



# Cardiovascular Disease as a Driver of Military Medical Separation

*A 7-year analysis of cardiology Medical Evaluation Board referrals · FY2018–FY2024*

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Caroline E. Murphy, MD has no conflicts/disclosures to report





# A leading killer — and an unmeasured burden



## BACKGROUND

### Heart Disease

is a leading cause of nontraumatic death in the active-duty Army

**Also, the leading cause of death among U.S. veterans.** The cardiovascular burden does not end at separation; it follows Soldiers into Veteran care.

*Decades of fitness-for-duty policy, yet no system-wide picture of cardiovascular separation.*

CDC/VA mortality data, 2022

## THE GAP



### Which conditions separate Soldiers?

The diagnostic burden driving cardiovascular separation has never been characterized.



### At what rate — and is it rising?

No estimate of how many boards cardiovascular disease accounts for, or the trend over time.



### With what outcome?

No data on whether affected Soldiers return to duty or leave the force.



# Cohort, classification, and outcomes



## METHODS



### Data sources

Military Health System electronic medical records linked to the Soldier Performance, Health & Readiness database (SPHERE).



### Cohort

Every active-duty Army Soldier referred for a cardiology Medical Evaluation Board (MEB), FY2018–FY2024.



### 15 cardiovascular domains

Diagnoses grouped into 15 cardiovascular domains using ICD-10-CM codes for a consistent classification.



### 5 disposition outcomes

Return to duty · permanent disability retirement · temporary disability retirement · medical separation · other.

