TITLE PAGE

The BASES Expert Statement on Exercise, Immunity and Infection

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The BASES Expert Statement on Exercise, Immunity and Infection

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Abstract

A person's level of physical activity influences their risk of infection, most likely by affecting immune function. Regular moderate exercise reduces the risk of infection compared with a sedentary lifestyle but very prolonged bouts of exercise and periods of intensified training are associated with increased infection risk. There are several lifestyle, nutritional and training strategies that can be adopted to limit the extent of exercise-induced immunodepression and minimise the risk of infection. This expert statement provides a background summarising the evidence together with extensive conclusions and practical guidelines.

Introduction

The relationship between habitual physical activity levels and immune function affects everyone because all people get infections and the amount of exercise people undertake affects their susceptibility to infection. Acute bouts of exercise cause a temporary depression of various aspects of immune function that will usually last for 3 to 24 hours after exercise, depending on the intensity and duration of the exercise bout. Several studies indicate that the incidence of symptoms of upper respiratory tract illness (URTI) is increased in the days after prolonged strenuous endurance events and it has been generally assumed that this reflects the temporary depression of immune function induced by prolonged exercise. More recently it has been proposed that at least some of the symptoms of URTI in exercisers are attributable to upper airway inflammation rather than to infectious episodes. Periods of intensified training have been shown to depress immune function and although elite athletes are not clinically immune deficient, it is possible that the combined effects of small changes in several immune factors may compromise resistance to common minor illnesses, particularly during periods of prolonged heavy training and at times of major competitions. There appears to be no influence of the sex of an athlete on susceptibility to URTI but some athletes are more illness-prone than others. This is a major concern for athletes as even minor infections can impair exercise performance or even prevent the athlete from competing. In contrast, moderate levels of regular exercise are thought to confer decreased susceptibility to illness compared with a sedentary lifestyle. This has relevance for the general population and in particular, elderly people.

Background and evidence

The most common infections in otherwise healthy people are those of the respiratory tract followed by infections of the gastrointestinal tract. The principal causative agents of respiratory infections are viruses such as rhinovirus and adenovirus that result in symptoms of the common cold and influenza viruses that cause the more severe symptoms of 'flu'. Episodes of URTI are more common in the winter months and adults typically experience 2-4 URTI episodes per year. However, the nature of URTI episodes associated with exercise is less clear, particularly in high-performance athletes. While URTI or 'sore throats' are the most common reason elite athletes visit their doctor, whether these symptoms are actually caused by infections or are a reflection of other inflammatory stimuli associated with exercise remains unclear (Bermon, 2007; Walsh et al., 2011). Infections are not usually verified by pathology examinations and doctor confirmation of an infective cause of the symptoms, based on clinical signs and symptoms, has been found to be less than 60% reliable (Cox et al., 2008). The focus on respiratory infections in exercise has been stimulated by the commonly held beliefs that the frequency of URTI is increased in endurance athletes and that the incidence is associated with more intensive training (Gleeson, 2005) but the evidence to support these concepts is inconclusive. The evidence does, however, support the concepts that exercised-induced immune depression increases susceptibility to URTI symptoms and that these are associated with impaired athletic performance.

Prolonged bouts of strenuous exercise have a temporary negative impact on immune function. Post-exercise immune function depression is most pronounced when the exercise is continuous, prolonged (>1.5 hours), of moderate to high intensity (55-75% of aerobic capacity), and performed without food intake (Gleeson, 2006a). Both aspects of innate immunity (e.g., neutrophil chemotaxis, phagocytosis, degranulation and oxidative burst activity and natural killer cell cytoxic activity) and acquired immunity (e.g., toll-like receptor expression and antigen presentation by monocytes/ macrophages; T lymphocyte cytokine production and proliferation, immunoglobulin production by B lymphocytes) are depressed by prolonged exercise. The salivary secretory immunoglobulin A (SIgA) response to acute exercise is variable, though very prolonged bouts of exercise are commonly reported to result in decreased SIgA secretion (Bishop & Gleeson, 2009). The causes of immune depression after prolonged exercise are thought to be related to increases in circulating stress hormones (e.g., adrenaline and cortisol), alterations in the pro-/anti-inflammatory cytokine balance and increased free radicals.

Markers of immune function in athletes in the true resting state (i.e., at least 24 hours after the last exercise bout) are generally not very different from their sedentary counterparts, except when athletes are engaged in periods of intensified training. In this situation immune function might not fully recover from successive training sessions and some functions can become chronically depressed (Gleeson, 2005). Both T and B lymphocyte functions appear to be sensitive to increases in training load in well-trained athletes undertaking a period of intensified training, with decreases in circulating numbers of Type 1 T cells, inhibition of Type 1 T cell cytokine production, reduced T cell proliferative responses and falls in stimulated B cell immunoglobulin synthesis and SIgA reported. However, to date, the only immune variable that has been consistently associated with increased infection incidence is SIgA. Low concentrations of SIgA in athletes or substantial transient falls in SIgA are associated with increased risk of URTI.

