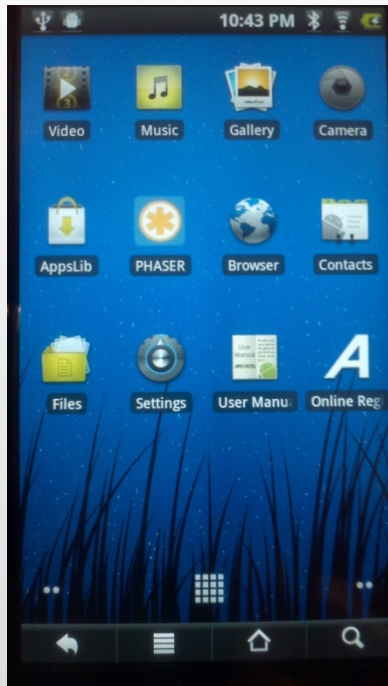
Section Five

PHASER-Net: Telehealth for the Fire Service

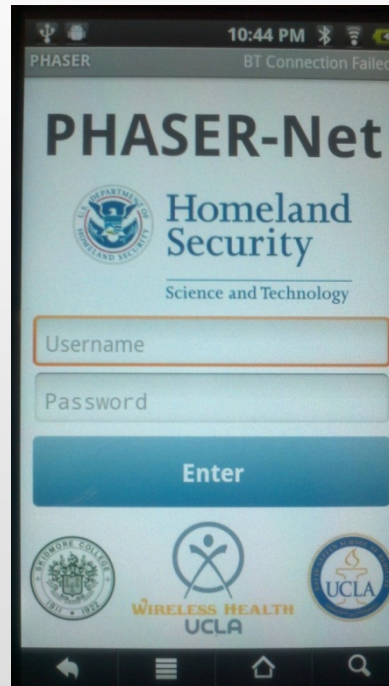


Section Five

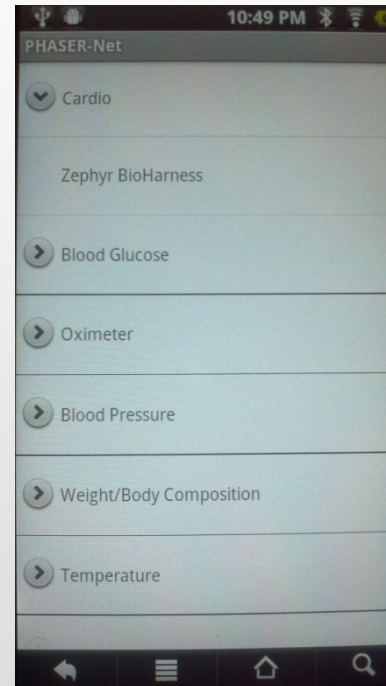
PHASER-Net: Android Application



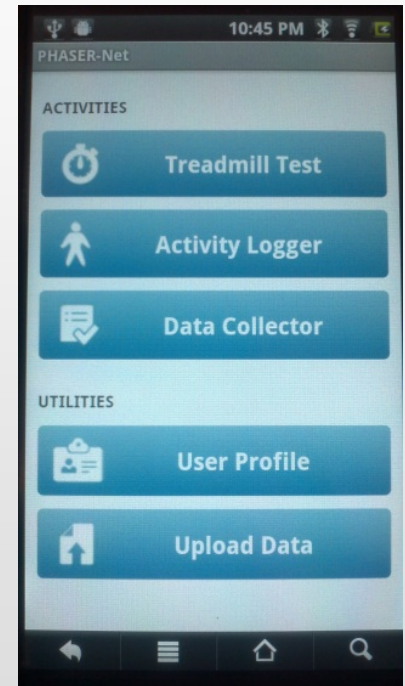
PHASER App



Secure Registration



Sensor Selection



Data Collection

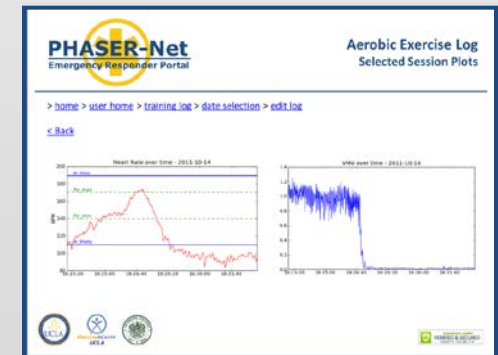
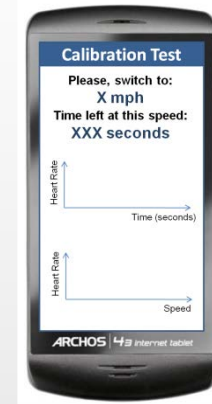
Figures are photos of the PHASER-Net Android mobile application in action on a mobile device

Section Five

PHASER-Net Deployment