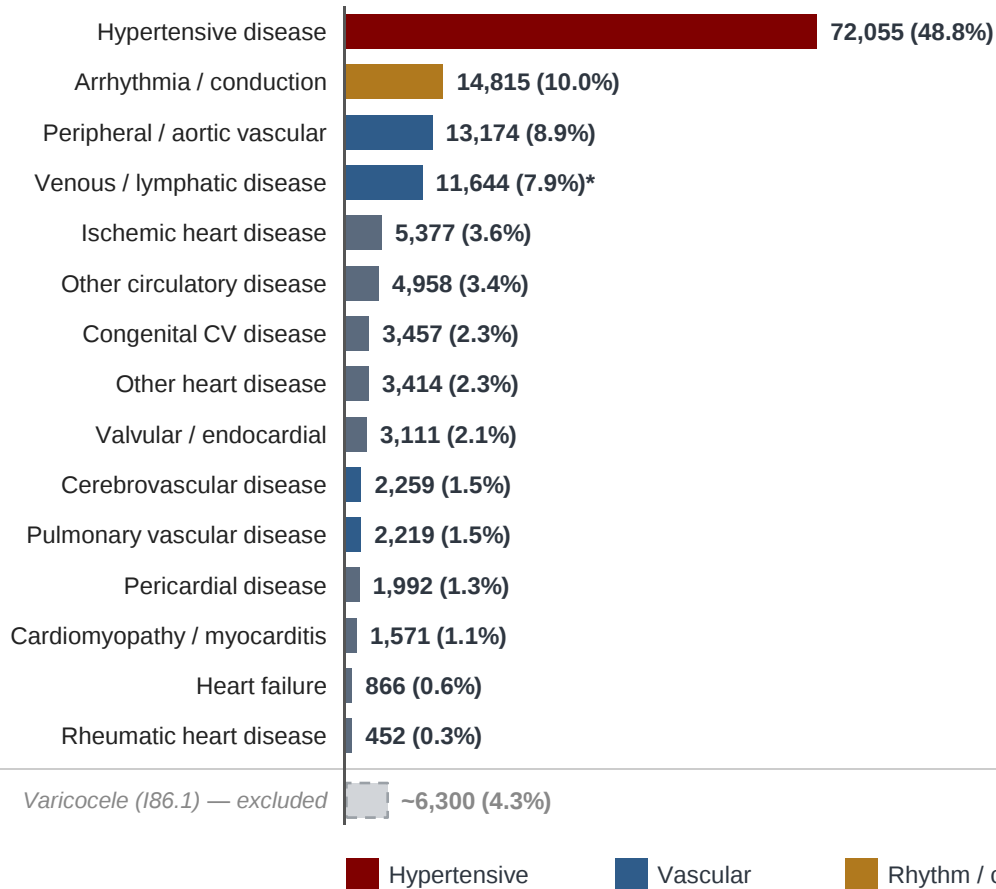


# The full spectrum of cardiovascular diagnoses



## RESULTS · DIAGNOSTIC SPECTRUM

147,661 Soldiers diagnosed · 235,296 encounters · 15 cardiovascular domains



### Representative diagnoses · % = share of all 147,661 diagnosed

e.g., Essential HTN (I10) ~48%; hypertensive CKD; HTN urgency

e.g., Atrial fibrillation (I48) 1.9%; PVCs (I49.3) 1.7%; SVT 1.0%

e.g., Raynaud's (I73.0) 2.2%; thoracic aortic aneurysm (I71.2) 0.3%

e.g., Chronic venous insufficiency (I87.2) 0.8%; DVT (I82.4) 0.5%

e.g., Coronary atherosclerosis (I25.10) 1.5%; old MI 0.4%; NSTEMI

e.g., Hypotension (I95.9) 1.4%; orthostatic hypotension (I95.1) 0.8%

e.g., Bicuspid aortic valve (Q23.1) 0.5%; ASD / PFO (Q21.1) 0.4%

e.g., Cardiomegaly (I51.7) 1.4%; myocarditis (I51.4) 0.6%

e.g., Mitral regurgitation (I34.0) 0.6%; aortic regurg (I35.1) 0.3%

e.g., Ischemic stroke (I63.9) 0.4%; cerebral aneurysm (I67.1) 0.1%

e.g., Pulmonary embolism (I26.99) 1.1%; pulmonary HTN (I27.2) 0.1%

e.g., Pericardial effusion / disease (I31) 0.5%; pericarditis 0.4%

e.g., Cardiomyopathy (I42.9) 0.3%; dilated (I42.0) 0.2%; HCM 0.1%

e.g., Heart failure (I50.9) 0.2%; systolic HF / HFrEF (I50.2) 0.1%

e.g., Rheumatic valve disease (I05-I09); <0.3% of all

Non-cardiac venous finding, removed from venous / lymphatic domain

\* Venous / lymphatic shown excluding varicocele; count estimated from coding distribution, pending patient-level confirmation.



# A rising share that has plateaued



## RESULTS · MEB REFERRALS

**1,749**

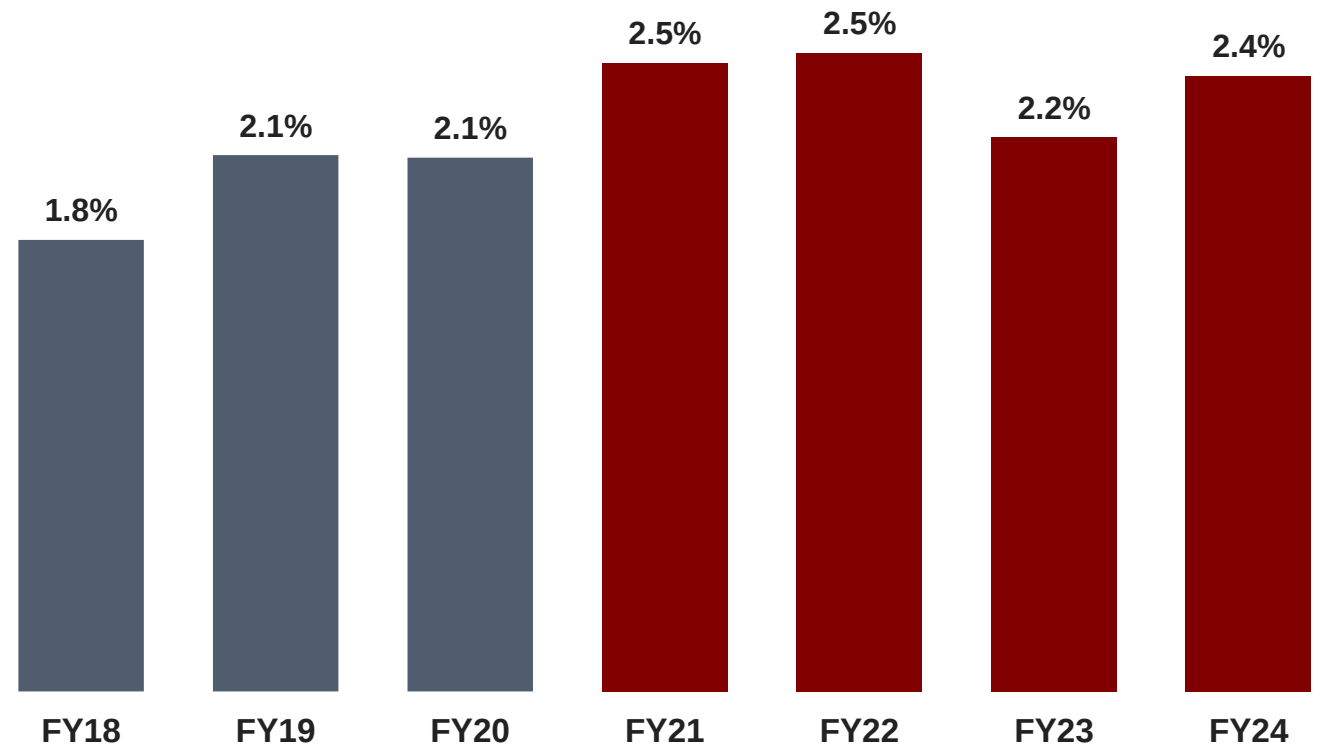
Soldiers referred for a cardiology MEB, FY2018–FY2024

