ESTABLISHING CARDIOVASCULAR DISEASE RISK CUTOFF VALUES IN FIREFIGHTERS

D. E. Gonzalez[1], R. J. Sowinski[1], A. Zapp[2], S. E. Martin[1], M. J. McAllister[3], & J. B. Mann[1]

[1]Texas A&M University, College Station, TX, USA; [2]Fire Rescue Wellness, Montgomery, IL, USA; [3]Texas State University, San Marcos, TX, USA

Abstract

Background

Previous work suggests a relationship between CVD risk among firefighters (FF) and oxidative stress (OS), poor fitness, and body composition. However, limited research has utilized receiver operating characteristic (ROC) curves to determine if these parameters can be indicative of CVD risk.

Purpose

This study determined if biomarkers of CVD risk, fitness, and body composition could be used to delineate between low-risk (LOW) and moderate-risk (MOD) classifications.

Materials and Methods

160 career structural FFs from a local fire department were recruited. Fasted blood samples were collected for lipids, glucose, and advanced oxidation protein products (AOPP). Dual-energy x-ray absorptiometry and girth measures were taken to assess body composition. The FF completed a cardiopulmonary exercise test, and VO2max was estimated via the Foster equation. Based on the American College of Sports Medicine Scoring standards, FFs were risk-stratified in LOW or MOD classifications. Shapiro-Wilk Test was used to assess normality. Independent sample T-tests or Mann-Whitney U tests (if normality was violated) were used to assess differences in CVD risk biomarkers, fitness, and body composition between LOW and MOD. Effect sizes were calculated as Cohen's d. ROC Curves were performed to establish cutoff values to discern LOW from MOD. An area under the curve (AUC) < 0.5 denotes poor ability to discern LOW from MOD, while 0.7-0.8 is acceptable, 0.8-0.9 is excellent, and >0.9 is outstanding. Cutoff values were derived using the minimum distance from the left upper corner of the unit square to the nearest point to the left upper corner on the ROC curve.

