Establishing Cardiovascular Disease Risk Cutoff Values Among First Responders

Jason Good[1], Kelly Hines[1], J. Jay Dawes[2], J. Bryan Mann[1], Steven E. Martin[1], Drew E. Gonzalez[2,3]
[1]Tactical Athlete Research Unit, Department of Kinesiology and Sports Management, Texas A&M University, College Station, TX, USA
[2]Oklahoma State University, Stillwater, OK, USA
[3]Occupational, Performance, and Nutrition Laboratory, Sam Houston State University, Huntsville, TX, USA

TACTICAL FITNESS AND NUTRITION LAB

Sam Houston State University

Abstract

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

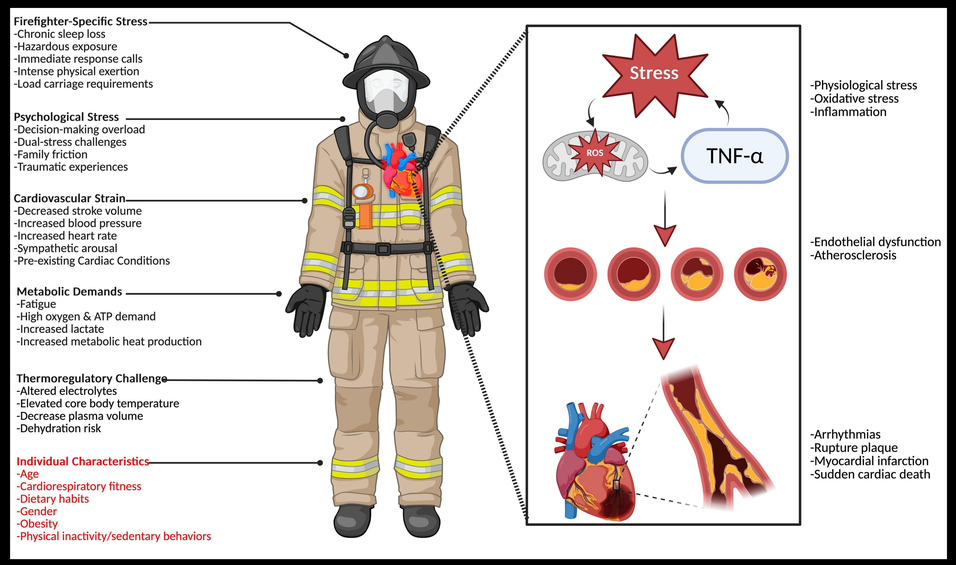
METHODS: One hundred and seventy-one male (n=171) first responders (73 LEOS; 98 FFs) were analyzed. Fasted (≥12h) blood and saliva bio-samples were collected to assess traditional (i.e., blood glucose and lipids) and non-traditional (i.e., oxidative stress and inflammation) CVD risk biomarkers. Dual-energy x-ray absorptiometry and waist and hip circumferences metrics were taken. A symptom-limited maximal cardiopulmonary exercise test (CPXT) was completed and VO2max was estimated via the Foster equation. LOW and MOD CVD risk classifications were based on the American College of Sports Medicine risk stratification scoring standards. Shapiro-Wilk Test assessed for normality. Independent sample T-tests or Mann-Whitney U tests (if normality was violated) assessed for 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 distinguish LOW from MOD. An area under the curve (AUC) less than 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 by using the minimum distance from the left upper corner of the unit square to the appropriate point on the ROC curve.

RESULTS: The LOW group was younger (p=0.002, d=-0.474), weighed less (p<0.001, d=-0.871), lasted longer on the CPXT (p<0.001, d=0.647), had greater VO2max values (p<0.001, d=0.664), and performed more push-ups (p=0.028, d=0.358), in addition to displaying better body composition parameters and indices of CVD risk (Table 1, Panel A). Several significant (p<0.05) but poor or near acceptable ROC curve AUCs were identified (Table 1 Panel B), while significant and acceptable ROC curve AUCs were found for the body roundness index (BRI; AUC=0.703, p=0.003), waist-to-hip ratio (WHR; AUC=0.701, p=0.004), android body fat (AUC=0.750, p<0.001), triglycerides (TAG; AUC=0.746, p<0.001), and advanced oxidation protein products (AOPP; AUC=0.703, p=0.003). As such, cutoff values were estimated for each of these parameters (Table 1 Panel B).