**1.8% → 2.4–2.5%**

Cochran-Armitage trend test:  $z = 3.40$ ,  $p = 0.0007$

*Absolute count is flat (205 → 251); the rising share partly reflects fewer total board referrals*

### Cardiology MEBs as a share of all Army MEBs



steel = baseline (FY18–20) · maroon = plateau (FY21–24)



# Most referred Soldiers never return to duty



## RESULTS • DISPOSITION

**89%**

**permanently leave the force**

permanent disability retirement (64.8%) + medical separation (24.2%)

**0.91%**

returned to duty

**8.4%**

temporary retirement  
(may return)

### MEB disposition — cardiology referrals (n = 1,749)

Permanent disability retirement

64.8%

Medical separation

24.2%

Temporary disability retirement

8.4%

Return to duty

0.9%



# Diagnoses behind each disposition



## RESULTS · INTERPRETATION

HEART DISEASE MEB · n = 1,083

VEIN AND ARTERY DISEASE MEB · n = 693

PDR

**Permanent disability retirement**  
**65.7% / 64.5%**  
*VASRD rating ≥ 30%*

Hypertrophic cardiomyopathy (I42.1, I42.2) · dilated cardiomyopathy (I42.0) · chronic systolic heart failure (I50.22) · ischemic cardiomyopathy (I25.5) · aborted cardiac arrest (I46.9) · complete AV block (I44.2) · sustained VT (I47.2) · aortic stenosis (I35.0) · congenital aortic valve disease (Q23.1)

Thoracic aortic aneurysm (I71.2) · PAD with claudication (I70.211) · chronic DVT on indefinite anticoagulation (I82.401) · post-thrombotic syndrome with ulcer (I87.001) · pulmonary hypertension (I27.0, I27.20)

MS

**Medical separation**  
**23.0% / 25.4%**  
*rating < 30%, < 20 yrs service*

Paroxysmal and persistent atrial fibrillation (I48.0, I48.1) · stable coronary disease without angina (I25.10) · resolved myocarditis with minor residua (I40.9) · long QT syndrome (I45.81) · left bundle-branch block (I44.1)

Varicose veins with complications (I83.10) · chronic venous insufficiency (I87.2) · superficial thrombophlebitis (I80.00) · treated proximal DVT off anticoagulation (I82.401)

