

Recommendations for Participation in Sport Activities and Exercise for Persons with Exercise-Induced Bronchospasm

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Asthma affects 14 to 15 million people in the United States and is associated with significant morbidity.¹ It is the most common chronic respiratory disease of childhood, affecting an estimated 4.8 million US children.²⁻⁴ Historically, parents and physicians have approached childhood asthma conservatively, often managing it by limiting the child's activities.⁵ As a result, asthmatic persons tend to be less physically fit and active than are nonasthmatic persons.^{6,7} Each year in the United States, persons with asthma collectively have more than 100 million days of restricted activity and 470,000 hospitalizations, and more than 5000 persons die annually of the disorder.⁸

Asthma is characterized by three key factors: (1) airway obstruction, (2) airway inflammation, and (3) airway hyperreactivity. Symptoms of asthma (eg, wheezing, coughing, recurrent difficulty breathing, chest tightness) are episodic and variable in intensity. When the precipitator or stimulus of airway obstruction is physical exercise, the term *exercise-induced bronchospasm* (EIB) (or *exercise-induced asthma* or *exercise-induced bronchoconstriction*) is used.⁹⁻¹³ Approximately 80% to 90% of persons with asthma (ie, 12%–15% of the general population) and 40% of patients with allergic rhinitis experience EIB.¹⁴⁻¹⁷

Because it was formerly believed that persons with EIB should not engage in exercise, they often became trapped in a seemingly endless cycle of deconditioning. In order to avoid the sensation of breathlessness, activity was reduced, allowing deconditioning to occur, which then resulted in breathlessness at even lower levels of activity.¹⁸ Consequently, persons with EIB typically could not meet the minimum standards for health and fitness set forth by agencies such as the Centers for Disease Control and Prevention, National Center for

Chronic Disease Prevention and Health Promotion, and the President's Council on Physical Fitness and Sports.

The goal of this article is to provide a current overview of the pathophysiology of EIB and to make specific recommendations for safe and effective participation in exercise and sports for persons with EIB. Topics covered include screening for EIB, follow-up diagnostic procedures for cases of suspected EIB, the pharmacologic management of EIB as it pertains to exercise, and appropriate precautionary measures. The paper concludes with recommendations for effective and safe exercise that can enhance the health and fitness of persons with EIB.

PATHOPHYSIOLOGY OVERVIEW

EIB is characterized by a temporary increase in airway resistance or bronchoconstriction that occurs during or following physical activity. Persons with EIB initially have diminished bronchodilation during exercise. In cases of EIB, the airways narrow by a combination of 3 events: (1) the muscles surrounding the bronchioles tighten,

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thus narrowing the airway; (2) constriction occurs because of swelling of the bronchial lining; and (3) increased secretions of mucus block airflow and cause air to be trapped in the alveoli.⁵ The immediate response of bronchoconstriction usually occurs 5 to 12 minutes after exercise begins. Persons with EIB who are highly fit may not have maximal decreases in pulmonary function until 15 minutes after exercise begins. Although some persons with mild asthma may be able to continue exercising during airflow obstruction, others will have to discontinue the exercise session. EIB usually subsides, with complete recovery occurring within 30 to 90 minutes (depending on the severity of the initial bronchoconstriction).^{18,19} Approximately 50% of persons with EIB experience a 1- to 4-hour refractory period following exercise²⁰ (ie, a period during which an identical activity results in 50% less bronchoconstriction, compared to the initial activity²¹). A second wave of airflow obstruction, referred to as the *late-airway response*, occurs in some persons approximately 3 to 8 hours after exercise ceases.²²

EIB is induced as minute ventilation increases, leading to drying and cooling of the airways. Drying and cooling are difficult to separate, because the majority of heat exchange results from evaporative losses. This fact has led to 2 major hypotheses about the initial stimulus for EIB: the thermal exchange theory and the airway-drying theory.