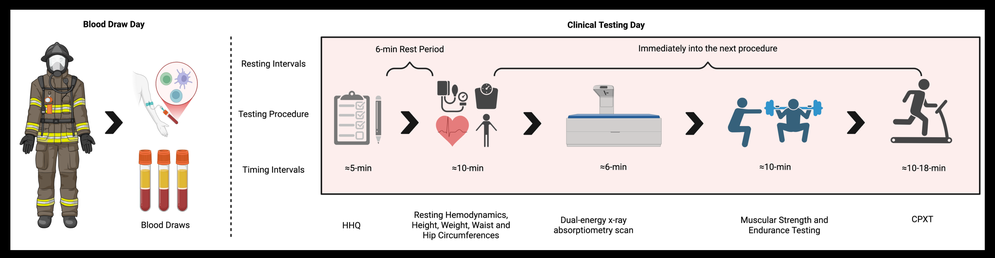
CONCLUSIONS: These results provide evidence of the importance of assessing body composition and CVD risk biomarkers among first responders – namely, BRI, WHR, android body fat, TAG, and AOPP. These findings align with previous data demonstrating that first responders tend to have adverse health profiles, often illustrated by poor body composition, blood lipids, and increased oxidative stress. These findings suggest practitioners should emphasize tracking body composition and CVD risk biomarkers among first responders.

PRACTICAL APPLICATION: Practitioners should consider these cutoff values for body composition and CVD risk biomarkers when monitoring first responders in exercise and resistance training programs.

Disease Risk



Experimental Design



Figures

A		Risk Group Comparison				B	ROC Curve Results			
	Parameter	LOW	MOD	*p*-Value	*d*	Parameter	AUC	*p*-Value	95% CI diff	Cut-Off Value
Demographics	Age (years)	35.41 ± 9.47	39.97 ± 9.75	0.002	-0.474	Age (years)	0.582	0.235	0.45 to 0.72	-
	Height (cm)	177.5 ± 15.14	180.09 ± 6.78	0.473	-0.228	Height (cm)	0.455	0.519	0.32 to 0.59	-
	Body Mass (kg)	86.48 ± 13.99	99.27 ± 15.24	<0.001	-0.871	Body Mass (kg)	0.603	0.135	0.47 to 0.74	-
	Body Mass Index (kg/m2)	29.32 ± 20.56	30.61 ± 4.34	0.562	-0.091	Body Mass Index (kg/m2)	0.653	0.027	0.52 to 0.78	-
Fitness	Cardiopulmonary Exercise Test Time (min)	11.32 ± 1.56	10.2 ± 1.84	<0.001	0.647	Cardiopulmonary Exercise Test Time (min)	0.276	0.001	0.15 to 0.4	-
	VO2max (ml/kg/min)	39.67 ± 6.44	35.59 ± 5.9	<0.001	0.664	VO2max (ml/kg/min)	0.275	0.001	0.15 to 0.4	-
	Hand Grip Strength	107.58 ± 19.69	109.48 ± 20.67	0.381	-0.094	Hand Grip Strength	0.499	0.991	0.36 to 0.64	-
	Push-Ups	50.41 ± 15.54	44.72 ± 16.15	0.028	0.358	Push-Ups	0.330	0.014	0.2 to 0.46	-
	Sit-n-Reach (in)	15.05 ± 2.71	15.62 ± 13.81	0.002	-0.055	Sit-n-Reach (in)	0.369	0.058	0.24 to 0.5	-
Body Composition	Hip Circumference (cm)	97.2 ± 9.79	103.67 ± 11.48	<0.001	-0.601	Hip Circumference (cm)	0.663	0.000	0.58 to 0.75	-
	Wasit Circumference (cm)	87.42 ± 8.83	98.63 ± 10.18	<0.001	-1.168	Wasit Circumference (cm)	0.682	0.009	0.56 to 0.81	-
	Waist-to-Hip Ratio	0.9 ± 0.07	0.95 ± 0.07	<0.001	-0.707	Waist-to-Hip Ratio	0.701	0.004	0.58 to 0.82	0.905
	Body Roundness Index ¥	8.39 ± 6.08	9.95 ± 2.36	0.029	-0.352	Body Roundness Index ¥	0.703	0.003	0.58 to 0.83	8.355
	Body Fat Percentage (%)	22.71 ± 5.36	25.79 ± 4.8	<0.001	-0.610	Body Fat Percentage (%)	0.693	0.005	0.57 to 0.82	-
	Fat Mass (kg)	20.31 ± 6.49	26.58 ± 8.34	<0.001	-0.831	Fat Mass (kg)	0.689	0.006	0.56 to 0.81	-
	Lean Mass (kg)	68.17 ± 11.09	74.56 ± 8.7	<0.001	-0.649	Lean Mass (kg)	0.550	0.468	0.41 to 0.69	-
	Android Body Fat (%)	25.37 ± 6.82	30.87 ± 6.07	<0.001	-0.856	Android Body Fat (%)	0.750	0.000	0.63 to 0.87	25.75
	Gynoid Body Fat (%)	25.15 ± 5.97	26.5 ± 5.18	0.124	-0.242	Gynoid Body Fat (%)	0.591	0.191	0.46 to 0.72	-
Markers of Disease Risk	Blood Glucose (mg/dL)	87.16 ± 7.81	92.73 ± 11.16	<0.001	-0.571	Blood Glucose (mg/dL)	0.672	0.013	0.54 to 0.8	-
	Hemoglobin-A1c (%)	5.42 ± 0.22	5.47 ± 0.32	0.314	-0.183	Hemoglobin-A1c (%)	0.548	0.489	0.41 to 0.68	-
	Insulin (µlU/mL)	4.67 ± 2.34	3.3 ± 2.85	0.001	0.522	Insulin (µlU/mL)	0.291	0.003	0.17 to 0.42	-
	Tryglicerides (mg/dL)	92.91 ± 48.98	144.24 ± 86.73	<0.001	-0.717	Tryglicerides (mg/dL)	0.746	0.000	0.63 to 0.86	85.5
	Total Cholesterol (mg/dL)	176.21 ± 26.76	209.68 ± 31.03	<0.001	-1.150	Total Cholesterol (mg/dL)	0.854	0.000	0.76 to 0.95	-
	Low-Density Lipoprotein Cholesterol (mg/dL)	101.65 ± 23.34	138.94 ± 27.31	<0.001	-1.462	Low-Density Lipoprotein Cholesterol (mg/dL)	0.898	0.000	0.82 to 0.97	-
	High-Density Lipoprotein Cholesterol (mg/dL)	57.1 ± 16.89	44.87 ± 9.42	<0.001	0.910	High-Density Lipoprotein Cholesterol (mg/dL)	0.255	0.000	0.14 to 0.37	-
	Advanced Oxidation Protein Products (µM)	103.97 ± 69.64	141.52 ± 89.89	<0.001	-0.464	Advanced Oxidation Protein Products (µM)	0.703	0.003	0.58 to 0.83	94.66
	C-Reactive Protein (ng/mL)	1215.88 ± 1188.06	1638.08 ± 1335.13	0.021	-0.334	C-Reactive Protein (ng/mL)	0.648	0.033	0.52 to 0.78	-
	Blood Cortisol (µg/dL)	13.73 ± 5.5	13.38 ± 5.13	0.584	0.065	Blood Cortisol (µg/dL)	0.452	0.486	0.31 to 0.59	-
	Salivary α-Amylase (U/mL)	65.28 ± 48.64	51.62 ± 33.2	0.185	0.336	Salivary α-Amylase (U/mL)	0.455	0.519	0.32 to 0.59	-
	Salivary Cortisol (µg/dL)	0.34 ± 0.19	0.32 ± 0.2	0.437	0.077	Salivary Cortisol (µg/dL)	0.475	0.716	0.33 to 0.62	-
	Estimated Pulse Wave Velocity (m/s)	6.82 ± 0.61	7.21 ± 0.87	0.002	-0.507	Estimated Pulse Wave Velocity (m/s)	0.555	0.426	0.42 to 0.69	-

