Chapter 10

Stress, Stress Reactivity, and Exercise
Stress Defined

• What we experience when we face challenges in our lives
• Can be negative or positive
  – Distress (e.g., exams, divorce, deadlines)
  – Eustress (e.g., marriage, graduation, job promotion)
• Stressors
  – External (physical) or internal (fear) challenges
• Responses to stress occur:
  – Cognitively in form of worry
  – Somatically in form of biological responses
Causes of Stress

• Biological
  – Substance abuse (alcohol, drugs)
  – Nutritional excess (caffeine, sugar)

• Psychological
  – Perfectionist attitudes
  – Obsessiveness/compulsiveness
  – Need for control

• Interpersonal
  – Lack of social skills, shyness, insecurity, loneliness
  – Environmental strain (noise, temperature)
General Adaptation Syndrome

• The effects of prolonged stress on animals and humans
• There is predictable pattern of physical response to prolonged stress called the general adaptation syndrome.
• This response pattern is comprised of three stages.
Stage 1: Alarm-reaction

A state of initial shock (reduced activity) is followed by over-mobilization of forces within the organism to meet the shock.

- In this stage the organism responds as to fear or anger.
- The adrenal glands become enlarged as they produce more adrenalin and discharge their stored-up supply of steroids.
Stage 2: Resistance Stage

After a few days of prolonged stress, the organism seems to adapt to the stress and return to normal. The adrenal glands return to their usual size and color, and their supply of steroids is renewed. Blood sugar and salt levels also return to normal.
Stage 3: Stage of exhaustion

The acquired adaptation to the stress is lost.

In this stage the adrenal glands again become enlarged.

The animal or human due to oversecretion or elevated levels of hormones will prematurely die.
Warning! Warning! System Overload!

SAM (Sympathetic adrenal medullary system) and HPA (hypothalamic-pituitary-adrenal activation) become overworked or if neither is turned off after the stressor(s) is/are removed it will cause the other systems of the body to become overloaded!

Fit person’s SAM & HPA respond rapidly to the stressor and then “turn off” as soon as they are not needed as compared to a unfit person.
Natural Killer Cells

Myeloid & cytolytic cells are our killer cells.

Commonly referred to as NK cells

Relationship between stress and one’s ability to fight off diseases.
SRESS

Increased Anxiety and Depression

Active Coping

SAM Activation

NE and E release

Passive Coping

HPA Activation

Cortisol Release

IF CHRONIC

Immune Suppression
Decreased Number of NK cells
Decreased NK function

Accelerated Disease Progression
Conclusions

Studies found that the second stage, "resistance," stage were not so normal as they seemed.

- If a second stress were added at this stage, animals or human quickly died.
- This seemed to indicate that they had exhausted their defenses in adapting to the original stress and had none left to deal with additional stress.
Stress Response

• Is initiated when some real or perceived threat or challenge is encountered

• Involves the secretion of two kinds of hormones from the adrenal glands:
  – Catecholamines (epinephrine and nonepinephrine): Generally occurs when situations present a challenge to an individual
  – Cortisol: Generally occurs when an individual is faced with a threat or unpleasant challenge
Epinephrine

• Epinephrine plays a central role in the short-term stress

• It is secreted by the adrenal medulla.

• When released into the bloodstream, epinephrine binds to multiple receptors and has numerous effects throughout the body.
  – increases heart rate and stroke volume,
  – dilates the pupils, and,
  – constricts arterioles in the skin and gut while dilating arterioles in leg muscles.
  – It elevates the blood sugar level by increasing hydrolysis of glycogen to glucose in the liver, and at the same time begins the breakdown of lipids in adipocytes.
  – Epinephrine has a suppressive effect on the immune system.
Cortisol

• Higher and more prolonged levels of cortisol in the bloodstream (like those associated with chronic stress) have been shown to have negative effects:
  – Impaired cognitive performance
  – Suppressed thyroid function
  – Blood sugar imbalances such as hyperglycemia
  – Decreased bone density
  – Decrease in muscle tissue
  – Higher blood pressure
  – Lowered immunity and inflammatory responses in the body, as well as other health consequences
Physiological Study of Stress