The thermal exchange theory states that, during exercise, cooling of the airways occurs, leading to vasoconstriction followed by rebound hyperemia as exercise ceases and the airways rewarm. It has been shown that the rapidity and magnitude of postexercise rewarming influences the severity of EIB.²³ This theory is based on the vasculature of the airways. The bronchial vasculature consists of subepithelial capillaries that underlie the airway, extending from the trachea to the small bronchioles. These capillaries merge to form vessels. Hyperemia or engorgement of these vessels could result in narrowed airways. In addition, the engorged vessels may exude fluid into the tissues, possibly leading to mediator release and resultant bronchospasm.²⁴ This process produces a thickening of the mucosa and reduced airway caliber.

In contrast, the airway-drying theory states that, during strenuous exercise, hyperventilation is associated with a loss of water through the epithelium of the bronchial mucosa. This loss of water leads to changes in intracellular osmolarity, pH, and temperature. The hyperosmolar state of the airways causes mediator release and bronchoconstriction.^{25,26} Recent evidence showing that leukotriene blockade attenuates EIB lends strong support to the airway-drying hypothesis; evidence from the

canine airway model clearly indicates that, during exercise, airways dry, resulting in an increase in airway osmolarity.²⁷ The increased osmolarity triggers the release of mediators from airway cells (eg, mast cells). Although one must be cautious in extrapolating results from animals to humans, in normal canine bronchi, excessive airway drying stimulates secretory and mast cell degranulation and results in mucus secretion, smooth muscle constriction, and bronchovascular hyperpermeability. There is also evidence showing that bronchoconstriction occurs during exercise while the airways remain cool,²⁸ making the thermal exchange theory unlikely as the only explanation of the pathogenesis of EIB.

In summary, EIB is most likely triggered by an accelerated exchange of heat, water vapor, or both between airway mucosa and inspired air.²⁹ Both hypotheses merit further investigation, because both theories have support from clinical observations.^{13,15,23,25,30,31}

RECOMMENDATIONS PRIOR TO EXERCISE PARTICIPATION

Many persons with EIB are not aware of their condition. Early detection of EIB in school-age children through screening can facilitate early treatment and thus enhance exercise-related activities throughout their lives.^{32–35} When EIB is identified early, symptoms can be managed, and children can remain active and avoid self-image problems caused by estrangement from peers. In fact, recent data suggest that patients initially treated with therapy appropriate for mild asthma are rarely treated later with the more aggressive therapy required by severe disease.³⁶

Screening for Exercise-Induced Bronchospasm

The most commonly used screening tools for EIB are self-report questionnaires (Figure 1) and peak expiratory flow rate obtained after exercise.^{37,38} However, studies have shown that the true magnitude of EIB is underestimated by screening history alone and that peak expiratory flow rate may also misclassify children, compared with more extensive spirometric testing after exercise.^{39,40} According to some researchers, exercise testing in large groups of children may not be a suitable screening procedure for undiagnosed asthma.⁴¹

Follow-up Diagnostic Procedures for Suspected Exercise-Induced Bronchospasm

If EIB (or asthma) is suspected, diagnosis begins with a detailed medical history of the possibly affected person. A physical examination of the upper and lower respiratory tracts and measurement of spirometric capacities (eg, forced inspiratory volume in 1 second [FEV₁], ratio of FEV₁ to forced vital capacity [FVC])

are routine procedures for the diagnosis of EIB. A low FEV₁-FVC ratio or a low forced expiratory flow rate in the midrange (25%–75%) of vital capacity are viewed as indicators of obstructive airway disease.⁴²

Other diagnostic testing procedures include bronchoprovocation and exercise-challenge testing. In bronchoprovocation testing, bronchoconstrictors (eg, methacholine, histamine) are inhaled in increasing dosages, while airflow changes are recorded on a spirometer. Hyperreactivity of the airway is correlated with the amount of bronchoconstriction necessary to induce bronchospasm. Bronchoprovocation can also be performed using cold air instead of bronchoconstrictors.

