Fighting fit – how exercise affects your immunity and susceptibility to infection

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Structure of Lecture:

- Exercise and risk of upper respiratory tract infection (URTI)
  - The J-shaped Curve
  - The General Population: regular moderate exercise
  - Sportsmen and women: prolonged strenuous exercise and training

- The effect of heavy exercise on immune function

- Can nutritional supplements influence the immune response to exercise?
The 'J-shaped' model


Risk of URTI

Above average

Average

Below average

Low  Moderate  High

Weekly amount of exercise
Moderate exercise and infection risk - anecdotal reports

- Common belief among fitness enthusiasts that regular exercise confers resistance against infection:

- **Example 1:** 170 non-elite marathon runners: 90% agreed that they ‘rarely get sick’
  
  (Nieman, 2000)

- **Example 2:** 750 ‘Masters Athletes’: 76% perceived themselves as ‘less vulnerable to viral illnesses’
  
  (Shephard et al., 1995)
Moderate exercise and incidence of Upper Respiratory Tract Infection (URTI)

- 36, mildly obese, sedentary women
- Assigned to either:
  - 15 wk training, 45 min/day, 5 x per week at 60% heart rate reserve
  - Non-exercising control group

A larger scale study


- 547 men and women aged 20-70 years (mean 48 yr)
- 12 month study with periodic visits to a clinic
  - 3 month recall of colds, flu or allergic episodes
  - 3 x 24 h recall of physical activity (24PAR)

- Adjusted data for confounders
Physical activity levels and incidence of URTI

Matthews et al., 2002

Data adjusted for age and gender.
29% lower URTI risk in Q4 compared with Q1
\( (P < 0.01) \)

Approx 1/3rd fewer URTI
### Activity levels and URTI over the winter months in 1002 men and women aged 18-85

*Nieman et al., Br J Sport Med 45(12):987-992, 2011*

<table>
<thead>
<tr>
<th>Activity Level</th>
<th>URTI Total Days</th>
<th>URTI Severity Score</th>
<th>URTI Symptom Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low activity (&lt; 1 day/week) N=214</td>
<td>8.6</td>
<td>18.2</td>
<td>93.9</td>
</tr>
<tr>
<td>Medium activity (1-4 days/week) N=573</td>
<td>5.5*</td>
<td>11.5*</td>
<td>63.7*</td>
</tr>
<tr>
<td>High activity (&gt; 5 days/week) N=215</td>
<td>4.9*</td>
<td>10.7*</td>
<td>55.0*</td>
</tr>
</tbody>
</table>

* P<0.05, compared with Low activity. Data adjusted for age, education, martial status, gender, stress level, BMI and fruit intake
Influence of other lifestyle factors

Influence of other lifestyle factors

Why might moderate exercise be associated with a decreased risk of URTI?
Exercise and immune cell function

Nieman et al., 1994

45 min at either 80% (high) or 50% (moderate) VO₂max

Moderate

High

‘Open window for infection’?
Regular moderate exercise, saliva IgA & URTI

Klentrou et al., Eur J Appl Physiol 87: 153-158, 2002

12 week training study (3 x 30 min sessions at 70% HR reserve)

- **Saliva IgA (mg.l⁻¹)**
  - Week 1: Exercise (200), Control (200)
  - Week 12: Exercise (300), Control (250)

- **Severe symptom days**
  - Weeks 1-6: Exercise (1.5), Control (1.0)
  - Weeks 6-12: Exercise (2.0), Control (0.5)
Summary - Moderate exercise and infection risk

- **J-shaped curve**: Suggests that moderate exercise training is associated with a lower than average risk of URTI.

- **Generally** supported by a number of epidemiological studies published to date.

- To date, few studies report ‘enhanced’ immune function following acute moderate exercise, but **circulating leukocyte numbers increase** without functional suppression. Also, a programme of regular moderate exercise may be associated with increased salivary IgA concentration and improved natural killer cell activity.

- **Other influences** need to be taken into account (e.g. improved nutrition, reduced psychological stress).
Heavy exercise and infection risk - anecdotal reports

- “...upper respiratory infections abound”
  - (Officials with the 1976 US Olympic Team)

- “...those familiar coughs and colds”
  - (David Moorcroft, after setting the 5km WR in 1982)

- “I caught everything. I felt like I should have been living in a bubble”
  - (Alberto Salazar talking about how he caught 12 colds in 12 months when training for the 1984 Olympic Marathon)
The 'J-shaped' model - revisited


Risk of URTI

Above average

Average

Below average

Low

Moderate

High

Amount of weekly exercise

High volumes of exercise
Marathon running and self-reported URTI

- 140 runners surveyed before and 2 weeks after a 56 km ultramarathon
- Controls: age-matched non-runners living in the same household