TDRL

**Temporary disability retirement**  
**8.8% / 7.5%**  
*condition not yet stable*

Acute myocarditis (I40.0, I40.9) · peripartum cardiomyopathy pending recovery (I42.8) · recent STEMI awaiting remodeling (I21.3) · new cardiomyopathy on guideline therapy (I42.9) · recent valve repair or replacement

Acute proximal DVT on time-limited anticoagulation (I82.411) · acute pulmonary embolism (I26.99) · recent aortic or peripheral arterial repair

RTD

**Return to duty**  
**0.83% / 1.01%**  
*n = 9 and 7 over seven years*

SVT after successful ablation (I47.1) · first-degree AV block (I44.0) · isolated right bundle-branch block (I45.10) · single resolved acute pericarditis (I30.9)

Superficial thrombophlebitis (I80.00) · uncomplicated varicose veins (I83.90) · single provoked DVT, course completed (I82.401)

Percentages are observed. Code assignments are clinical expectation based on AR 40-501 Chapter 3 retention standards and VASRD cardiovascular criteria (38 CFR 4.104); the extract captures all cardiovascular codes in the year preceding adjudication and cannot attribute disposition to an individual code.



# Hypertension: the largest, most modifiable driver



## SPOTLIGHT

**48.8 %**

of CVD-diagnosed Soldiers — the single largest domain

**26.8 M**

U.S. adults newly treatment-eligible for stage 1 HTN (2025 ACC/AHA, PREVENT)

**~50 %**

of them aged 18–39 — the core active-duty demographic



Uncontrolled / undertreated hypertension



Cardiovascular strain



Accelerated end-organ injury



Fitness-for-duty failure

**Upstream blood-pressure control is a scalable prevention lever.** Hypertension is modifiable — controlling it early targets the largest single contributor before end-organ injury sets in.



# A high-cost loss that is largely preventable



## THE STAKES • COST & PREVENTION

### THE COST OF EACH LOSS

**\$3–11M**

to develop a specialty-trained Soldier such as a combat aviator, over ~5 years (GAO 2018). An entry-level trainee alone runs ~\$60,000 (Niebuhr 2013).

**1,557**

career-ending cardiology boards in this cohort alone (89% of 1,749), each also a lasting disability-retirement obligation

### WHY IT CAN BE MITIGATED



#### Half the burden is one condition

Hypertensive disease is 48.8% of the spectrum; essential hypertension (I10) is 98% of it. Screenable and treatable.



#### Treating it changes outcomes

Intensive blood-pressure control lowers cardiovascular events and all-cause death (SPRINT, NEJM 2015).