Exercise-challenge testing begins with collection of spirometric data to establish a resting baseline of lung function. EIB is diagnosed by a 10% to 15% decrease in FEV₁ or peak expiratory flow rate obtained at 0, 3, 5, 10, 15, and 20 minutes after a 6- to 8-minute period of strenuous exercise (ie, that achieves ~85% of the predicted maximum heart rate). Postexercise decreases of 10% to 20% in FEV₁ correlate with mild EIB, whereas decreases of 20% to 40% suggest moderate EIB and of more than 40% suggest severe EIB. Although more specifically related to EIB, exercise-challenge testing is less sensitive than is bronchoprovocation, and negative results on an exercise-challenge test do not exclude the diagnosis of EIB.³¹

PHARMACOLOGIC MANAGEMENT OF EXERCISE-INDUCED BRONCHOSPASM

Classification of asthma severity by the National Heart, Lung, and Blood Institute and a stepwise approach for the pharmacologic management of asthma in adults and children older than 5 years is presented in **Table 1**. The primary and most effective treatment for EIB is the use of a short-acting β_2 -agonist. Inhaling 2 to 4 puffs of a short-acting β_2 -agonist 5 to 60 minutes prior to exercise will prevent EIB in as many as 80% of patients, with benefits lasting from 2 to 4 hours.^{1,14,43–47} The National Asthma Education and Prevention Program (NAEPP) recommends these drugs for initial treatment of EIB.¹ As with all inhalational medicine, proper metered-dose inhaler (MDI) techniques must be used for effective treatment. Pressurized MDIs are the most popular device for persons older than 2 to 3 years and are especially easy to use with the addition of a spacing device. Spacers should always be used to maximize the amount of medication that goes to the lungs (as opposed to remaining in the mouth). If a short-acting β_2 -agonist alone is not adequate, 2 puffs of inhalational cromolyn may be added prior to exercise, with benefits lasting for 1 to 2 hours.^{1,48–50}

Please answer the following questions:

1. Have you ever been told you have (had) asthma or exercise-induced bronchospasm?
No Yes Not sure
2. Do you ever have chest tightness?
No Yes Not sure
3. Do you ever have wheezing?
No Yes Not sure
4. Do you ever have itchy eyes?
No Yes Not sure
5. Do you ever have itching of the nose or throat or sneezing spells?
No Yes Not sure
6. Does running ever cause chest tightness, cough, wheezing, or prolonged shortness of breath?
No Yes Not sure
7. Have you ever had chest tightness, cough, wheezing, or other chest (lung) problems that made it difficult for you to perform in sports?
No Yes Not sure
8. Have you ever missed school or work because of chest tightness, cough, wheezing, or prolonged shortness of breath?
No Yes Not sure

Figure 1. Sample screening questionnaire to detect a history of exercise-induced bronchospasm. (Adapted with permission from Randolph C, Fraser B, Matasavage C. The free running athletic screening test as a screening test for exercise-induced asthma in high school. *Allergy Asthma Proc* 1997;18:93–8.)

Long-acting β_2 -agonists, taken 30 minutes prior to exercise, have been reported to be an effective management tool in the prevention of EIB. A study indicated that long-acting inhalational β_2 -agonists continued to have a therapeutic effect for as long as 9 to 12 hours after prolonged use.⁵¹ However, other studies have reported that the length of time a single dose of a long-acting β_2 -agonist remains active decreases with prolonged use.^{52,53}

Use of leukotriene inhibitors also has been shown to be effective for some patients with EIB⁵⁴; part of the pathophysiology of EIB is related to the release of inflammatory mediators, such as the cysteinyl leukotrienes. This therapy can be considered for patients who are unable to use a MDI correctly or prefer taking a pill to using an inhaler.