Marathon running and self-reported URTI


Higher URTI incidence in fastest runners (= highest training loads?)
Marathon running and self-reported URTI


2,311 runners surveyed 1 week after the 1987 LA marathon

% with URTI symptoms

Controls

Runners

12.9

2.2
Training volume and URTI


Odds ratio for URTI

km/week in 2 months prior to marathon

<32 32 - 47 48 - 63 64 - 79 80 - 96 >96
Football players and URTI

- Episodes of URTI over a season in a group of Belgian 1st division football players
- URTI was confirmed by medical diagnosis and serology
- 77% of episodes in footballers were diagnosed in winter
- Episodes of URTI also tended to last longer in the footballers

Mucosal IgA and URTI in American College Football Players: A Year Longitudinal Study


![Graph showing the percentage of footballers and controls with URTI across different stages of the season.](image-url)
Why might heavy exercise be associated with increased risk of URTI?
Strenuous Exercise & Immune Function

**Acute exercise**
- Elevated white blood cell (leukocyte) counts
- But... Suppressed leukocyte function

**Exercise training**
- Lower resting leukocyte counts
- Decreased resting leukocyte function
- Suppressed antibody production
Acute intense exercise and stimulated T cell lymphocyte proliferative responses

Nieman et al., Int. J. Sports med 15: 199-206, 1994

Con-A stimulated proliferative response (cpm/CD3+)

pre post + 1 h + 2 h + 3 h

‘open window’ for infection??
Mucosal IgA and URTI in American College Football Players: A Year Longitudinal Study


![Graph showing the percentage of footballers and controls with URTI across different stages of the season.](image-url)
Mucosal IgA and URTI in American College Football Players: A Year Longitudinal Study


![Graph showing saliva IgA (mg/L) for footballers and controls across different stages of the season.](image)
Salivary-IgA and risk of URTI


\[ R_{\text{adj}}^2 = 0.24, \quad P = 0.006 \]

![Graph showing the relationship between mean resting s-IgA and the number of infections over a 7 month swim season.](image)

- X-axis: Mean resting s-IgA over a 7 month swim season (mg/l)
- Y-axis: Number of infections
- Data points and trend line indicating a negative correlation
- Statistical significance: \( R_{\text{adj}}^2 = 0.24, \quad P = 0.006 \)
A longitudinal study of changes in s-IgA and respiratory illness in athletes

- 38 members of America’s Cup yacht crew
- Studied over 50 weeks of training and sailing
- Morning saliva samples collected weekly
- Clinically confirmed illness

Neville, Gleeson & Folland (2008)
Med Sci Sports Exerc 40(7):1228-1236
Relation between the weekly number of infections within the athlete cohort and their mean relative s-IgA

$r = 0.54$, $n=50$, $P<0.005$
Relative s-IgA before and after an infection episode
Relationship between relative s-IgA and weekly combined sailing and training load

$r=0.41$, $N=50$, $P<0.005$
Other influencing factors?

- A number of other factors which could influence infection risk in athletes have been suggested, including:
  - Increased oral breathing
  - Psychological stress
  - Exposure to crowds
  - Pollution
  - Poor diet
  - Poor sleep
  - Frequent foreign travel
  - Insufficient recovery between training sessions
Summary - Heavy exercise and infection risk (1)

- **J-shaped curve**: Suggests that heavy exercise is associated with *an above average risk of URTI*

- **Supported** by a number of epidemiological studies

- Susceptibility for URTI is related to both the *intensity and duration* of acute exercise and also *training volume*
Summary - Heavy exercise and infection risk (2)

- Heavy schedules of training and competition are associated with *depressed immune function*

- **Direct evidence** linking falls in immune function with increased infection risk is hard to obtain and other factors may also influence infection risk (N.B. exposure to pathogens)

- Keep in perspective! Hard training may mean a few more colds but is good for reducing risk of chronic metabolic and cardiovascular diseases!
Nutritional strategies to maintain immunity

- Ensure energy balance and adequate carbohydrate and protein intake
- Avoid micronutrient deficiencies (daily multivitamin tablet)
- Avoid dehydration and a dry mouth (drink plenty)
- Ingest carbohydrate during exercise (30-60 g/hour)
- High antioxidant intake (lots of fruit & veg)
- Dietary immunostimulants that might work for athletes:  
  - Flavonoids/Polyphenols (about 1 g/day)
  - Vitamin C (500 – 1000 mg/day)
  - Probiotics (daily according to manufacturer’s recommendation)

And…Nutrition is only one factor in illness prevention
Thank you for your attention

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Immune Function in Sport & Exercise

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