

Exercise Related Breathing Disorders

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June 5, 2016

How Many Kids Have Asthma?

- **Approximately 2.5 students in a class of 30 are likely to have asthma.**
- **An estimated 7.9% of Minnesota children ages 0-17 have asthma which is equivalent to more than 98,000 children.¹**

¹ Asthma in Minnesota, 2005 Epidemiology Report

Definition

Work group report of the Sports Medicine committee of the American Academy of Allergy, Asthma and Immunology

- “EIA is the condition in which exercise induces symptoms of asthma in patients who have asthma.”**
- “EIB is airway obstruction that occurs in association with exercise without regard to the presence of chronic asthma.”**

Pathophysiology

- **The onset of symptoms of pure EIB typically are delayed well into the start of intermittent intense exercise, or occurs 5-15 minutes after exercise has ceased.**
 - **Patients with asthma are not immune to this phenomenon**
- **When other causes of bronchial hyperactivity or congestion exist, symptoms can occur more frequently during continuous exercise itself**

Is there a difference between EIA and EIB?

EIA

- **Decrease S/S with ICS**
- **90% with + methacholine**
- **Eosinophil inflammation**

EIB

- **No effect of ICS**
- **75% with - methacholine**
- **Often neutrophilic inflammation**

Despite these differences the agreement is to use the term EIB

Clinical Presentation

- **Cough**
 - Most frequent symptom
 - Most common complaint among athletes who test positive with exercise
- **Chest tightness**
- **Dyspnea**
- **Wheeze**
- **Excess mucous**
- **Poor performance**
- **Chest pain**
- **Seasonal fluctuation of asthma-like symptoms**
- **Activity avoidance**
- **Overall, symptoms are not well-correlated with a positive exercise challenge**

Pathophysiology



During exercise, there is a bronchodilatory response in asthmatics that may keep athletes symptom-free until exercise has ceased.

**Crimi E et al. J Appl Physiol
2002. 92(6):2353-60**

Prevalence

Prevalence varies widely according to

- The means used for diagnosis
- The population being assessed
- Climate



Prevalence

Children

- **The higher the baseline severity of asthma, the higher the prevalence of EIB**
 - Up to 90% of patients with asthma
- **The intensity of response to exercise is not consistently related to the clinical severity of disease in patients with persistent asthma**
 - Intermittent asthma never decreased FEV1 more than 30%

Prevalence

Adolescent athletes:.

- 1241 middle and high school student athletes
- Students with positive history or abnormal resting FEV1
- Exercise challenge by standard testing protocol
- Positive test considered 15% drop in FEV1
 - 66/230 tested students had a positive test (29%)
 - 50/66 had at least a 20% drop in FEV1
 - 28% of students with positive histories had EIB
 - 15% of students with abnormal resting spirometry (but no clinical history) had EIB
 - 61% of students with both abnormal screening history and resting spirometry had EIB
- Overall student body prevalence of 12% (145/1241)

Prevalence

- **Collegiate Athletes**
 - **Cross-country: 14%**
 - **22 sport survey at Ohio State University**
 - **EVH used for diagnosis**
 - **39% positive**
 - **36/42 positive cases had no prior history of EIB or asthma**
 - **No sex differences or differences on the basis of ventilation demands (though athletes in high ventilation sports had more symptoms).**
 - **Symptoms were not predictive of the presence of EIB**
 - **Prevalence of 36% in athletes without symptoms and 35% in athletes with symptoms.**

Prevalence

- Use of β -2 agonists at the Olympics
 - 1984 (L.A.): 1.7%
 - 1996 (Atlanta): 10.4% (of U.S. athletes)
 - 2000 (Sydney): 5.5%
 - First attempt at restriction of medication use, in that an athlete simply needed to notify of the intention to use a bronchodilator



Prevalence

- **Winter Olympic Data**
 - **1998: U.S. Olympic Team (Nagano)**
 - **Exercise-challenge either immediately around competition or after a mock competition**
 - **Biathlon, cross-country ski, figure skating, ice hockey, nordic combined, speed-skating included**
 - **Positive test considered drop in FEV1 of 10%**
 - **23% incidence across all sports and genders**
 - **26% of females, 18% of males**
 - **50% incidence among cross-country skiers**
 - **Three medal winners were positive**
 - **Wilber, RL et al. Med Sci Sports Exerc 2000. 32(4):732-7**

Prevalence

– 2002 (Salt Lake City)

- **First time objective evidence required**
 - Increase of FEV1 of 12% over predicted after bronchodilator administration
 - Reduction of FEV1 of 10% in response to exercise/EVH
 - A positive methacholine/histamine challenge
- **147/163 applications had accompanying evidence**
- **130 applications approved (5.2%)**
- **Median decrease in FEV1 was 15.9%**
- **Median rise in FEV1 to bronchodilation was 16.2%**
 - Anderson SD et al. J Allergy Clin Immunol 2003. 111(1):45-50.