The long-term use of inhalational corticosteroids is also effective in protecting against the symptoms of EIB.

Table 1. National Heart, Lung, and Blood Institute General Guidelines for the Management of Asthma*

Classification of Asthma Severity	Daily Medication(s) [†]
Mild intermittent [‡]	No daily medication needed
Mild persistent [§]	Cromolyn or Nedocromil or Low-dose inhalational corticosteroid
Moderate persistent	Medium-dose inhalational corticosteroid or Low-to-medium dose inhalational corticosteroid plus a long-acting bronchodilator (eg, a long-acting inhalational β_2 -agonist, sustained-release theophylline, or long-acting β_2 -agonist tablets), especially for nighttime symptoms <i>If needed:</i> Medium-to-high dose inhalational corticosteroid plus a long-acting bronchodilator (eg, a long-acting inhalational β_2 -agonist, sustained-release theophylline, or long-acting β_2 -agonist tablets), especially for nighttime symptoms
Severe persistent [¶]	High-dose inhalational corticosteroid plus a long acting bronchodilator (long-acting inhalational β-agonist, sustained-release theophylline, or long-acting β_2-agonist tablets) and long-term corticosteroid tablets/syrup[#]

Adapted with permission from Houghlum JE. Asthma medications: basic pharmacology and use in the athlete. *J Athletic Training* 2000;35:179–87.

FEV₁ = forced expiratory volume in 1 second; PEF = peak expiratory flow.

*For quick relief of exercise-induced bronchospasm in affected persons, a short-acting bronchodilator (eg, 2 to 4 puffs of an inhalational β_2 -agonist) can be used, as needed for symptom control. However, daily use of a short-acting β_2 -agonist is generally not recommended; use should be on an as-needed basis. Long-acting β_2 -agonists provide prolonged protection against exercise-induced bronchospasm; however, their effect diminishes when given chronically because of decreased bronchoprotective efficacy.

[†]Preferred treatments appear in boldface type.

[‡]Days with symptoms, 2 or fewer weekly; nights with symptoms, 2 or fewer monthly; PEF or FEV₁, \geq 80% of predicted; PEF variability, < 20%.

[§]Days with symptoms, 3 to 6 weekly; nights with symptoms, 3 to 4 monthly; PEF or FEV₁, \geq 80% of predicted; PEF variability, 20%–30%.

^{||}Days with symptoms, 7 days weekly; nights with symptoms, 5 or more monthly; PEF or FEV₁, 60%–80% of predicted; PEF variability, > 30%.

[¶]Days with symptoms, continual; nights with symptoms, frequent; PEF or FEV₁, \geq 60% of predicted; PEF variability, > 30%.

[#]Repeated attempts should be made to reduce the dosage of systemic corticosteroids and to maintain control with high-dose inhalational corticosteroids.

However, the benefit of inhalational corticosteroid therapy occurs over several weeks and may require as long as 3 months for maximal effect.^{45,55,56} Other pharmacologic agents with a documented effect on EIB (although less of an effect than the previously mentioned medications) include theophylline, antihistamines, calcium channel blockers, and anticholinergic agents.^{14,45}

Finally, when treating an athlete for EIB, one must know which methods are approved and which methods are banned by the organization for which the athlete is competing. A complete list of medications banned and

approved by the International Olympic Committee can be found on the US Anti-Doping Agency Web site (http://www.usantidoping.org/prohibited_sub/list.as).

PRECAUTIONARY MEASURES PRIOR TO EXERCISE

Persons with severe breathing problems or those who use supplemental oxygen at rest or during exercise should begin exercising in a supervised program for at least the first 12 weeks. For children with a diagnosis of EIB who participate in sports and exercise during school, certain safety precautions should be taken before

beginning exercise training. The environmental conditions in which exercise will occur must be considered when deciding on appropriate precautionary measures. The parents and child should know the day's activities beforehand, so that medication can be taken at appropriate times.⁵ Moreover, an emergency action plan should be devised for the possible occurrences of EIB during participation in sports and exercise, and the plan should be discussed with the parents, child, teacher, coach, nurse, and family physician.

