



AFRL

OPTIMIZING THE HUMAN WEAPON SYSTEM: AIR & SPACE

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HUMAN WEAPON SYSTEM

The Human Weapon System (HWS) is a comprehensive framework designed to optimize the performance of military service members & teams throughout their life-cycle by adopting the programmatic principles of DoD acquisitions.

PLATFORM LIFE-CYCLE MANAGEMENT

PROCUREMENT

ACCESSION - Basic training & development

FIELDING & SUSTAINMENT

MAINTENANCE - specialized training & tactical operations

DISPOSITION

SEPARATION - transition from service to civilian

THE HUMAN EFFECTIVENESS DIRECTORATE (RH) is aligning its R&D efforts to support the HWS framework which is increasingly being reflected in human performance policies and programs emerging across the Department of the Air Force (DAF) such as ACC's Optimizing the Human Weapon System (OHWS), AETC's Comprehensive Readiness for Aircrew Flying Training (CRAFT) and USSF's Holistic Health Approach (HHA)

FOUNDATIONS OF OPTIMIZED PERFORMANCE

EMPHASIZES HOLISTIC HEALTH in developing, maintaining and enhancing the building blocks of performance using cutting edge science.

COGNITIVE & PSYCHOLOGICAL:

Mental Agility, Stress Regulation, Confidence, Self Efficacy

PHYSICAL:

Strength, Endurance, Nutrition, Rapid Recovery

SPIRITUAL:

Strong Sense of Purpose, Ethics

FAMILY & SOCIAL:

Healthy & Functional Support Network



TACTICAL EDGE OF OPTIMIZED PERFORMANCE

ENHANCING LETHALITY & SURVIVABILITY in a variety of mission environments through personalized technologies.

TRAINING:

Personalized Learning, High-Fidelity Simulations, Adaptive Proficiencies

TACTICS:

AI Planning Tools, Real-Time Decision-Aids, Human-Centered CONOPS, Directed Energy Collateral Effects

TOOLS:

Protective Safety Gear & Monitoring, Directed Energy Mitigation, Telemedicine

ENHANCEMENT:

Human-Machine Teaming, Neuro-Accelerants for Learning, Alertness and Decision-Making





CONTINUOUS FITNESS ASSESSMENT (CFA): CAPABILITY CONCEPT



A DOW READINESS DISRUPTOR

USSF GOAL: Use *TECHNOLOGY* to support:

- **Real-Time Readiness Assessment:** Ensures accurate and up-to-date determination of total force fitness (on-demand).
- **Personal Accountability:** Reinforce personal responsibility for health and fitness through real-time compliance monitoring.
- **Personalized Training:** Create flexibility so that fitness programming can be molded to individual responsiveness, motivation, and occupational requirements (e.g., shift work)
- **Healthy Habit Formation:** Require consistent exercise behaviors, which reinforces habit formation and eliminates 'cramming' that may increase propensity for injury.
- **Operational Readiness:** Explore dual-use opportunities to support factors deemed operational relevant for Guardians, such as cognitive fatigue, diet, environmental exposures, and sleep cycles.





BUILDING A VIABLE PROTOTYPE

Commercial smart tech coupled with customized software application tailored to CFA fitness requirements

WHY GARMIN?

- Multiple watch options
- Accessory integrations
- National Security Agency Approval for SCIFs
- Acceptable fitness metric accuracy



Smartwatch



HR Strap



Smart Bike



Lab-Grade Assessments



Participant Easy Access



Real-time Data Sync

KEY HARDWARE FEATURES:

- **Smartwatch**
- **Heart rate (HR) chest strap** (*optional*) for improved accuracy
- **Smart Bike integration:** accommodates those with limiting injuries and those in cold weather environments
- **Lab-grade fitness assessments** for enhanced personalization or as cross-check on wearables fitness assessments

KEY SOFTWARE FEATURES:

- **Accessible** on mobile device or a computer's (*personal or NIPR*) internet browser
- **Displays** CFA-specific metrics and standards
- **Access & complete** Study Surveys
- **Contact & correspond** with Study Helpdesk
- **Syncing data in real-time**



CFA: THE STUDY



USSF EMPLOYS AFRL to Execute a CFA Study

- **USSF determined that fielding CFA without definitive evidence for technical feasibility and readiness impact presented risk to implementation & sustainment.**
 - Risk is not just CFA's intent to leverage contemporary tech to meet the physical readiness requirements but also:
 - Cybersecurity requirements
 - Individual privacy laws
 - Data access/use by supervisors
 - AFRL is well-positioned to help USSF mitigate these risks because
 - It has a core mission to **de-risk technology** through development and validation.
 - It possesses internal safeguards, including Human Subjects Research (HSR) policy and Authorizations to Operate (ATOs) that can be leveraged until more nuanced policies are developed.

