THE POWERFUL ROLE OF EXERCISE IN IMMUNE FUNCTION

Patrick Gélinas

Department of Exercise and Sports Science

University of South Carolina Aiken

WHAT A YEAR, EH?

- Without diminishing the unique & horrible impact of the past 12 months
  - Humans have always been plagued by illness
  - And will continue to be

IN THE ABSENCE OF MODERN MEDICINE

- What have been our protective shields against illness and infection?
- How did we thrive?
- What was our lifestyle like?
  - More physical activity
  - More pristine nutrition

WHAT IS WITHIN OUR CONTROL & WHAT IS NOT

"The chief task in life is simply this: to identify and separate matters so that I can say clearly to myself which are externals not under my control, and which have to do with the choices I actually control. Where then do I look for good and evil? Not to uncontrollable externals, but within myself to the choices that are my own..."

-Epictetus

FOCUS ON WHAT WE CAN CONTROL…

…and do those things with gravitas!

- Cannot control illness, infection, and pandemics
  - But we **can** improve our resiliency

With minor exception, we have control over

- Exercise/Physical Activity
- Nutrition

EXERCISE AND HEALTH MEASURES

- Powerful role of exercise in health maintenance and disease prevention is well-established
- Many positive adaptations to biomarkers of health
  - Cardiovascular responses
    - Heart rate
    - Blood pressure
  - Body composition
  - Muscular strength & endurance

EXERCISE AND IMMUNE FUNCTION, *CONT'D.*

- Less is known about the effect of exercise on immune function
- What's clear:
  - In general, exercise supports immune function
- What's *less* clear:
  - By what specific mechanisms?
  - Is there a preventive benefit?

COVID-19 RISK FACTORS
CAN EXERCISE HELP?

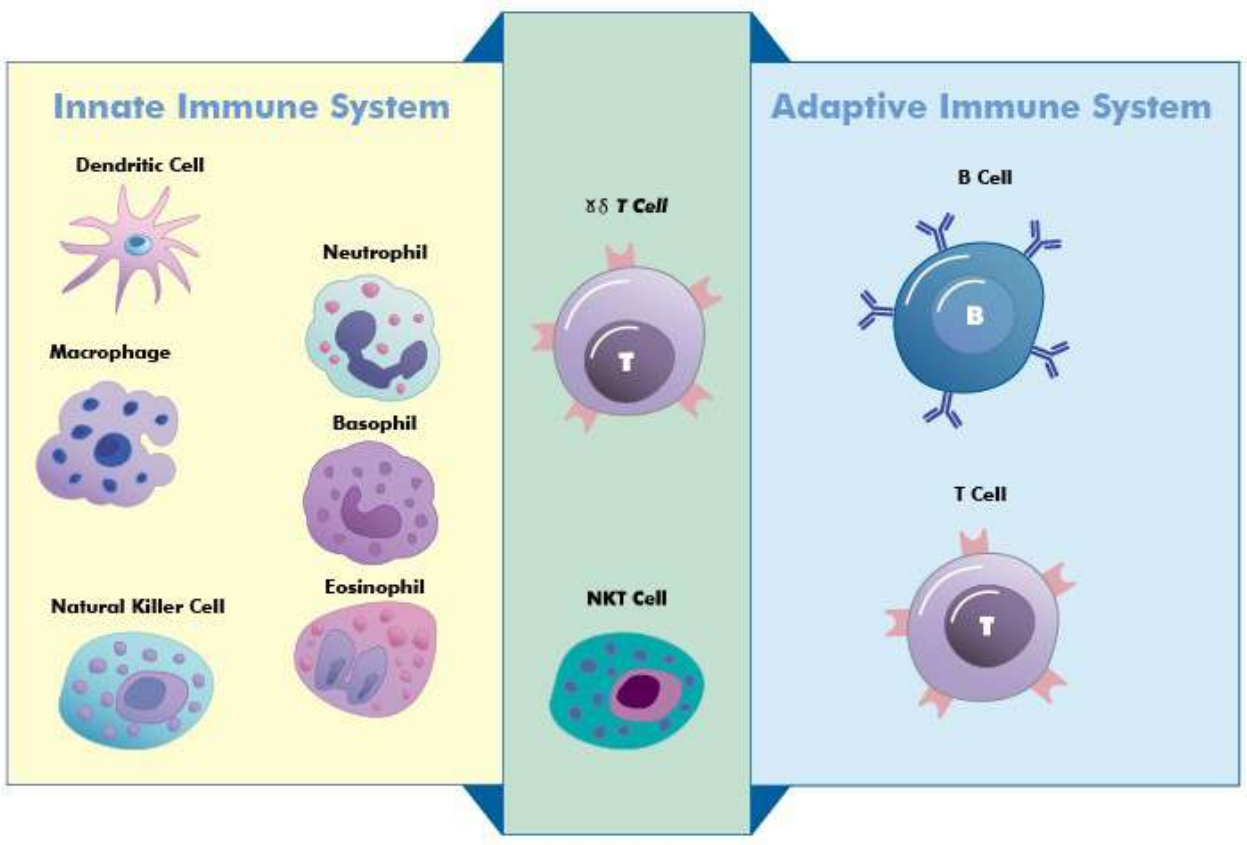
- Older age
- Lung problems
- Heart disease
- Diabetes
- Obesity
- Cancer & blood disorders
- Weakened immune system
- Chronic kidney or liver disease