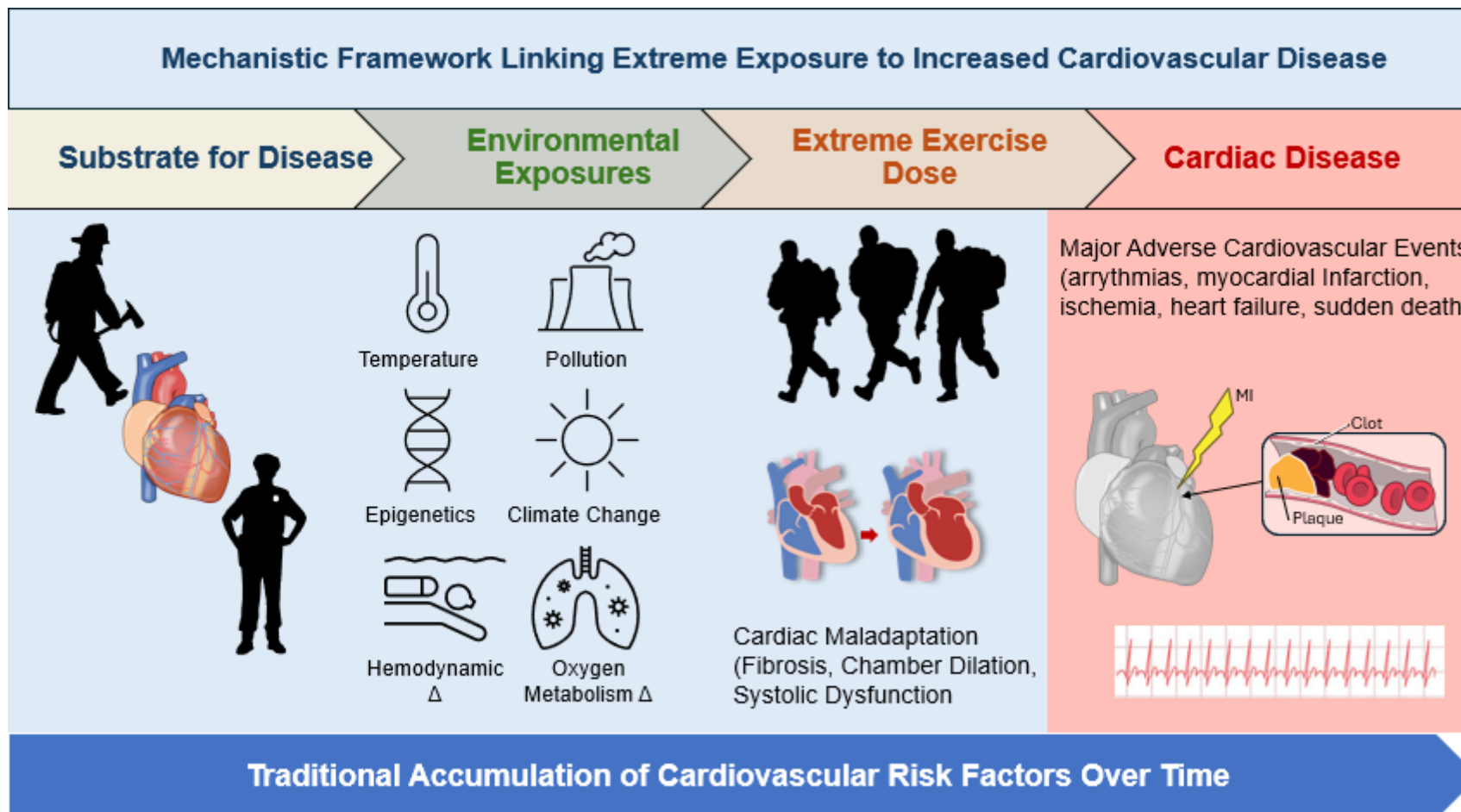
#### Scalable levers already exist

Routine BP screening and control, Periodic Health Assessments, plus H2F as force-wide primary prevention. No new technology required.

Every separation forfeits a readiness investment of tens of thousands to millions of dollars, to a largely preventable disease. **The tools to prevent it already exist.**