Results

Compared to FF classified as LOW, MOD FF exhibited lower (p< 0.05) fitness, as well as unfavorable body composition and CVD risk parameters (See Table 1A). Significant and poor ROC curves were noted for all fitness parameters. Significant ROC curve AUCs ranging from acceptable to excellent were noted for body mass (BM), body mass index (BMI), body fat percent (BF%), fat mass (FM), waist circumference, android and gynoid adiposity, AOPP, total cholesterol (TC), low-density lipoprotein cholesterol (LDL), and triglycerides (TG), while a near-acceptable ROC curve was noted for and glucose (See Table 1B). Cutoff values were established for BM, BMI, BF%, FM, waist circumference, android adiposity, and AOPP, TC, LDL, and TG (See Table 1C).
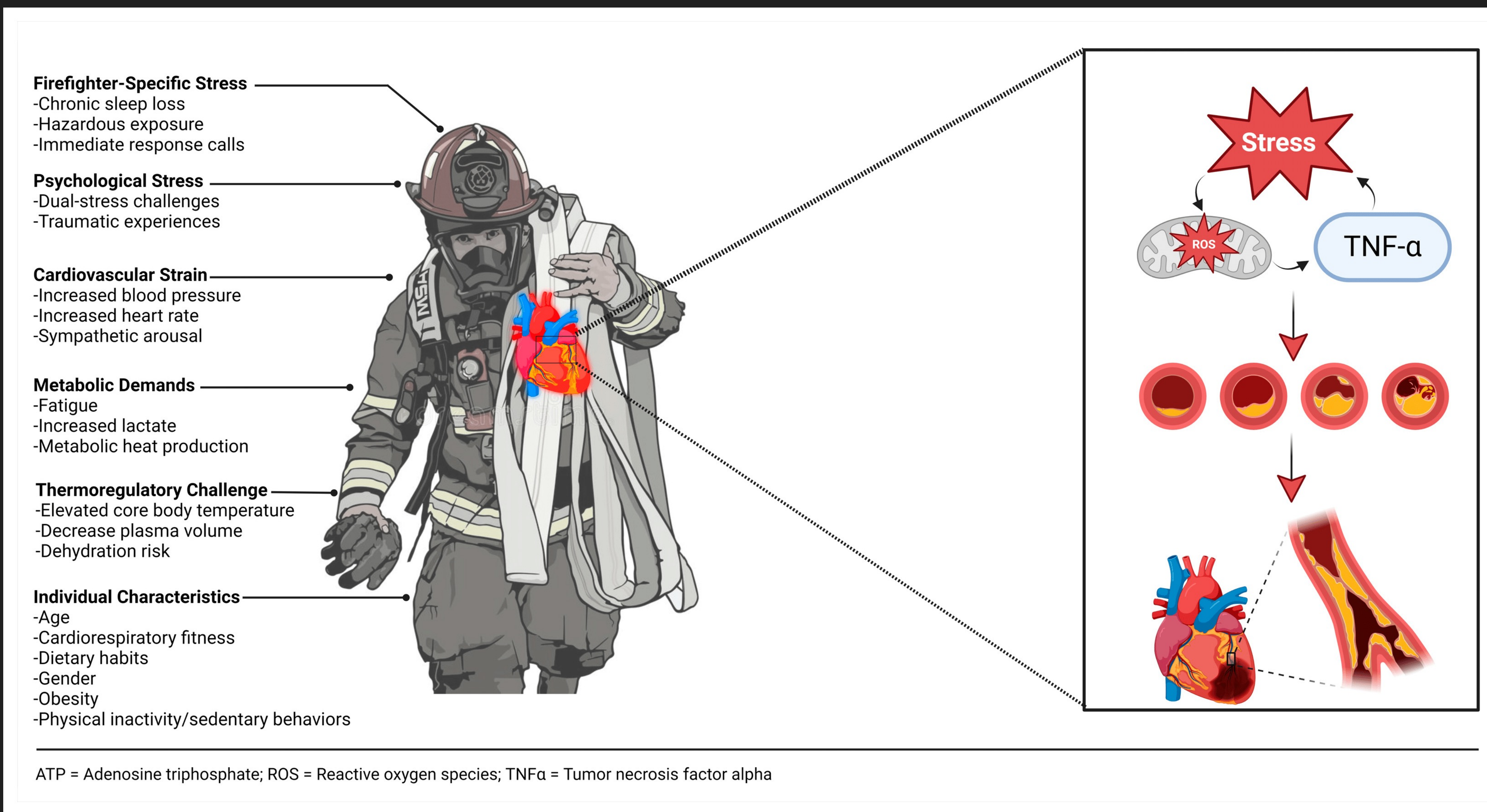
Conclusion

BM, BMI, BF%, FM, waist circumference, android adiposity, and AOPP, TC, LDL, and TG can be used to discern LOW from MOD. These findings suggest that coaches should emphasize tracking body composition and CVD risk biomarkers among FFs.

Practical Application

Coaches can impact FF health, wellness, and longevity by closely monitoring the cutoff values for body composition and CVD risk biomarkers. Educating FF and fire departments on these cutoff values and designing fitness training programs to improve these relevant markers will improve outcomes.

Firefighter Stressors

Firefighter-Specific Stress
-Chronic sleep loss
-Hazardous exposure
-Immediate response calls

Psychological Stress
-Dual-stress challenges
-Traumatic experiences

Cardiovascular Strain
-Increased blood pressure
-Increased heart rate
-Sympathetic arousal

Metabolic Demands
-Fatigue
-Increased lactate
-Metabolic heat production

Thermoregulatory Challenge
-Elevated core body temperature
-Decrease plasma volume
-Dehydration risk

Individual Characteristics
-Age
-Cardiorespiratory fitness
-Dietary habits
-Gender
-Obesity
-Physical inactivity/sedentary behaviors

ATP = Adenosine triphosphate; ROS = Reactive oxygen species; TNFα = Tumor necrosis factor alpha

Background

Firefighters have one of the most physically demanding occupations in today's society. It is well established that there is a high prevalence of cardiovascular disease (CVD) among structural firefighters due to the stressful nature of the occupation. Previous work suggests a relationship between CVD risk among firefighters (FF) and oxidative stress (OS), poor fitness, and body composition. However, limited research has utilized receiver operating characteristic (ROC) curves to determine if these parameters can be indicative of CVD risk.