PRIMARY STUDY GOALS

1. **Build a viable CFA prototype that leverages the latest in government and commercial tech.**
2. **Compare effects of CFA for Guardians to Airmen that perform the traditional USAF Physical Fitness Assessment (PFA).**
3. **Examine effects of the CFA prototype for improving Guardian physical readiness.**
4. **Baseline the historical prevalence of traditional fitness test cramming and anxiety.**



STUDY SAMPLE



CFA GROUP

USSF Guardians



Participants: 5,383



Estimated VO₂ Source: Garmin wearable algorithm



Frequency: ~Monthly



Observation Window: 24 months



Male / Female: 4,211 / 1,172



PFA GROUP

USAF Airmen (Comparison)



Participants: 220,374



Estimated VO₂ Source: Cooper Eq. (1.5-mile run)



Frequency: Annual



Observation Window: 27 months



Male / Female: 176,600 / 43,774



CFA: FITNESS CATEGORIES



FITNESS CATEGORIES: THE OPERATIONAL LENS

HEALTH CONCERN (HC)

Below minimum operational fitness thresholds — not cleared for full operational duties.

CFA: 813 baseline | PFA: 27,511 baseline

Implication:

Highest priority for intervention. Most to gain from CFA.

HEALTH MAINTENANCE (HM)

Meeting minimums but below optimal standards — operationally functional but at risk of regression.

CFA: 953 baseline | PFA: 57,131 baseline

Implication:

Goal: advance to F2F. CFA moves 43.5% of HM members upward vs. 29.0% under PFA.

FIT TO FIGHT (F2F)

At or above optimal fitness standards — highest operational readiness.

CFA: 3,617 baseline | PFA: 135,732 baseline

Implication:

Goal: retain and sustain. CFA retains 88.1% vs. 81.7% under PFA.

Fitness category is time-varying: a member's tier is re-assigned at each measurement occasion based on their $\dot{V}O_{2\text{Max}}$. Not a permanent label.

AGE	SEX	FIT TO FIGHT (F2F)	HEALTH MAINTENANCE (HM)	HEALTH CONCERN (HC)
20–29	♂ Male	≥ 43 (41)	40 – 42 (40 – 42)	≤ 39 (36)
	♀ Female	≥ 37 (35)	33 – 36 (32 – 34)	≤ 32 (31)
30–39	♂ Male	≥ 42 (40)	38 – 41 (37 – 39)	≤ 37 (36)
	♀ Female	≥ 35 (33)	32 – 34 (31 – 32)	≤ 31 (30)
40–49	♂ Male	≥ 38 (37)	35 – 37 (33 – 36)	≤ 34 (32)
	♀ Female	≥ 33 (32)	30 – 32 (29 – 31)	≤ 29 (28)
50–59	♂ Male	≥ 37 (35)	33 – 36 (32 – 34)	≤ 32 (31)
	♀ Female	≥ 30 (29)	28 – 29 (27 – 28)	≤ 27 (26)
60+	♂ Male	≥ 33 (32)	30 – 32 (29 – 31)	≤ 29 (28)
	♀ Female	≥ 28 (27)	25 – 27 (24 – 26)	≤ 24 (32)



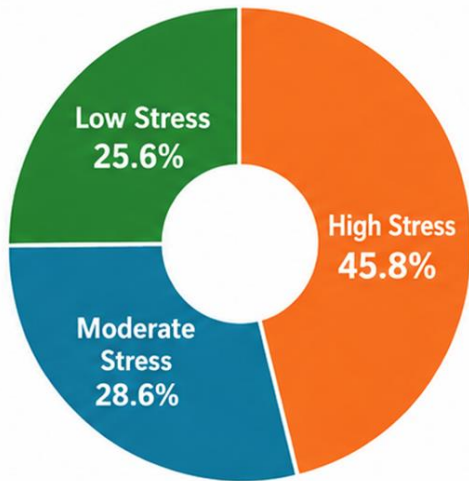
HISTORICAL PREP FOR THE PFA: BEHAVIORS & ATTITUDES



FITNESS TEST PREP & PERFORMANCE EXECUTION

Pre-test performance anxiety (affecting ~ 75% of Guardians) and physical "cramming" behaviors (e.g., rapid increase in exercise volume, restricted diets, and intentional dehydration) are prevalent across the force - disproportionately reported by Guardians in the *Health Concern* fitness category