Role endocrine system
- Hypothalamus
- Adrenal gland

Endocrine Responses to stress
- Epinephine (widely referred to as "adrenaline")
- Cortisol (also produced by adrenal gland)
- Cateholamine (urinary epinephine and norepinehine)

Personality
- Type A behavior
- Vital Exhaustion (feeling of excessive fatigue, increased irritability, and feelings of demoralization)
Stress pathways are diverse and involve many regions of the brain in feedback loops that can sometimes greatly amplify a response. The process—simplified somewhat in this diagram—begins when an actual or perceived threat activates the sensory and higher reasoning centers in the cortex (1). The cortex then sends a message to the amygdala, the principal mediator of the stress response (2). Separately, a preconscious signal may precipitate activity in the amygdala (3). The amygdala releases corticotropin-releasing hormone (CRH), which stimulates the brain stem (4) to activate the sympathetic nervous system via the spinal cord (5). In response, the adrenal glands produce the stress hormone epinephrine; a different pathway simultaneously triggers the adrenals to release glucocorticoids. The two types of hormones act on the muscle, heart, and lungs to prepare the body for “fight or flight” (6). If the stress becomes chronic, glucocorticoids induce the locus coeruleus (7) to release norepinephrine, which communicates with the amygdala (8), leading to the production of more CRH (9)—and to ongoing reactivation of stress pathways.

Source: Sapolsky, R. (September 2003)
Homeostasis and Allostasis

• Homeostasis:
  – The ability of an organism to change and stabilize its internal environment despite constant changes to external environment

• Allostasis:
  – A wide range of functioning of the coping/adaptation systems, depending on a variety of factors (time of day, internal needs, external demands)
Allostatic Load

- The cost of coping/adaptation
- Wear and tear on the brain and body
- Ongoing stress means that the stress response never “turns off,” which ultimately leads to illness and disease
  - Example: Chronic elevations of heart rate and blood pressure can lead to decreased immune function, memory loss, and increased risk of anxiety and depression
Combat Stress in Soldiers

• Charles Morgan and colleagues (2001) documented stress in active-duty soldiers

• Experiment involved interrogations following a mock capture, food and sleep deprivation, and problem solving

• Resulted in elevated cortisol levels:
  – Dissociated thinking, psychological disconnect from one’s environment, and poor performance
Cross-Stressor Adaptation Hypothesis

• A stressor of sufficient intensity and/or duration will induce adaptation of stress response systems

• Exercise training is thought to develop cross-stressor tolerance:
  – Habituation: A decreased magnitude of response to some familiar challenge
  – Sensitization: An augmented response to a novel stressor  

(continued)
Cross-Stressor Adaptation Hypothesis (continued)

- Exercise can be viewed as a familiar challenge and should influence the stress response to nonexercise stressors
Exercise and Stress

• People report feeling less stress following acute exercise bouts
• They are less stressed in general when they are physically active as opposed to being sedentary
Your Viewpoint

• Have you seen any relationship between your level of activity and your perceived stress?

• If yes, how has exercise (or lack thereof) affected your level of stress?
Psychophysiology

- A scientific discipline that examines cognitive, emotional, and behavioral events through their manifestation as physiological processes and events.
- Includes relatively noninvasive measures of many bodily systems:
  - Electrical activity in muscle, brain, and cardiovascular system
  - Endocrine and immune function
Measures of Stress

• Perceived Stress Scale (PSS) by Cohen, Kamarck & Mermelstein (1983).
  – Measures the degree to which situations in one’s life are viewed as stressful
  – Reliance on self-report does not help to uncover the physiological mechanisms underlying the stress response

• Cardiovascular measures
  – Heart rate, and blood pressure

• Hormonal Measures
  – Catecholamines from urine
  – Salivary IGA levels
  – and cortisol from blood plasma
Exercise–Stress Research

• Numerous research studies have examined self-reports of stress or perceived stress and whether exercise influences those perceptions.