Prevalence

- Athens, 2004
 - 10,653 athletes
 - 4.6% applied for use of bronchodilators
 - 4.2% approval



Getty Images / Jacques Demarthon

Prevalence

Other studies involving elite endurance athletes:

- **Competitive swimmers: 36-79%**
- **Track and Field athletes: 10% of men, 26% of women, using 10% decrease in FEV1 as marker**
- **Cross-country skiers: 42%**
- **Ice hockey players**
 - **Female: 21%**
 - **Male: 11.5%**
- **Professional male cyclists: 52%**



Pro's Who Have Asthma:

- **Isiah Thomas – NBA**
- **Jerome Bettis - NFL**
- **Dominique Wilkins - NBA**
- **Gary Roberts - NHL**
- **Donnell Bennett - NFL**
- **Amy Van Dyken - Olympic Gold Medallist (swimming)**
- **Jackie Joyner-Kerse - Olympic Gold Medallist (track & field)**
- **Greg Louganis - Olympic diver**

Asthma and Mortality

- **In the U.S.**
 - 1994-1996: 2.1 deaths/100,000
 - 2000: 1.6
 - 2001: 1.5
 - 2002: 1.4
- **This decline may be linked to more frequent use of inhaled corticosteroids**

Exercise, Asthma and Mortality

- In a substantial portion of fatalities, deterioration is rapid
 - “Sudden asphyxic asthma”
 - These people are not found to have evidence of typical mucous plugging at autopsy
 - Fewer eosinophils in the airway submucosa

Exercise, Asthma and Mortality

- **Severity of asthma at the time of death was as follows:**
 - **Trivial/Mild: 13%**
 - **Moderate: 22%**
 - **Severe: 65%**
- **34% had no limitations or only sport-related limitations**
- **58% had sudden onset of their fatal attack**
- **29% of deaths were classified as preventable**
 - **35% inadequate assessment of prior asthma or therapy**
 - **33% poor compliance**

Exercise, Asthma and Mortality

- Review of all U.S. athlete deaths during or immediately after sporting activity between 1993 and 2000.
- Suspected asthma deaths were followed up with review of autopsy records and personal contact with the victim's family to obtain:
 - Specific information about circumstances surrounding the death
 - Medical history
 - Sports involvement
 - Medication history

Exercise, Asthma and Mortality

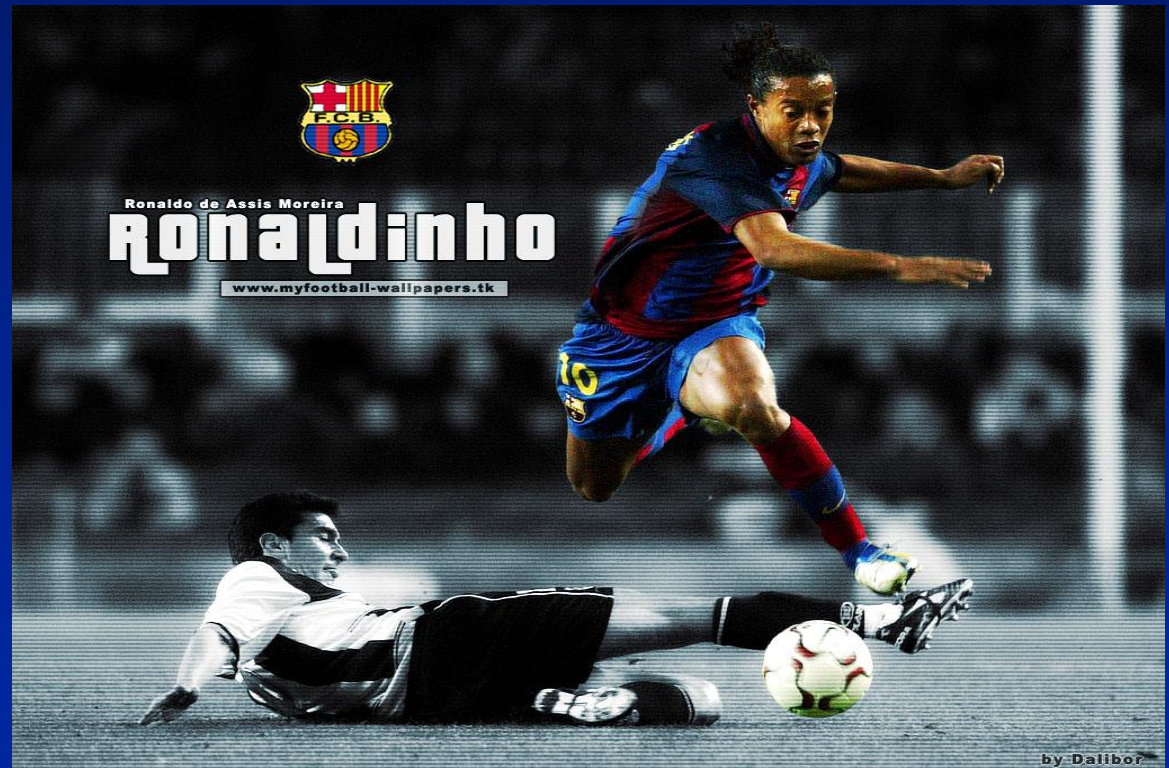
- **Secondary sources used to supplement information when necessary.**
- **263 possible cases**
- **61 deaths met criteria for inclusion**
 - **Caucasian deaths outpaced African-Americans 2:1**
 - **Most subjects were males < 20 y.o. (average age 10-14)**