In order to optimize safe participation in sports and other activities for children with EIB, the American Academy of Pediatrics (Web site, <http://www.aap.org>) makes the following 3 recommendations: (1) Those patients who have physician-prescribed MDIs should use them before school-sponsored sport activities; additional use during practice or competition should be allowed but is rarely needed if inhalers are used appropriately before participation. (2) The athlete should not expect a benefit from a β_2 -agonist if fewer than 5 minutes remain in the sporting event; if symptoms are severe enough to stop the event, the athlete should be medically disqualified. (3) Athletes using MDIs before a sporting event and more than once during the event should be evaluated by their pediatrician to evaluate the need for additional treatment of inflammation as well as bronchoconstriction.

Persons who experience symptoms with exercise for the first time should stop activity. However, after evaluation for EIB, they should follow the recommendations of their physicians regarding continuation of activity if symptoms develop. It is important to adjust treatment as necessary and to alternate training strategies during exacerbation. Many patients are instructed simply to take another dose of the bronchodilator for symptoms occurring during exercise.

SAFE AND EFFECTIVE PARTICIPATION IN SPORT ACTIVITIES AND EXERCISE

Research Findings

Research supports the concept that persons can safely participate in sports and exercise following diagnosis and control of EIB. In fact, participation in sports and exercise following the control of EIB is encouraged.^{7,11,57} It has been shown that persons with moderate asthma can achieve a maximum heart rate similar to that of persons without asthma and that the effects of aerobic training are similar for both groups.⁷ Moreover, physically trained persons with EIB do not experience breathlessness during exercise until they reach a much higher level of activity than untrained person with EIB.¹⁸ Reductions in the occurrence of EIB with training may

result from the reduction of minute ventilation at high work loads after training, resulting in a decrease in the stimulus of EIB rather than any change in underlying pathophysiology.^{5,7} Additional improvements through exercise training for persons with asthma include increased confidence in participating in physical activity, an increase in actual daily physical activity, and improvements in overall self-confidence.^{55,58,59} Finally, safe participation in exercise and sports depends on both the environmental conditions and the type of activity.

Recommendations for Safe Participation in Activity

Generally, sport and exercise recommendations for persons with EIB can be classified (for the most part) as either anaerobic or aerobic activities, although both anaerobic and aerobic systems are used in most, if not all, activities. Basically, anaerobic activities refer to those activities that are shorter in duration and generally are performed at a higher level of exertion for a briefer period of time. In contrast, aerobic activities usually are continuous activities that involve use of large muscle groups, are rhythmic in nature, and are performed at a low-to-moderate intensity. Much of the research regarding safe participation in sports has focused on specific sports that fall fairly easily into the anaerobic or aerobic category. An exception is yoga, in which there has been an increased interest for asthmatic patients.⁶⁰⁻⁶⁶ Yoga cannot be easily classified as either anaerobic or aerobic exercise and instead is considered a combination of aerobic and anaerobic activities, depending on the type and intensity of the yoga techniques. Regardless of the type of activity, however, an extended warm-up and cool-down period should occur before and after exercise sessions for the person with EIB.^{22,67}

As stated earlier, EIB is induced by inhalation of dry cold air, so warming and humidifying inhaled air should decrease the symptoms of EIB. This humidification and warming can be accomplished by wearing a muffler or taking part in exercise performed in a warm and humid environment, such as an indoor swimming pool.^{1,14} A proper warm-up prior to exercise has been shown in some cases to decrease the symptoms of EIB and to reduce the need for repeated medications.^{1,14,44} The NAEPP recommends 6 to 10 minutes of warm-up activities before exercise. Sports that have been particularly bothersome for persons with EIB are running, cross-country skiing, hockey, and competitive bicycling, especially when performed in cold climates.^{68,69} Generally, the longer the duration or the greater the cardiorespiratory intensity of the exercise, the greater the risk for inducing EIB. EIB is more likely to occur in higher intensity aerobic sports of intermediate or long duration