Methods

- Retrospective Analysis of 160 career structural firefighters.
- Fasted blood biomarkers of OS and cardiometabolic health were assessed.
- Fitness parameters included the cardiopulmonary exercise test time to completion and estimated VO2max via the Foster equation.
- Firefighters were classified as either LOW or MOD CVD risk via ACSM standards.

Statistical Analysis

- Normality check: Shapiro-Wilk Test.
- Differences in CVD risk biomarkers, fitness, and body composition between LOW and MOD:
  - Independent sample T-tests or Mann-Whitney U tests
- Effect sizes: Cohen's d.
- ROC Curves: establish cutoff values to discern LOW from MOD.
  - An area under the curve (AUC) = ability to discern LOW from MOD
    - <0.5 = poor
    - 0.7-0.8 = acceptable
    - 0.8-0.9 = excellent
    - >0.9 = outstanding

Results

- MOD FFs exhibited lower (p<0.05) fitness, as well as unfavorable body composition and CVD risk parameters compared to the LOW FFs.
- Significant and poor ROC curves were noted for all fitness parameters.
- Significant ROC curve AUCs ranging from acceptable to excellent were noted for:
  - BM, BMI, BF%, FM, waist circumference, android and gynoid adiposity, AOPP, total cholesterol, low-density lipoprotein cholesterol, and triglycerides
- A near-acceptable ROC curve was noted for glucose.
- Cutoff values were established for BM, BMI, BF%, FM, waist circumference, android adiposity, and AOPP, TC, LDL, and TG.

Conclusions

BM, BMI, BF%, FM, waist circumference, android adiposity, AOPP, TC, LDL, and TG discern LOW from MOD CVD risk FFs.

PRACTICAL APPLICATION

Coaches can impact FF health, wellness, and longevity by closely monitoring the cutoff values for body composition and CVD risk biomarkers. Educating FF and fire departments on these cutoff values and designing fitness training programs to improve these relevant markers will improve outcomes.

Figures

A. Independent T-test

	Parameter	LOW	MOD	Sig.	d
Demographics	Age (years)	30.71 ± 6.25	37.23 ± 10.12†	<0.001	-0.73
	Height (cm)	179.19 ± 5.43	179.12 ± 14.32	0.973	0.006
	Body Mass Index (kg/m²)	26.96 ± 3.12	32.74 ± 18.64†	0.034	-0.383
	Body Mass (kg)	86.71 ± 11.62	100.1 ± 14.75†	<0.001	-0.975
Fitness	Cardiopulmonary Exercise Test Time (min)	12.11 ± 1.15	10.43 ± 1.48†	<0.001	1.222
	VO2max (ml/kg/min)	42.98 ± 4.88	36.06 ± 5.94†	<0.001	1.243
	Sit-Ups (total reps)	42.37 ± 7.18	38.56 ± 9.64†	0.019	0.431
	Push-Ups (total reps)	53.4 ± 11.89	43.52 ± 15.18†	<0.001	0.704
	Grip Strength	110.73 ± 12.46	113.43 ± 19.28	0.222	-0.159
Body Composition	Hip Circumference (in)	38.03 ± 2.944	40.72 ± 4.31†	<0.001	-0.693
	Wasit Circumference (in)	35.16 ± 3.04	39.06 ± 4.15†	<0.001	-1.028
	Wasit -to-Hip	0.92 ± 0.06	0.96 ± 0.05†	0.004	-0.568
	Body Fat Percent (%)	21.34 ± 3.73	25.24 ± 5.04†	<0.001	-0.844
	Fat Mass (lbs)	41.82 ± 11.02	56.86 ± 17.59†	<0.001	-0.968
	Lean Mass (lbs)	148.34 ± 23.31	161.79 ± 20.74†	<0.001	-0.619
	Android Adiposity (%)	24.14 ± 5.62	29.84 ± 6.42†	<0.001	-0.927
	Gynoid Adiposity (%)	24.15 ± 3.76	26.02 ± 4.68†	0.014	-0.426
Biomarkers	Total Cholesterol (mg/dL)	172.65 ± 29.74	202 ± 35.09†	<0.001	-0.882
	Low-Density Lipoprotein (mg/dL)	98.53 ± 25.65	134.84 ± 40.68†	<0.001	-1.007
	High-Density Lipoprotein (mg/dL)	56.97 ± 11.54	44.72 ± 10.46†	<0.001	1.128
	Triglycerides (mg/dL)	81.89 ± 43.5	142.05 ± 87.27†	<0.001	-0.805
	Glucose (mg/dL)	88.57 ± 11.66	92.59 ± 11.64‡	0.055	-0.345
	Advanced Oxidation Protein Products (μM)	122.63 ± 79.53	157.19 ± 88.7†	<0.001	-0.405