In contrast, increases in SIgA can occur after a period of regular moderate exercise training in previously sedentary individuals and could, at least in part, contribute to the apparent reduced susceptibility to URTI associated with regular moderate exercise compared with a sedentary lifestyle.

The available, albeit limited, evidence does not support the contention that athletes training and competing in cold conditions experience a greater reduction in immune function compared with thermoneutral conditions. The inhalation of cold dry air can reduce upper airway ciliary movement and decrease mucous flow but it remains unknown if athletes who regularly train and compete in cold conditions report more frequent, severe or longer-lasting infections. Other environmental extremes (e.g., heat and altitude) or dehydration do not seem to have a marked impact on immune responses to exercise.

Infections can occur following exposure to new pathogens but can also be caused by reactivation of a latent virus. For example, it has been shown that symptoms of URTI in swimmers were positively associated with previous Epstein-Barr viral infection and partially with viral shedding (Gleeson et al., 2002). Furthermore, there is increasing evidence that infection history has a strong influence on cellular immune responses to exercise (Turner et al., 2010; Simpson et al., 2011).

Conclusions and practical guidelines

It is generally agreed that prevention is always preferable to treatment, and although there is no single method that completely eliminates the risk of contracting an infection, there are several effective lifestyle and nutritional strategies that can reduce the extent of exercise-induced immunodepression and lower the risk of infection (Walsh et al., 2011).

The following provides some practical guidelines:

• Individuals should be updated on all vaccines needed at home and for foreign travel.

• Minimise contact with infected people, young children, animals and contagious objects.

• Keep at distance to people who are coughing, sneezing or have a ‘runny nose’, and when appropriate wear (or ask them to wear) a disposable mask.

• Wash hands regularly, before meals, and after direct contact with potentially contagious people, animals, blood, secretions, public places and bathrooms.

• Use disposable paper towels and limit hand to mouth/nose contact when suffering from respiratory or gastrointestinal infection symptoms. Carry alcohol-based hand-washing gel with you.

• Do not share drinking bottles, cups, towels, etc with other people.

• While competing or training abroad, choose cold beverages from sealed bottles, avoid raw vegetables and undercooked meat. Wash and peel fruit before eating.

• Quickly isolate an individual with infection symptoms from others.

• Protect airways from being directly exposed to very cold and dry air during strenuous exercise by using a facial mask.

• Ensure adequate dietary energy, protein and essential micronutrient intake.

• Avoid crash dieting and rapid weight loss.

• Ensure adequate carbohydrate intake before and during strenuous prolonged exercise in order to limit the extent and severity of exercise-induced immunodepression. Ingestion of 30-60 g carbohydrate per hour during prolonged exercise has been shown to reduce stress hormone and anti-inflammatory cytokine responses and attenuate the suppression of interferon-γ production from stimulated T lymphocytes (Gleeson, 2006b).

• The efficacy of most so-called dietary immunostimulants has not been confirmed. However, there is limited evidence that some flavonoids (e.g., quercetin) and *Lactobacillus* probiotics can reduce URTI incidence in highly physically active people. Daily ingestion of probiotics could also reduce risk of gastrointestinal infections.

• Wear appropriate outdoor clothing in inclement weather and avoid getting cold and wet after exercise.

• Get adequate sleep (at least 7 hours per night is recommended). Consider monitoring sleep quantity and quality using small, non-invasive movement sensors.

• Wear flip-flops or similar footwear when going to the showers, swimming pool and locker rooms in order to avoid dermatological diseases.

• Keep other life stresses to a minimum. Consulting a sport psychologist may be helpful to find ways to reduce stress and adopt suitable coping behaviours.

Should infection occur, exercisers must use some basic guidelines for exercise during infectious episodes (Ronsen, 2005) before being referred to a doctor.

- *First day of illness:* Avoid strenuous exercise or competitions when experiencing URTI symptoms like sore throat, coughing, runny or congested nose. Avoid all exercise when experiencing symptoms like muscle/joint pain and headache, fever and generalised feeling of malaise, diarrhoea or vomiting.

- *Second day:* Avoid exercise if fever, diarrhoea or vomiting present or if coughing is increased. If no fever or malaise is present and there is no worsening of ‘above the collar’ symptoms; undertake light exercise (heart rate < 120 beats per minute) for 30-45 minutes (indoors during winter), by yourself.

- *Third day:* If fever and URTI (or gastrointestinal) symptoms are still present, consult your doctor. If no fever or malaise is present and there is no worsening of initial symptoms; undertake moderate exercise (heart rate < 150 beats per minute) for 45-60 minutes, preferably indoors and by yourself.

- *Fourth day:* If there is no symptom relief, do not try to exercise and visit your doctor. If this is the first day of improved condition, wait one day without fever and with improvement of URTI or gastrointestinal symptoms before returning to exercise.

- Finally, it is important to stop training and consult your doctor if a new episode with fever occurs or if initial symptoms become worse, coughing persists or breathing problems during exercise occur. Observe closely your tolerance to increased exercise intensity and take an extra day off if recovery is incomplete.

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