Table 2. Cardiorespiratory Fitness and Health Guidelines for Adults

Cardiorespiratory fitness guidelines*

Exercise frequency: 3 to 5 days weekly

Exercise intensity: 60% to 90% of maximum heart rate, or 50% to 85% of heart-rate reserve or maximum oxygen consumption

Exercise duration: 20 to 60 minutes of continuous aerobic activity (Duration is dependent on intensity, so lower-intensity exercises should be maintained for longer periods of time.)

Cardiorespiratory health guidelines†

Exercise frequency: daily, if possible

Exercise intensity: strenuous physical activity is not necessary to achieve health benefits; men and women of all ages benefit from a moderate amount (eg, equivalent to a brisk walk at a pace of 3–4 miles per hour) of daily physical activity.

Exercise duration: 30 minutes of activity daily (continuous or intermittent)

Key message: Being active does not require an exercise regimen; if sedentary persons were to adopt a more active lifestyle, there would be enormous benefits to public health and individual well-being.

Note: Adults who have chronic health problems (eg, heart disease, diabetes mellitus, obesity, asthma) or are at high risk for such conditions should first consult a physician before beginning a new program of physical activity. Men older than 40 years and women older than 50 years who plan to begin a new program of vigorous activity should first consult a physician to ensure they do not have heart disease or other health problems.

*Data from Franklin et al.⁷⁵

†Data from: A report of the Surgeon General: physical activity and health: adults. Available at <http://fitness.gov/adults.html>. Accessed 4 Dec 2002.

(eg, basketball, track, soccer) than in sports of brief duration or little exertion that can be classified as either aerobic or anaerobic (eg, baseball, golf, badminton, walking, moderate resistance training, yoga).^{22,70} If an athlete with EIB routinely has a postexercise refractory period 1 to 4 hours after exercise, it may be advisable for the athlete to exert near maximal effort prior to competition (ie, during warm-up) so that the benefits of the postexercise refractory period occur during competition.⁴⁵

Of course, appropriate activity recommendations for persons with EIB cannot be based simply on the intensity level of the activity, the duration of the activity, or the predominant energy system used to perform the activity, but also must take into account environmental consider-

ations. The chief environmental factors contributing to EIB are weather conditions and air pollution.^{12,22,26,59,70}

Studies have shown, for example, that a level of airborne sulfates as low as 0.4 ppm can induce bronchospasm in exercising persons prone to asthma.⁷¹ Additionally, exercising in cold, dry air is more likely to cause bronchospasm than is exercising in warm, humid air. In this regard, Mannix and colleagues attributed the high incidence of EIB among highly trained figure skaters to the intense exercise the skaters performed in dry, cold air.⁷² Breathing dry air leads to drying and cooling of the airway mucus as the water evaporates from the surface, and this cooling is accentuated if the dry air is also cold. The warm, humid environment of a swimming pool (ideal water temperature, 30°C [86°F]) provides the best climate for a person with asthma to perform exercise, and swimming is the preferred activity for persons with EIB. Fitch and colleagues⁵⁸ found that during participation in their sport, only 35% of swimmers with a previous diagnosis of EIB developed EIB, as opposed to 72.5% of runners and 65% of cyclists with a previous diagnosis of EIB.

Thus, for persons with severe EIB, the following 4 activity recommendations can be made: (1) warm up slowly before the exercise session and cool down sufficiently afterward; (2) avoid higher-intensity activities that are more likely to result in bronchoconstriction; (3) avoid strenuous outdoor exercise during high-pollen seasons and cold, dry weather (because breathing cold, dry air increases bronchoconstriction)^{22,58,69–72}; and (4) if possible, exercise in a warm, humid environment, such as a swimming pool. Of course, it is often not possible to exercise in perfect conditions. Consequently, it is important for persons prone to EIB to wear a facemask in cold weather, to breathe through the nose, and—if sensitive to airborne pollens—to exercise indoors during high-pollen seasons. If exercise is performed indoors, the facilities should be clean, well aired, and void of mold and dust.