Performance Anxiety Prevalence



54.1%

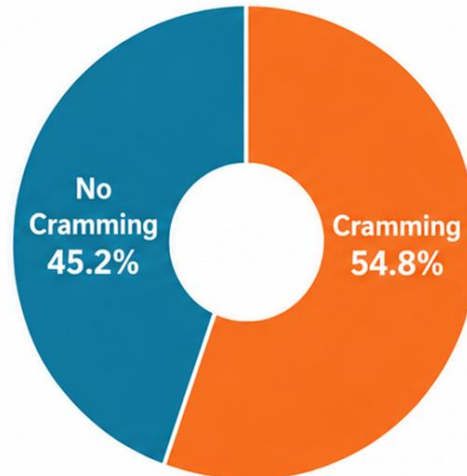
*High Stress of
Health Maintenance*

60.1%

*High Stress of
Health Concern*

Data derived from a modified version of the Sport Competition Anxiety Test (SCAT) survey with 5,685 responses.

Cramming Prevalence



71.6%

*Cramming of
Health Concern*

Data pulled from a CFA study baseline surveys with 6,965 cramming responses and 6,899 preparation strategy responses.

Cramming Strategies

68.3%

*Focus on test
components*

62.1%

*Increase exercise
amount*

47.9%

*Increase exercise
intensity*

Health Concern Guardians

> 2x

*more likely to
restrict food intake and
dehydrate*



CFA: CARDIORESPIRATORY FITNESS REQUIREMENT

VO₂ Max



CARDIORESPIRATORY FITNESS ($\text{VO}_{2\text{ Max}}$)

WHAT IS $\text{VO}_{2\text{ Max}}$?

- The 'gold standard' laboratory metric of cardiorespiratory (***physiological***) fitness.
- Represents the maximum amount of oxygen the body can use during exercise.

WHY $\text{VO}_{2\text{ max}}$?

- A valid and reliable measure of cardiorespiratory fitness.
- Takes several months to improve with ***consistent*** exercise.

The CFA difference

- The CFA smartwatch uses GPS, Heart Rate (HR) and Demographics to estimate $\text{VO}_{2\text{ Max}}$ ($\tilde{\text{VO}}_{2\text{ Max}}$).
- The PFA uses a 1.5 mile run conversion equation to estimate cardiorespiratory fitness.
- The Cooper Equation is used to convert the PFA 1.5 mile run time to a $\tilde{\text{VO}}_{2\text{ Max}}$.

WHAT ARE WE TRYING TO MEASURE?

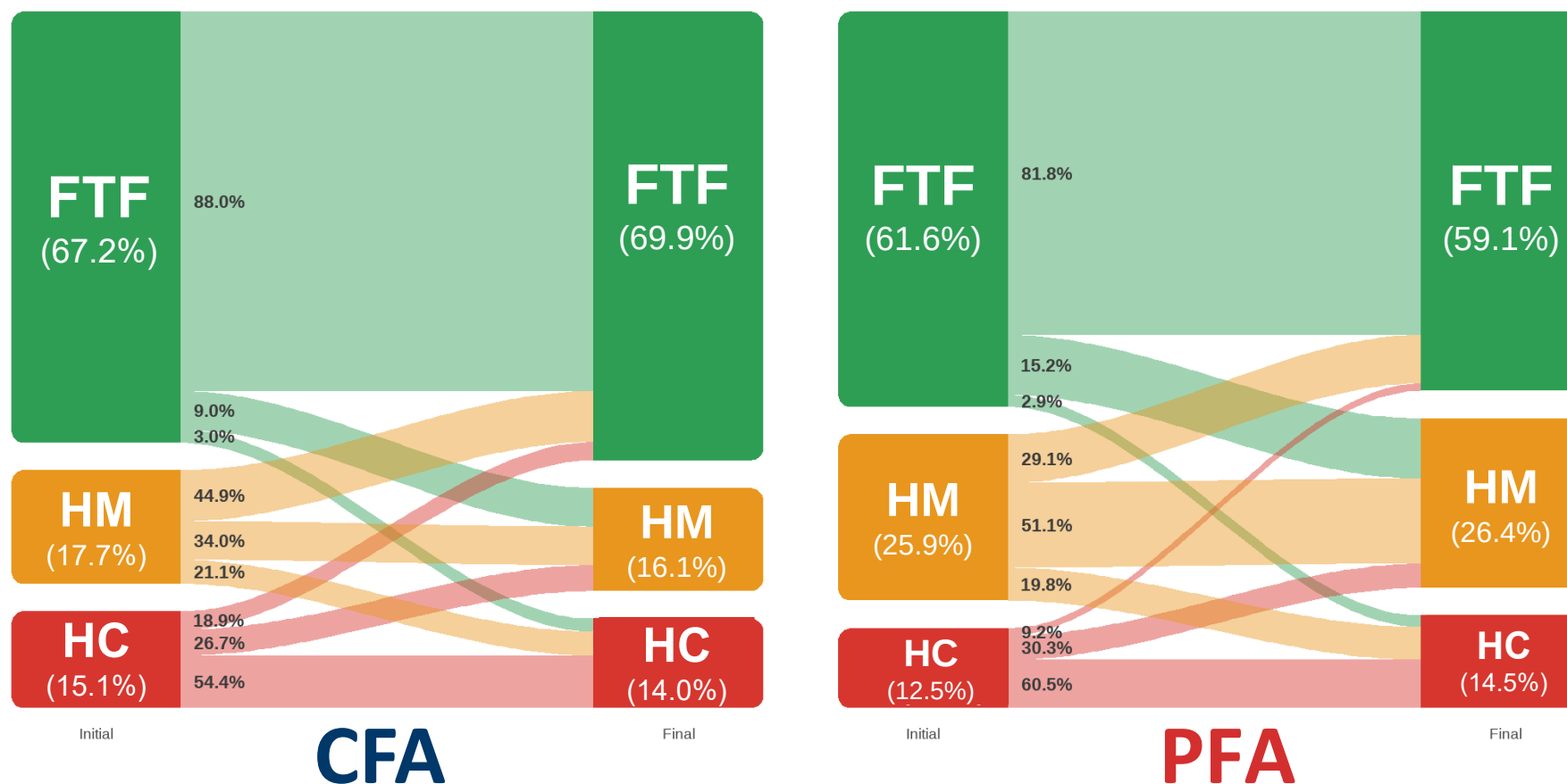
- Physiological performance **NOT** athletic performance
- PFA 1.5-mile run was the USAF cardiorespiratory fitness assessment.
- Converting the 1.5-mile run times to $\tilde{\text{VO}}_{2\text{ max}}$ allows for consistent analysis between CFA and PFA records.

