Endocrine Stress Reactivity Associated with Extreme Sports

Anthony C. Hackney, PhD, DSc, FACSM, FNAK

Director – Exercise Endocrine Research Laboratory
Department of Exercise & Sport Science
Department of Nutrition
School of Medicine - Gilling's School of Global Public Health
University of North Carolina at Chapel Hill

1st International Extreme Sports Medicine Congress
Eustress \(\leftrightarrow\) Distress

“Positive” \(\leftrightarrow\) “Negative”

Stress Hormone Reactivity
Focus on athletes in “traditional Olympic sports and military personnel.

Research group focus
Focus on athletes in “traditional Olympic sports and military personnel.”
Stress

Physiological Adjustment Allowing Exercise

Physiological Changes Supporting "Fight or Flight" Responses
• Physical activity stress
• Environmental stress

Endocrine disruption – dysfunction associated with excess stress

Overtraining Syndrome
Underperformance Syndrome
“Burnout”
Hypogonadism
PTSD

Health issue risks
Purpose

To provide an overview of the hormonal stress responses to a variety of extreme sports, and examine whether there are implications for health relates issues due to these responses.
Purpose

- Systematic and controlled research studies
- Avoided case studies, anecdotal reports, “junk science”

  - Ultra-endurance events
  - Extreme mental stress events

“Cherry picked”

Limited research – number an scope
Ultra-Endurance Events
Two Oceans Ultra-marathon

Hew-Butler et al. 2008

- ↑↑ cortisol
- ↑↑ aldosterone
- ↑↑ BNP
- ↑↑ IL-6
- ↓↓ AVP

Before and after completing race (56 km) and in comparison to 60 min laboratory run
Hawaiian Ironman

Ginsburg et al. 2001

- Men
  - ↑ cortisol
  - ↑ estradiol
  - ↓ testosterone
  - ↓ lipid peroxidation (free radical formation)
- Females no Δ hormones, peroxidation ($n$)

Before vs. after completing race
160 km Ultra-marathon

- Kraemer et al. 2008
- Hackney et al. 2009
  - ↑ IL-6
  - ↑ TNF-α
  - ↑ growth hormone
  - ↑ cortisol
  - ↓ testosterone
  - ↓ innate immune function (days in recovery)

Before vs. after completing race
Greenland Artic Trek

- Bishop et al. 2001
  - ↓↓ testosterone:cortisol ratio
    » $\propto$ length of trek
  - ↑ psychological stress
    » $\propto$ length of trek
    » e.g., anxiety, fatigue, depression
    » ↑ cortisol ($\propto$ association)

Measured immediately before and throughout trek
Military War Games

- Aakvaag & Opstad 1978, 81
- Hackney et al. 1994, 95, 96

- ↓ testosterone
- ↑ cortisol
- ↓ T₃
- ↑ prolactin

Measured before and throughout maneuvers (4-6 day, continuous, minimal sleep)
Mountaineering

- Benso et al. 2007
- Hackney et al. 1993, 95
  - ↑ growth hormone
  - ↑ IGF
  - ↑ catecholamines
  - ↑ rT₃, ↓ T₃

  » “Low T3 Syndrome” (Euthyroid sick syndrome)

Measured before and throughout ascent-descent (3 weeks to 2 months)
Extreme Mental Stress Events
Bungee Jumping

- Henning et al. 1994
- Van Westerloo et al. 2011
  - ↑ cortisol
  - ↑ β-endorphins
  - ↑ leukocytes
  - ↑ catecholamines

Measured day before, at time of jump and ↓ rapidly after jump
Potholing

- Stenner et al. 2007
  - ↑cortisol
  - ↑growth hormone
  - ↑free T₄

Measured day before and as preparing to descent, upon ascent back to normal
Rock Climbing

- Hodgson et al. 2009
- Sherk et al. 2011
  - ↑, no Δ cortisol
  - ↑ growth hormone
  - ↑ testosterone
  - ↑ anxiety ∝ difficulty climb

Measured before and after climb
Skydiving - Paragliding

- Chatterton et al. 1997
- Thatcher et al. 2003
  - ↓ testosterone
  - ↑ cortisol
  - ↑ catecholamines
  - ↑ prolactin
  - ↑ growth hormone
  - ↑ anxiety (peaked immediately before jump)

Measured day before vs. immediately before jump, returned to normal rapidly after jump
What about these sports? We do not know, due to a lack of research. Needs to be studied.
Summary

- **Ultra-endurance events**
  - Hormonal response $\propto$ metabolic load
  - $\uparrow$ heat, cold, hypoxia, hypocaloric
  - $\uparrow$ Anxiety, fear, apprehension (smaller degree)
  - Changes persist into recovery $-$ hours, days

- **Extreme mental stress events**
  - $\uparrow$ Anxiety, fear, apprehension (greater degree)
  - Changes transient, abate early in recovery
  - Hormonal response $\propto$ metabolic load (smaller degree)
Conclusions

- Limited research on this topic – need more
- Extreme sports provoke
  - Stress hormone reactivity
    » ↑ cortisol, GH, PRL, catecholamines
    - ∞ metabolic demands (select sports)
    - ∞ anxiety encountered (select sports)

- Medical implications
  » Stress hormone reactivity could exacerbate select medical conditions (e.g., hypertension)
  » Caution may be advised for some sports activities and a good level of physical fitness is recommended prior to participation for all
“Fear is an incredibly strong emotion. If something scares us, the body immediately releases endorphins, dopamine and norepinephrine. Endorphins mitigate pain, dopamine and norepinephrine are performance enhancers. There haven’t been direct studies on so-called action sports, but the general scientific thinking is that the more fearful a certain sport makes you, the greater the release of these chemicals. The greater the release of these chemicals, the greater the addiction-like symptoms.”

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Exercise Endocrine Research Group

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Central Nervous System Interactions HPA Axis and SNS

CRH

PVN

Mesocortical Mesolimbic System

Amygdala Hippocampus

Serotonin - Acetylcholine

Arcuate N POMC

GABA/BZD

Dynorphin

NE

Mesocortical Mesolimbic System

Amygdala Hippocampus

Serotonin - Acetylcholine

Epinephrine Norepinephrine

ACTH AVP

Adenohypophyseal

GABA/BZD

Dynorphin

Glucorticoids

GH PRL

Glucorticoids

Target Tissues

Mastorakos 2005
Stress Hormones – Exercise Response

- Norepinephrine (NE) >1000%
- Epinephrine (E) >2000%
- Adrenocorticotropic Hormone (ACTH) > 500%
- Cortisol > 400%
- Prolactin >1000%
- Growth Hormone >1000%

Increase from basal levels
Stress Hormones – Exercise Response

- Norepinephrine (NE)
- Epinephrine (E)
- Adrenocorticotropic Hormone (ACTH)
- Cortisol
- Prolactin
- Growth Hormone
Exercise Effects

Exercise Work

Stress Hormone Level

Low

High

Exercise Effects
Stress Response Model

STRESS     SYSTEM     REACTIVITY

↑

STRESSOR     POTENCY

Tsigos, Kyrou & Chrousos, 2002
↑ paratelic state ("thrill - excitement seeking")