# The Framework and Next Steps

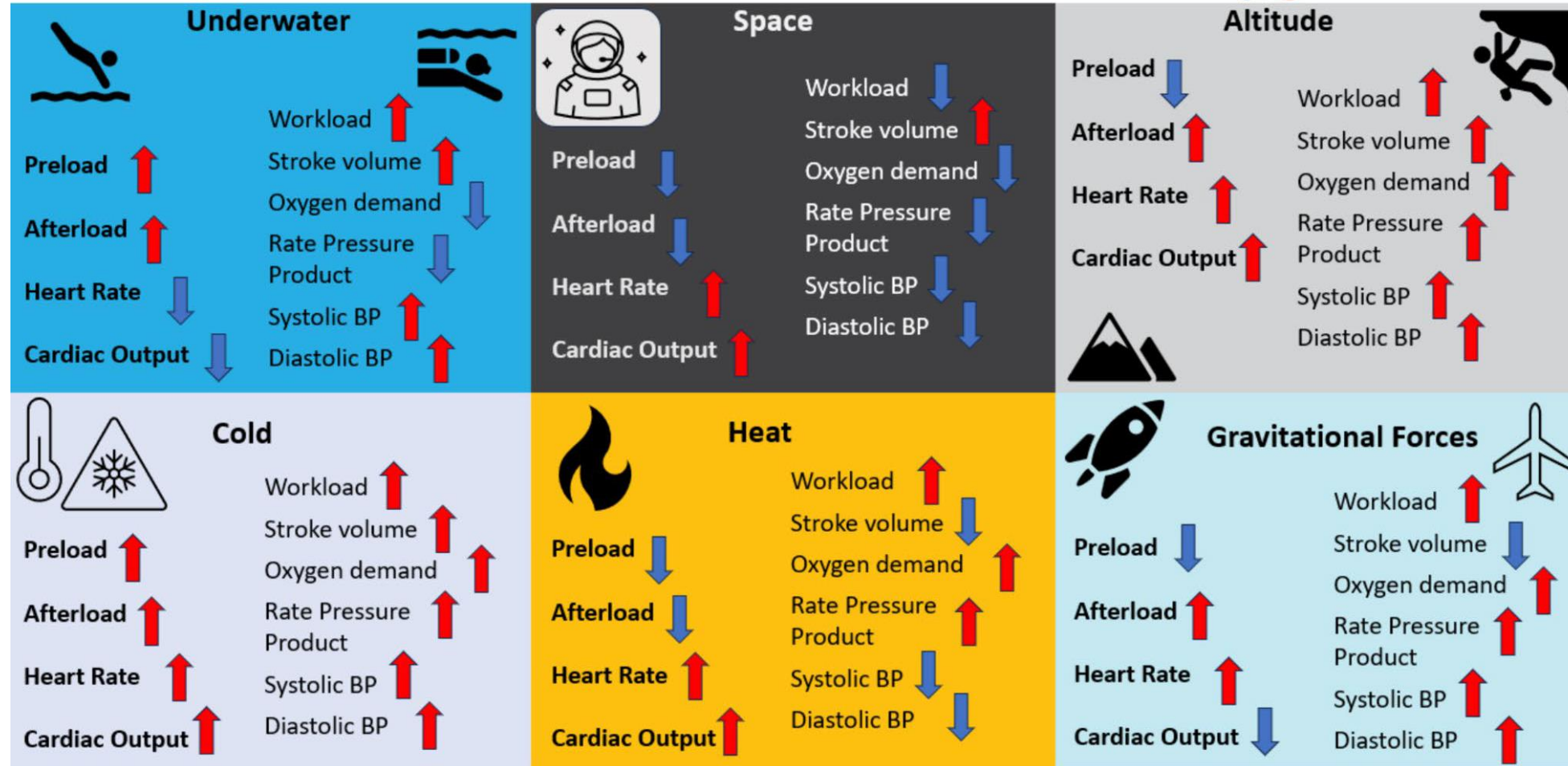




# How Operational Stressors Impact the Heart



## Overview of the Cardiovascular Impacts of Common Operational Environments for Tactical Athletes



Murphy et al., 2025

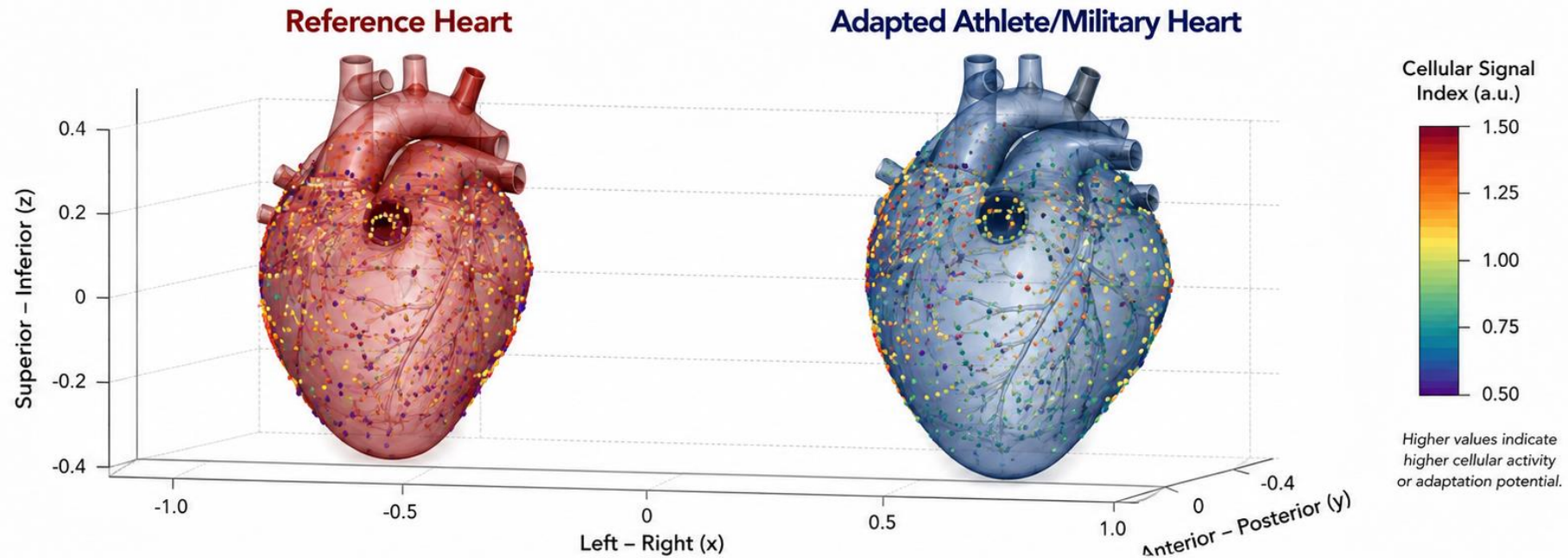


# Why the Military literally has more Heart



## Digital Physiological Heart Prototype

Reference vs. Adapted Athlete/Military Heart



### Key Morphological & Physiological Differences



LV Mass

↑ 18%



LV Volume (EDV)

↑ 15%



Wall Thickness

↑ 14%



Capillary Density

↑ 28%



Mitochondrial Signal

↑ 28%



Stroke Volume

↑ 17%



Performance Index

↑ 20%

Conceptual prototype integrating anatomy, cellular phenotype, and physiology.

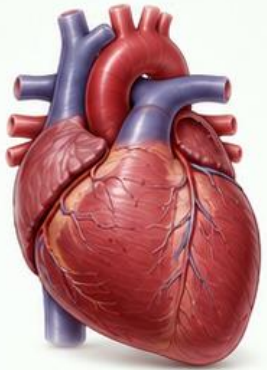
Murphy et al., 2025