AN EXERCISE PRESCRIPTION FOR PERSONS WITH EXERCISE-INDUCED BRONCHOSPASM

General Guidelines

General exercise guidelines for health and fitness for persons with EIB are not different from those for the general population. However, greater caution must be taken in adherence to these recommendations. In general, persons should use their inhalers as prescribed, warm up slowly at a low level of activity, and avoid high-intensity exercises for the first 10 to 15 minutes of exercise.⁷³ If symptoms occur following warm-up activities, affected persons should inhale a short-acting β_2 -agonist (eg, albuterol, bitolterol, pirbuterol,

Table 3. Initial Walking Program for Deconditioned Persons with Controlled Exercise-Induced Bronchospasm

Week	Session Duration	Daily Frequency	Weekly Frequency	Intensity
1	3 to 5 min exercise/1 min rest	2 to 3 times	3 to 5 times	50% to 55% of HRR*
2	3 to 5 min exercise/1 min rest	3 to 5 times	3 to 5 times	50% to 55% of HRR
3	5 min exercise/1 min rest	2 to 3 times	3 to 5 times	50% to 55% of HRR
4	5 min exercise/1 min rest	3 to 5 times	3 to 5 times	50% to 55% of HRR
5	5 min exercise/1 min rest	4 to 6 times	3 to 5 times	50% to 55% of HRR
6	5 min exercise/1 min rest	5 to 6 times	3 to 5 times	50% to 60% of HRR
7	5 min exercise/1 min rest	6 times	3 to 5 times	50% to 60% of HRR
8	15 min	Once	3 to 5 times	50% to 55% of HRR
9	20 min	Once	3 to 5 times	50% to 55% of HRR
10	25 min	Once	3 to 5 times	50% to 55% of HRR
11	30 min	Once	3 to 5 times	50% to 55% of HRR
12	30 min	Once	3 to 5 times	50% to 60% of HRR

Data from Franklin et al.⁷⁵

HRR = heart-rate reserve.

*HRR is calculated using the following formula: 220 – age – resting heart rate = HRR.

terbutaline) and resume warm-up exercises. When symptoms subside, these persons can then participate at a higher level of intensity.²² It is further suggested that persons prone to EIB cool down following exercise for 10 to 30 minutes by walking, stretching, or performing light calisthenics.²² The cool-down period is as important to the persons prone to EIB as is the warm-up period and should be considered an essential part of the exercise prescription.

Guidelines for Children

Exercise guidelines for children with EIB are less structured than for adults. Children with EIB should be encouraged to participate in physical activity on a regular basis.⁷⁴ Emphasis should be placed on play rather than exercise and on activities that the child enjoys, that are consistent with the child's skill level, and that are compatible with the personal resources and interests of the child's family. The maximum heart rate in healthy children is approximately 200 bpm; it is not necessary to arbitrarily restrict children with EIB to lower heart rates. Therefore, taking target heart rates in otherwise healthy children is neither recommended nor necessary.

Guidelines for Adults

Guidelines for health and fitness for adults, including those with EIB, are shown in [Table 2](#). The exercise prescription for adults with EIB should be for conser-

vative and gradual activity. Low-intensity interval training is well tolerated by most adults with asthma, and exercising to less-than-full tolerance may avoid the onset of EIB. For the deconditioned adult with EIB, exercise should initially consist of 3- to 5-minute periods of exercise followed by periods of rest. The goal should be 30 minutes total of activity (eg, walking for 5 minutes then resting for 1 minute, repeated 5 times) ([Table 3](#)). It is preferable for persons who walk as exercise to continue walking at a decreased intensity during their rest periods, because a complete stop can cause a dangerous decrease in blood pressure.