IMMUNE SYSTEM BASICS

- In humans, system redundancy

- Innate system
  - Physical barriers
  - Cellular components
  - Complimentary proteins
- Adaptive system (or "acquired" system)
  - B-cells & T-cells

IMMUNE SYSTEM BASICS: DIVISIONS



IMMUNE SYSTEM BASICS, *CONT'D.*

- Most animals
  - Completely fine with innate system
- Humans
  - Additional system: adaptive (or "acquired")

- Food for thought: large area to be defended!
  - Skin surface area ~ $2m^2$
  - Mucosal surface area ~$400m^2$

EXERCISE IMPROVES IMMUNE FUNCTION

- Exercise immunology
  - Exercise, psychosocial, environmental influences
- Mechanisms are not entirely clear, but several theories exist:
  - PA may flush invading bacteria out of lungs & airways
  - Exercise increases WBC and antibody count & circulation speed
    - Quicker detection of illness & infection
  - Temporary rise in body temperature from exercise may impede further bacterial growth
  - Decrease in release of certain stress hormones

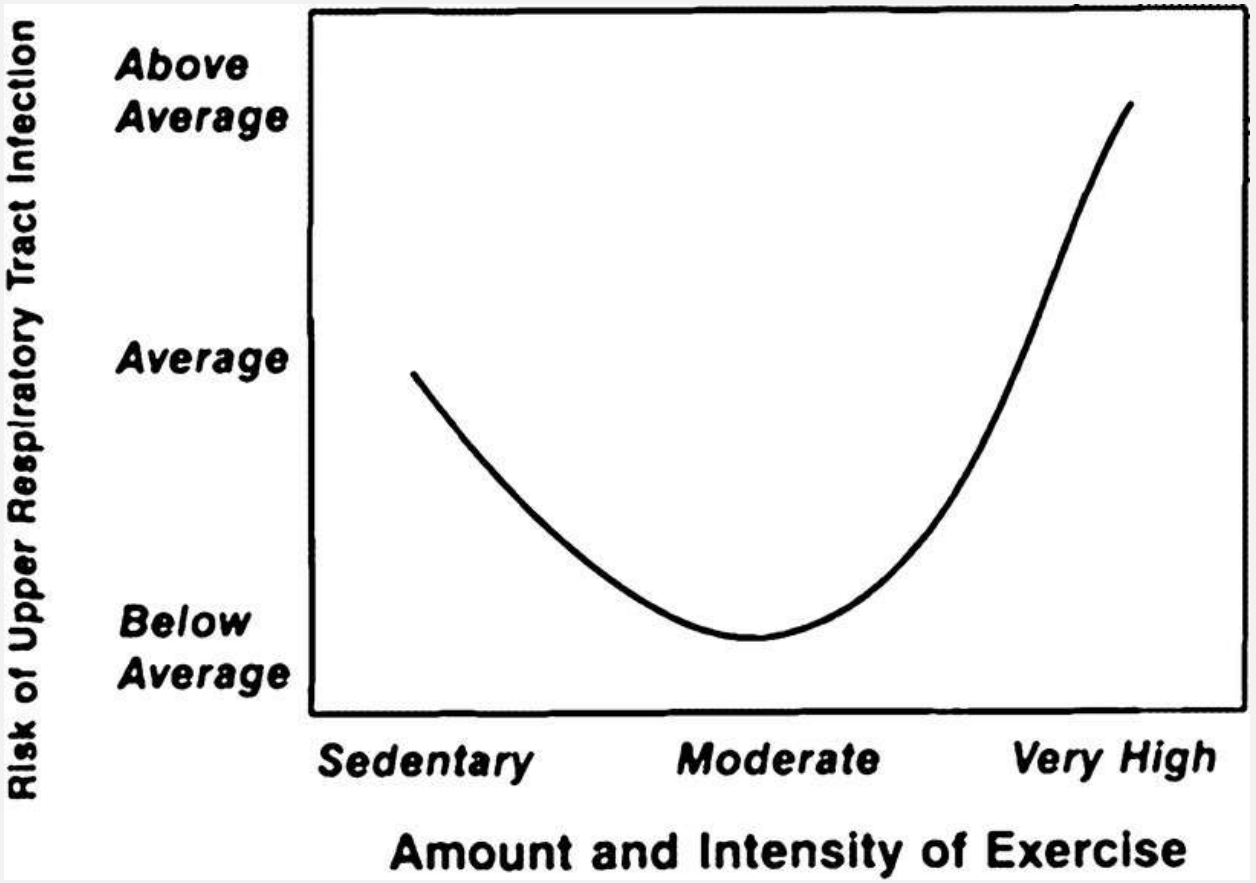
EXERCISE IMPROVES IMMUNE FUNCTION, *CONT'D.*