• Research has focused on the following areas:
  – Cardiovascular fitness
  – Fit versus unfit individuals
  – Hypothalamic-pituitary-adrenal (HPA) cortical axis response
  – Immunity
  – Reactivity vs. recovery
  – Physiological toughness model
Cardiovascular Fitness

• Researchers have not agreed as to whether exercise training has stress-buffering effects.

• Mechanisms responsible for the sympathetic aspect of the psychosocial stress response and the response to exercise stress may be different.

• Research does suggest that aerobic fitness may confer stress-buffering effects to psychosocial stressors.
Aerobic Training

Aerobically fit individuals may have experience a smaller sympathetic response when a stressor is present (Boutcher, 2004)

Individuals who improve significantly in their aerobic fitness experience a stress-buffering effects during stress exposure and during recovery from stress (Spalding et al, 2004)
Stress & PA

• Basic assumption is being fit reduces one reactivity to stress.

• Crew and Lander (1987) reviewed 34 studies of the effects of aerobic fitness on stress reactivity.
  – Studies used a variety of measures including HR, BP, self-reports, and catecholamines
  – Fit individuals have sizable smaller stress response than unfit individuals (Crew & Landers, 1987):
    • More efficient coping system
    • Being inoculated to the repeated stressors
Aerobic exercise training

- Decreased anxiety and depression
- Decreased sympathetic activation and catecholamine release

- Increased release of endogenous opioids (beta-endorphins)
- Decreased HPA activation and cortisol release

- Immune normalization
  - Increased number of NK cells
  - Increased NK function

- Decelerated disease progression
Physical Activity and Reactivity to Stressors Between Fit and Unfit Individuals

Crews & Landers, 1987
Who feels stress?

Individuals who are highly PA in their leisure time are 49% times less likely to report high perceived stress and 75% times less likely to report moderate perceived stress as compared to individuals low in PA.

Aldana, Sutton, Jacobson, & Quirk, 1996
Possible Mechanisms?

1. Coping hypothesis …
   ➔ Physical activity produces a more efficient system so recovery of the Autonomic Nervous System (ANS) is quicker

2. Inoculation hypothesis …
   ➔ Chronic physical activity enhances our ability to handle stress
   ➔ Magnitude of response in well-trained systems is reduced
Hypothalamic-Pituitary-Adrenal (HPA) Cortical Axis

- Study with fit and unfit women by Traustadottir and colleagues (2005) determined that aerobic fitness can influence sensitivity to stress, ultimately affecting the HPA axis in the direction of a reduced cortisol response to psychosocial stress.
Immunity

• Study by LaPierre and colleagues (1990) showed that men who had exercised for five weeks before being told they were HIV-positive had little change in psychological and immunological measures.

• Control group showed significant immunological changes as well as significant anxiety and depression.
Reactivity vs. Recovery

• Evidence suggests that fitness or exercise training may provide a more rapid recovery from the stressor once it is no longer present.

• Shorter duration of the stress response could have the effect of reducing the allostatic load and overall wear and tear on the body.
Physiological Toughness Model

- A psychophysiological framework for explaining how exercise can not only reduce the immediate effects of stress but also can enhance the recovery from stressors
- Intermittent but regular exposure to stressors (e.g., regular exercise) can lead to psychological coping, emotional stability, and physiological changes
Physiological Toughness Model (continued)

- Physiological changes lead to adaptive performance in challenge/threat situations, enhancement of immune system function, and greater stress tolerance
Your Viewpoint

• Do you consider yourself physiologically tough? If so, why?
Practical Recommendations

• Exercise can be a way of dealing with daily stressors of life
  – Morning exercise: Help get one ready to face day’s challenges
  – Noontime workout: Provide a much needed break in the day to recharge batteries
  – Evening workout: Useful to purge tensions and worries of the day