- State-of-the-art wearable sensor technology
 - Advanced personal protective equipment
 - Inbuilt unobtrusive sensors
- Wireless connectivity via smart phones
 - Secure logon
 - Confidentiality
 - Bluetooth
- Data transmission via cloud computing
 - Secure
 - Low cost
 - Automated
- Main functions
 - Acquisition of physiological data
 - Fitness assessment
 - Analysis and reporting
 - Guidance and intervention



Section Five

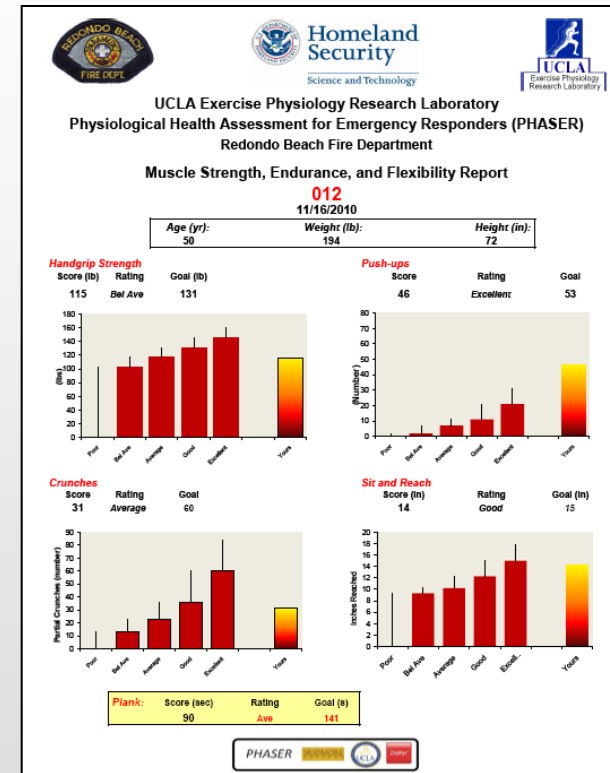
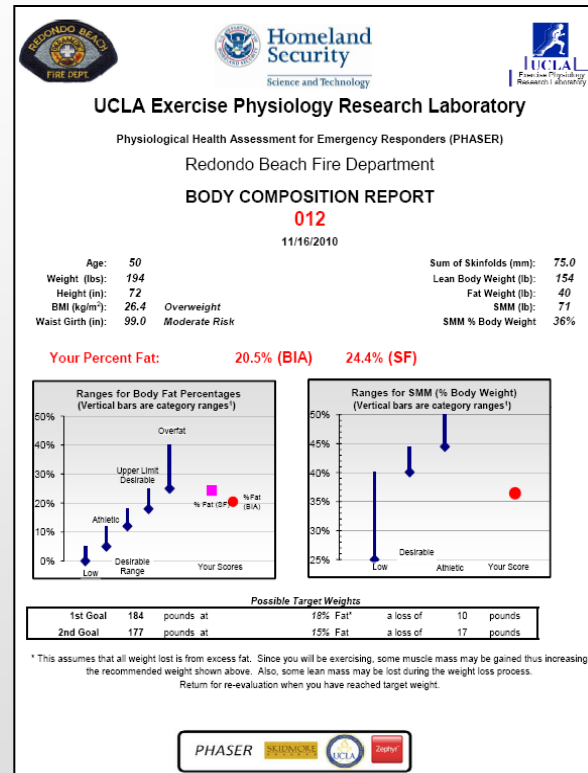
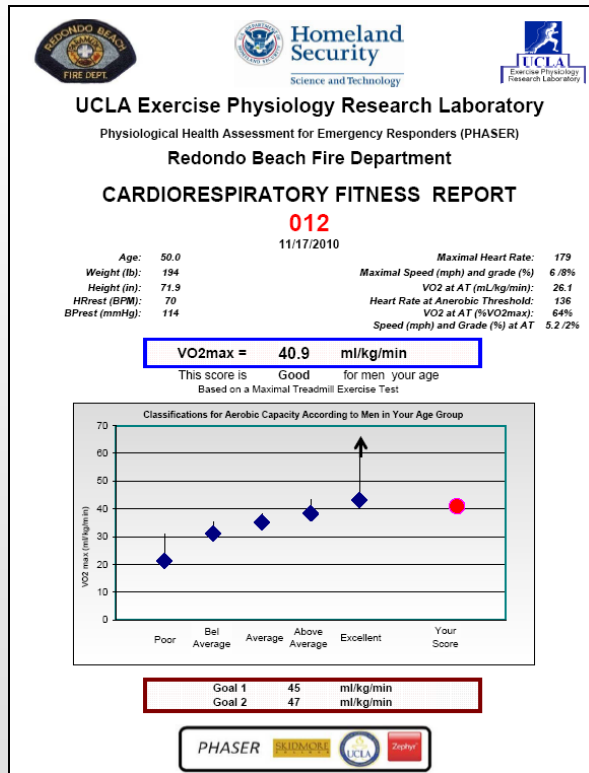
PHASER-Net: Wellness Fitness Assessments