†Significant difference from LOW risk group; ‡Non-Significant difference (p>0.05 to p<0.10) LOW risk group

B. ROC Curve Results

Parameter	AUC	Sig.	95% CI diff
Age	0.688	<0.001	0.601 to 0.775
Height	0.54	0.440	0.442 to 0.638
Body Mass Index	0.8**	<0.001	0.722 to 0.877
Body Mass	0.774*	<0.001	0.691 to 0.856
Cardiopulmonary Exercise Test Time	0.177	<0.001	0.104 to 0.250
VO2max	0.177	<0.001	0.104 to 0.250
Sit-Ups	0.371	0.014	0.275 to 0.468
Push-Ups	0.292	<0.001	0.204 to 0.381
Grip Strength	0.566	0.222	0.463 to 0.669
Hip Circumference	0.699	<0.001	0.612 to 0.785
Wasit Circumference	0.783*	<0.001	0.706 to 0.860
Wasit -to-Hip	0.647	0.005	0.548 to 0.746
Body Fat Percent	0.733*	<0.001	0.649 to 0.817
Fat Mass	0.767*	<0.001	0.687 to 0.847
Lean Mass	0.295	<0.001	0.201 to 0.388
Android Adiposity	0.749*	<0.001	0.664 to 0.834
Gynoid Adiposity	0.628	0.014	0.533 to 0.723
Total Cholesterol	0.748*	<0.001	0.664 to 0.831
Low-Density Lipoprotein	0.811**	<0.001	0.740 to 0.882
High-Density Lipoprotein	0.19	<0.001	0.118 to 0.262
Triglycerides	0.752*	<0.001	0.669 to 0.834
Glucose	0.627	0.014	0.528 to 0.725
Advanced Oxiation Protein Products	0.705*	<0.001	0.608 to 0.803

*0.7-0.8 is considered acceptable, **0.8-0.9 is considered excellent, and ***more than 0.9 is considered outstanding

C. Cutoff Values

Test	Position
Age	-
Height	-
Body Mass Index	≥28..02 kg/m²
Body Mass	≥90.68 kg
Cardiopulmonary Exercise Test Time	-
VO2max	-
Sit-Ups	-
Push-Ups	-
Grip Strength	-
Hip Circumference	-
Wasit Circumference	≥36.75 in
Wasit -to-Hip	-
Body Fat Percent	≥22.35%
Fat Mass	≥46.64 lbs
Lean Mass	-
Android Adiposity	≥26.35 %
Gynoid Adiposity	-
Total Cholesterol	≥187.50 mg/dL
Low-Density Lipoprotein	≥118.00 mg/dL
High-Density Lipoprotein	-
Triglycerides	≥86.50 mg/dL
Glucose	-
Advanced Oxiation Protein Products	≥108.76 μM

THE SYDNEY & J.L. HUFFINES INSTITUTE FOR SPORTS MEDICINE & HUMAN PERFORMANCE

TARU — TACTICAL ATHLETE RESEARCH UNIT — EST. 2022

FIRE RESCUE WELLNESS

ATM — KINESIOLOGY & SPORT MANAGEMENT

MAP LAB — Metabolic & Applied Physiology