Background

First responders, such as firefighters (FFs) and law enforcement officers (LEOs), have heightened cardiovascular disease (CVD), with data suggesting that ≈45% of on-duty FF fatalities are related to CVD, while LEOs have a 1.7 times higher CVD prevalence than the general public. However, it is not clear if there are predictive cutoff values that could suggest the risk of disease early on. Identifying these cutoffs could provide useful information to fire and police departments on how to best combat the risk of disease with evidence-based exercise training intervention. Therefore, this study determined if biomarkers of cardiovascular disease (CVD) risk, fitness, and body composition can be used to delineate between low-risk (LOW) and moderate-risk (MOD) CVD risk classifications.

Methods

- 171 first responders (73 LEOS; 98 FFs) were included.
- Fasted (≥12h) blood and saliva bio-samples were collected.
- Dual-energy x-ray absorptiometry and waist and hip circumferences metrics were taken.
- A symptom-limited maximal cardiopulmonary exercise test (CPXT) was completed and VO2max was estimated via the Foster equation.
- LOW and MOD CVD risk classifications were based on the American College of Sports Medicine risk stratification scoring standards.

Statistical Analysis

Shapiro-Wilk Test assessed for normality. Independent sample T-tests or Mann-Whitney U tests (if normality was violated) assessed for 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 distinguish LOW from MOD. An area under the curve (AUC) less than 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 by using the minimum distance from the left upper corner of the unit square to the appropriate point on the ROC curve.

Results

- The LOW group was:

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- Significant and acceptable ROC curve AUCs were found for the body roundness index (BRI; AUC=0.703, p=0.003), waist-to-hip ratio (WHR; AUC=0.701, p=0.004), android body fat (AUC=0.750, p<0.001), triglycerides (TAG; AUC=0.746, p<0.001), and advanced oxidation protein products (AOPP; AUC=0.703, p=0.003). As such, cutoff values were estimated for each of these parameters.

Conclusions

These results provide evidence of the importance of assessing body composition and CVD risk biomarkers among first responders – namely, BRI, WHR, android body fat, TAG, and AOPP. These findings align with previous data demonstrating that first responders tend to have adverse health profiles, often illustrated by poor body composition, blood lipids, and increased oxidative stress. These findings suggest practitioners should emphasize tracking body composition and CVD risk biomarkers among first responders

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