Garmin and 1.5-mile run are **estimates for $\text{VO}_{2\text{ Max}}$.
Garmin is dependent on accurate HR.*



Fitness Category Migration: A Comparison of CFA & PFA Outcomes

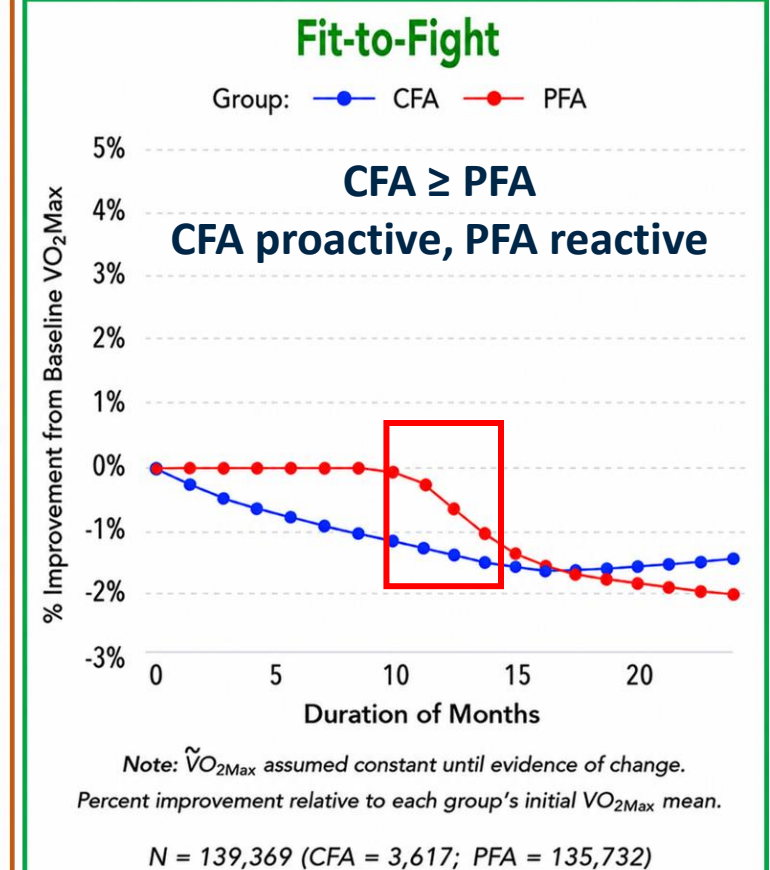
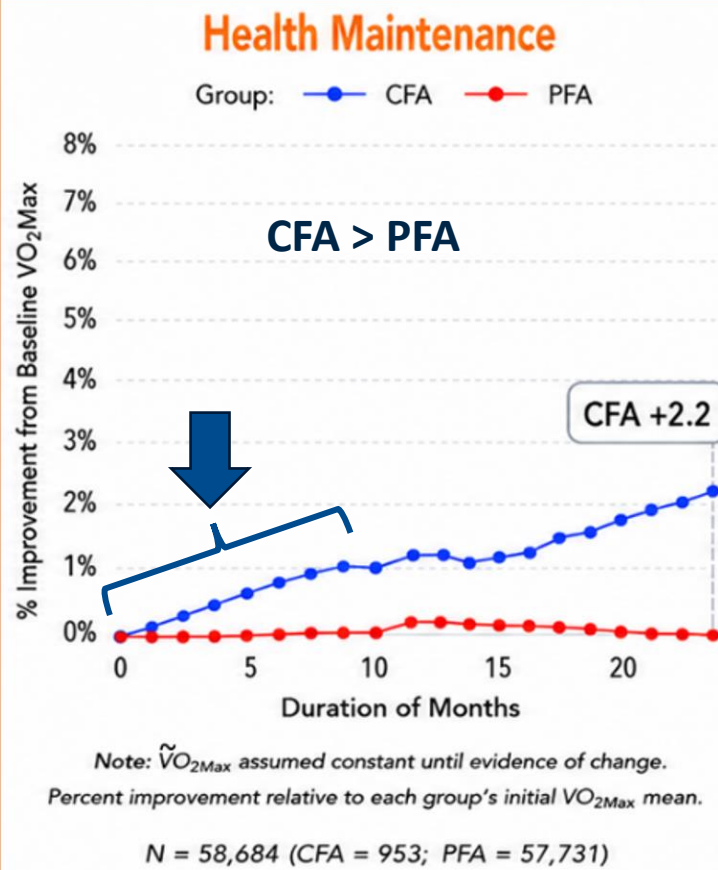
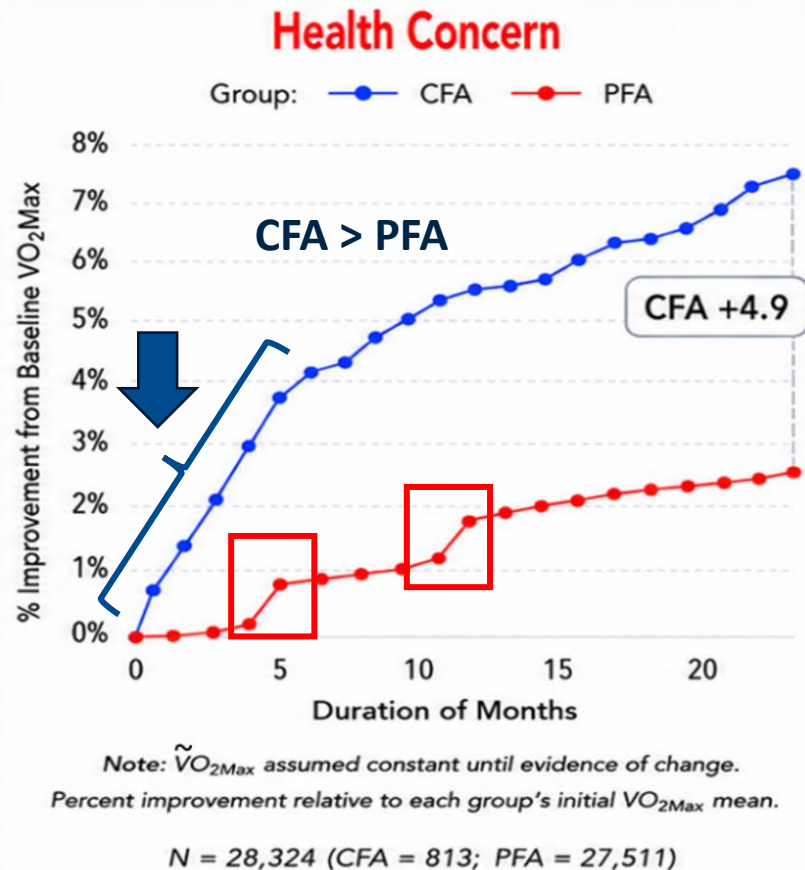
Guardians who participated in CFA experienced modest improvements in cardiorespiratory fitness, regardless of fitness category, as compared to Airmen who performed the PFA.





Which Guardians benefited most from CFA?

CFA had the **greatest effect** for less fit Guardians, i.e., those in the *Health Concern* and *Health Maintenance* categories.





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Questions?

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