- **Wellness Fitness Profile (Level 1A: Wellness)**
 - Age, sex (Logon)
 - Height, weight, BMI (Tanita)
 - Percentage body fat (Tanita)
 - Blood pressure (FORA Technologies)
 - Fasting glucose (FORA Technologies)
 - Cardiocaloric index (BioHarness™)
- **Wellness Fitness Profile (Level 1B: Fitness)**
 - Cardiocaloric index (BioHarness™)
- **Wellness Fitness Profile (Level 2: Medical)**
 - Implementation after a department is successfully up and running with PHASER-Net.
 - Spirometry (SpiroPro)
 - Pulse oximetry (Nonin)
 - Lipid profile (Quest)
- **Wellness Fitness Profile (Level 3: Advanced Medical)**
 - Implementation by PHASER team members visiting a PHASER-Net site.
 - Aerobic performance (OxyCon Mobile)
 - Advanced-ECG (Cardiax)

Section Five

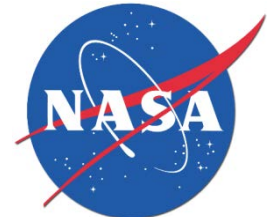
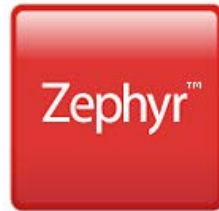
Example of a Wellness Fitness Report



- These reports were provided with individual interpretation and guidance to firefighters at Redondo Beach Fire Department in April 2011.
- This resulted in overwhelming adoption of wellness and fitness principles at this location.

Section Five

PHASER: Collaborations



Please visit our website: <http://phaser.med.ucla.edu/>

Conclusion



- Firefighting is physically demanding (requires high fitness to perform safely)
- On average, firefighters are not more fit than general public
- **Firefighters need improved fitness for**
 - Public safety
 - Firefighter safety
 - Firefighter health
- Sound training principles should be used – especially recognizing diverse demographics
- Technology may support fitness initiatives and help with cost



- Implementation plans

Thank You



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