When a person with a previous diagnosis of EIB can tolerate a 30-minute interval training program, exercise sessions should be designed to increase the duration, as recommended by the American College of Sports Medicine for healthy persons.⁷⁵ The person should exercise 3 to 5 days a week for 20 to 60 minutes per exercise session at 50% to 85% of maximum oxygen consumption or heart-rate reserve (calculated by subtracting resting heart rate from maximum heart rate) ([Table 4](#)).⁷⁶ Another useful method to monitor appropriate exercise intensity for fitness gains in adults with EIB involves using either the rating of perceived exertion scale or the rating of perceived breathlessness scale ([Table 5](#)).^{77,78} Persons prone to EIB should aim for a score of 3 on the rating of perceived breathlessness and should never exceed a rating of 5, even if heart rate is below the prescribed limit, because a score

Table 4. Karvonen’s Formula for Determining Exercise Intensity Using Heart Rate

Step	Calculation
1	220 – age = estimated MHR
2	MHR – resting heart rate = HRR
3	HRR × desired % of HRR (eg, 50%)
4	Number obtained in step 3 + resting heart rate = lower limit of target heart rate
5	HRR × desired % of HRR (eg, 85%)
6	Number obtained in step 5 + resting heart rate = upper limit of target heart rate
7	Target heart rate ranges from lower to upper limit

Data from Karvonen et al.⁷⁶

HRR = heart-rate reserve; MHR = maximum heart rate.

Table 5. Borg Scales for Rating of Perceived Exertion and Rating of Perceived Breathlessness

Rating of Perceived Exertion*		Rating of Perceived Breathlessness†	
0	Nothing at all	0	Nothing at all
0.5	Very, very weak	0.5	Very, very slight
1	Very weak	1	Very slight
2	Weak	2	Slight
3	Moderate	3	Moderate
4	Somewhat strong	4	Somewhat severe
5	Strong	5	Severe
6		6	
7	Very strong	7	Very severe
8		8	
9		9	Very, very severe
10	Very, very strong	10	Maximal
•	Maximal		

Note: use only 1 of these scales as a monitoring device during exercise. For health gains, a person should be exercising moderately.

*Reprinted with permission from Borg GA. Psychological bases of perceived exertion. *Med Sci Sports Exerc* 1982;14:377–81.

†Reprinted with permission from Wilson RC, Jones PW. A comparison of the visual analogue scale and modified Borg scale for the measurement of dyspnea during exercise. *Clin Sci* 1989;76:277–82. Published by Portland Press. Copyright © 1989 the Biochemical Society and the Medical Research Society.

of 5 or higher may provoke EIB. The rating of perceived exertion associated with physiologic adaptation is 4 to 6 (somewhat strong to strong).⁷⁴ However, if extreme breathlessness occurs with a rating in this range for an adult with EIB, the person is not ready to begin this phase of the exercise program.

SUMMARY

Evidence of the psychological and physiologic adaptations to safe exercise participation that can occur in persons with EIB is seen in the phenomenal achievements by US athletes with past histories of EIB. These athletes have excelled even in environmental conditions that are not optimal for the performance of persons who have a previous diagnosis of EIB. Among the US athletes participating in the 1998 Winter Olympics in Nagano, Japan, the overall incidence of previously diagnosed EIB across all genders was 23% (female athletes, 26%; male athletes, 18%).⁷⁹ From these athletes came a team gold medal, an individual gold medal, and an individual silver medal. These facts clearly support the concept that persons can safely participate in exercise and sports following a diagnosis of EIB. Participation in sports and exercise for persons with controlled EIB should be advocated; findings support the premise that appropriate long-term training regimens enable persons with EIB to compete at any level.^{11,79} **HP**

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