- Exercise can have both a positive and negative effect on risk of infection

- Moderate *vs.* High-Intensity/Long-Duration
  - Moderate aerobic exercise PROTECTS against infection & decreases risk
  - High-Intensity/Prolonged-duration increases risk of infection

- Boost in immune function = transient
  - Back to pre-exercise levels within 3 hrs.

J-SHAPED CURVE: AMOUNT OF EXERCISE *VS.* URTI RISK



EXERCISE AND IMMUNE FUNCTION

- Most research suggests: regular bouts of moderate-intensity exercise ENHANCES immune function
  - Evidenced by:
    - Enhanced vaccination responses
    - Increased T-cells
    - Reduced circulating cytokines
    - Increased phagocyte activity

MODERATE-INTENSITY AEROBIC EXERCISE

- 20-40 minutes per day
- 40-60% VO_{2max}
  - Approximately 55-70% Maximum Heart Rate (MHR)
  - *P*MHR = 206.9 – (0.67 x age)

- Holds true for young and middle-aged men & women
- Research is also promising for older adults

EXERCISE, IMMUNE FUNCTION, & AGING

- Immunosenescence
  - Age-related decline in normal immune function
    - Poor vaccine responses
    - Increased risk of infection
    - Increased risk of cancer
  - Reversible? Preventable? Optimal volume & intensity?
    - Debated topic
  - Regular moderate-intensity exercise can improve immune function in older adults

HIGH-INTENSITY/LONG-DURATION AEROBIC EXERCISE

- > 90 minutes, and/or > 85% MHR
- Many studies:
  - Athletes engaged in high-intensity/long-duration → Higher incidence of URTI
- Risk = 2-6X higher following a marathon
  - "Open Window" Theory
- Depression of immune function

OPEN WINDOW THEORY

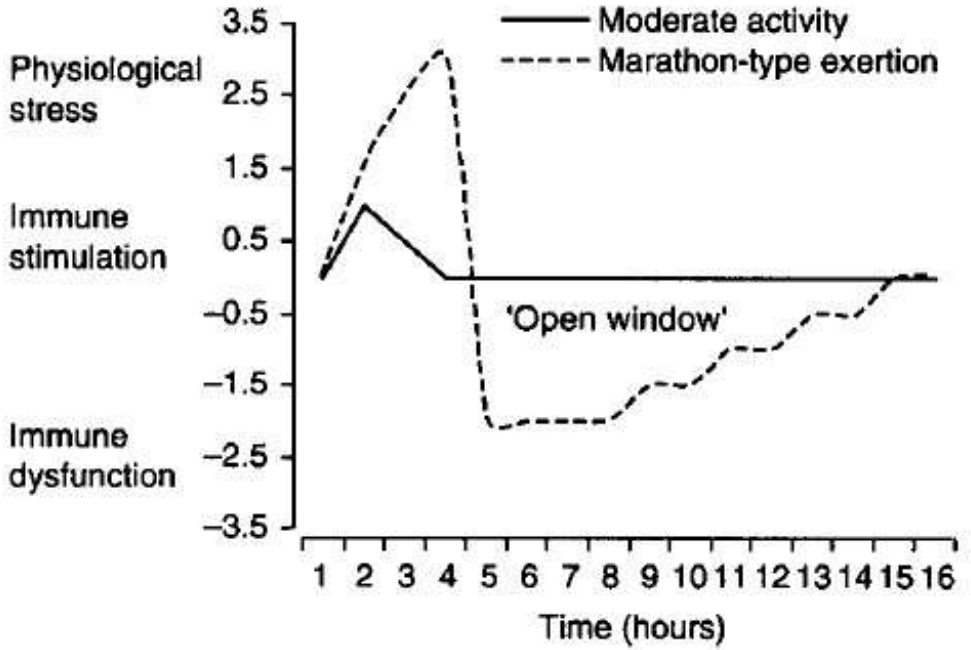


Fig. 1. The 'open window' theory. Moderate exercise causes mild immune changes; in contrast, prolonged, marathon-type exercise leads to immune dysfunction that increases the likelihood for opportunistic upper respiratory tract infections.