# Why the Military literally has more Heart



## 1 STRUCTURALLY NORMAL HEART

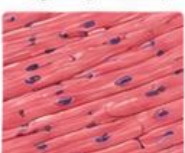


- ✓ Normal chamber size and geometry
- ✓ Normal wall thickness
- ✓ Healthy myocardium and minimal fibrosis
- ✓ Normal aorta and coronary arteries

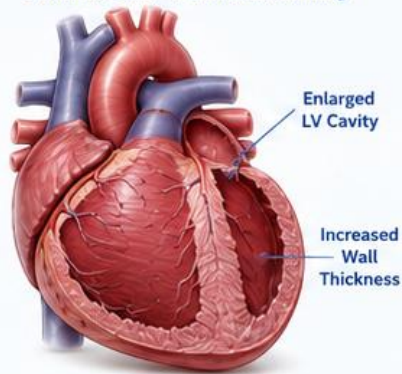
Coronary Artery (Cross-Section)



Myocardial Tissue (High Magnification)



## 2 EXTREME EXERCISE Chamber Dilation & Wall Thickening



- ✓ Increased chamber size (physiologic dilation)
- Concentric wall thickening
- Enhanced systolic function
- Increased stroke volume and cardiac output

Coronary Artery (Cross-Section)



Myocardial Tissue (High Magnification)



## 3 ENVIRONMENTAL EXPOSURES Fibrotic Remodeling

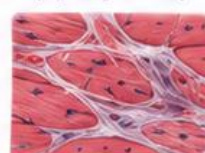


- ✓ Interstitial and replacement fibrosis
- ✓ Reduced myocardial compliance
- Diastolic dysfunction
- Increased arrhythmia susceptibility