CONT'D: REASONS FOR INCREASED RISK OF URTI

- Decreased levels of leukocytes & increased levels of cytokines (and inflammation)
- Results in depression of immune system's ability to defend against invaders
  - Increase in stress hormones (i.e., cortisol) = immunosuppression

- Also, athletes engaged in H-I/L-D may be exposed to other stressors
  - Lack of adequate sleep
  - Cognitive stress/distress
  - Inadequate diet*

EXERCISE, IMMUNE FUNCTION, AND ENVIRONMENTAL EXTREMES

- Heat
  - No evidence suggesting suppression or impairment of immune function
- Cold
  - No evidence suggesting suppression
  - May even have positive effect
    - Increased release of leukocytes!
- High-Altitude
  - Field studies suggest depressed immune function
    - Possibly result of low arterial O_2, altitude-related sleep issues, mountain sickness

EXERCISING WHEN YOU HAVE A COLD

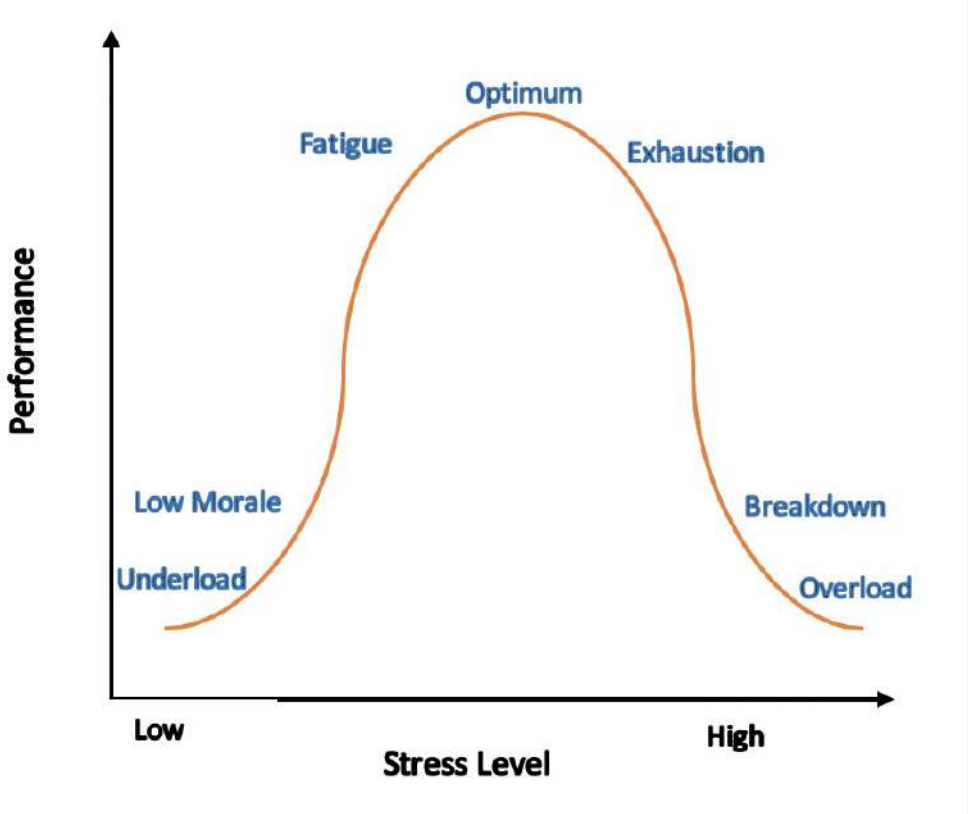
- Typically:
  - OK if symptoms are ABOVE the neck
  - Not advised if symptoms are BELOW the neck

- Feed a Cold starve a fever?
  - Not so much
  - If anything, **feed** a cold, **feed** a fever

PSYCHONEUROIMMUNOLOGY (PNI)

- How thoughts, emotions, and personality traits interact with the immune system to affect sickness & health
- Thoughts and emotions CAN enhance or suppress immune function
  - Neurotransmitters and hormones released in response
  - Prolonged stress → system breaks down
- Exercise = best form of stress management
  - AND improves tolerance to psychological stress

ALLOSTATIC LOAD



PNI AND STRESS (HOLMES & RAHE, 1985)

Events ("stressfulness" points)		
Death of spouse (100)	Marriage (50)	Personal achievement (28)
Divorce (73)	Fired from job (47)	Spouse starts/stops work (26)
Separation (65)	Retirement (45)	Trouble with boss (23)
Jail term (63)	Pregnancy (40)	Change of residence (20)
Death of family member (63)	Death of friend (37)	Vacation (13)
Personal injury/illness (53)	Mortgage (31)	Christmas (12)