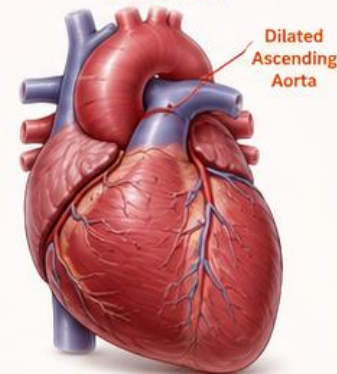
Coronary Artery (Cross-Section)



Myocardial Tissue (High Magnification)



## 4 RUCKING / LOAD CARRIAGE Aortic Dilation



- ✓ Increased afterload from load carriage
- ✓ Aortic root and ascending aorta dilation
- Altered aortic wall stress
- Long-term risk of aortic complications

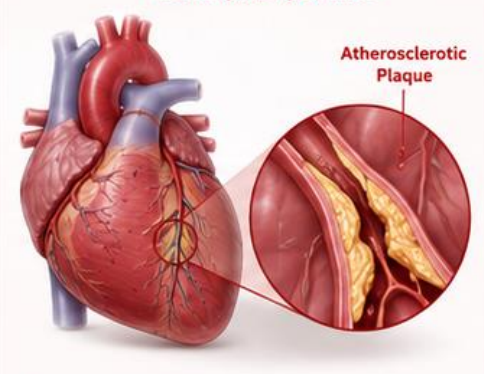
Aorta (Cross-Section)



Aortic Wall (High Magnification)

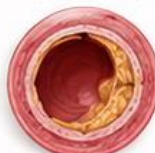


## 5 CARDIOTOXIC EXPOSURES Coronary Artery Disease

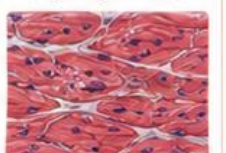


- ✓ Endothelial injury and inflammation
- Atherosclerotic plaque progression
- Reduced coronary blood flow reserve
- Increased risk of ischemia and events

Coronary Artery (Cross-Section)



Myocardial Tissue (High Magnification)



## CUMULATIVE IMPACT



Structural remodeling increases cardiac workload



Decreased efficiency and adaptability



Higher risk of arrhythmias, ischemia, and heart failure



Increased long-term cardiovascular risk



These changes may occur gradually over years, and the effects can be synergistic.

This is a conceptual educational model. Individual responses vary based on genetics, training status, exposures, and comorbid conditions.

Murphy et al., 2025



# Prevention reaches well beyond blood pressure



## PREVENTION • THE BROADER EVIDENCE



### Lipid lowering (statins)

Each 1 mmol/L LDL-C reduction lowers major vascular events ~21%.

*CTT meta-analysis, Lancet 2010*



### Cardiorespiratory fitness

Higher fitness tracks with lower mortality, with no observed ceiling of benefit.

*Mandsager et al., JAMA Netw Open 2018*



### Tobacco cessation

Quitting substantially lowers cardiovascular risk; excess CHD risk falls within a few years.

*U.S. Surgeon General's Report, 2014*



### Mediterranean diet

~30% fewer major cardiovascular events vs a low-fat control diet.

*PREDIMED; Estruch et al., NEJM 2018*



### Fixed-dose 'polypill'

Statin + antihypertensives ± aspirin cut major CV events 21–31% in primary prevention.

*TIPS-3; Yusuf et al., NEJM 2021*



**These levers already sit within H2F's domains nutrition, physical readiness, and tobacco-free living. The prevention infrastructure exists; the task is to apply it at scale.**



# A preventable readiness threat



## CONCLUSIONS



### First system-wide map

The first systematic characterization of the cardiovascular burden driving military medical separation.



### A heavy personnel cost

Nearly 9 of 10 referred Soldiers permanently leave the force — a substantial, recurring readiness and personnel loss.



### Modifiable contributors

Hypertension dominates and is treatable; upstream control is a concrete, scalable point of intervention.



### Next steps

Condition-specific analyses across the other domains, evidence-based fitness-for-duty policy, and prospective evaluation of H2F as a prevention mechanism.



# Key takeaway



**Cardiovascular disease quietly removes nearly 9 of 10 referred Soldiers from the force — and much of that burden may be preventable.**

**Thank you** · **Questions welcome**

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**With gratitude to my coauthors**

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References Available Upon Request