Exercise, Asthma and Mortality

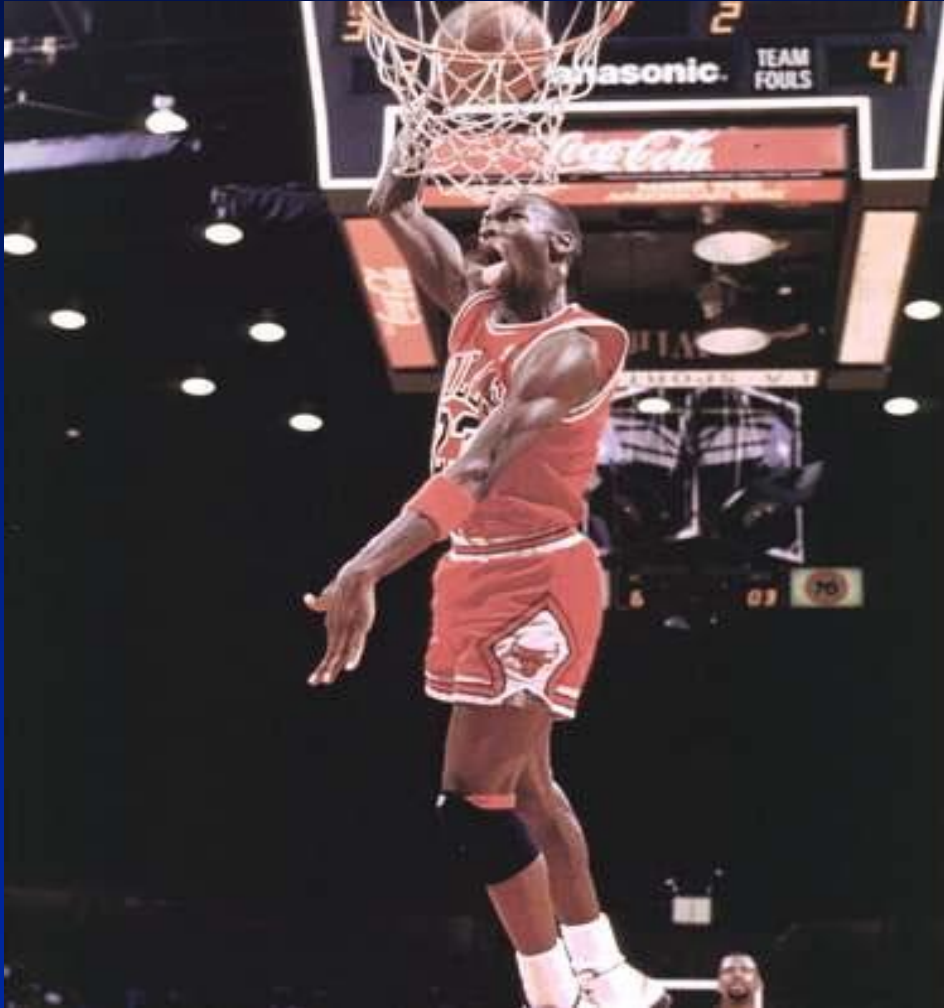
- 35/61 asthma fatalities involved competitive athletes
- 18/35 had their fatal event during participation in sport
 - 14/18 during practice
 - 4/18 during a game/meet
 - Basketball and track were the two most common sports involved

Asthma and Mortality

- Asthma can increase the morbidity of associated medical conditions
 - Sickle cell trait
 - Heat-related illness



Asthma and Mortality



- To summarize
 - Athletes do die from asthma
 - The asthma that kills athletes is often classified as mild
 - Pathologically, the airways of some of these victims do not appear to be consistent with traditional asthma

ASTHMOGENIC SPORTS ACTIVITIES

- **Most asthmogenic: highest minute ventilation**
 - **Basketball**
 - **Cycling**
 - **Long distance running**
 - **Soccer**
 - **Cold air sports: Cross country skiing; Hockey; Skating**

(Storms, WW. *Medical Science and Sports Exercise* (1Suppl):S33-8.1999.)

EIB AGGRAVANTS

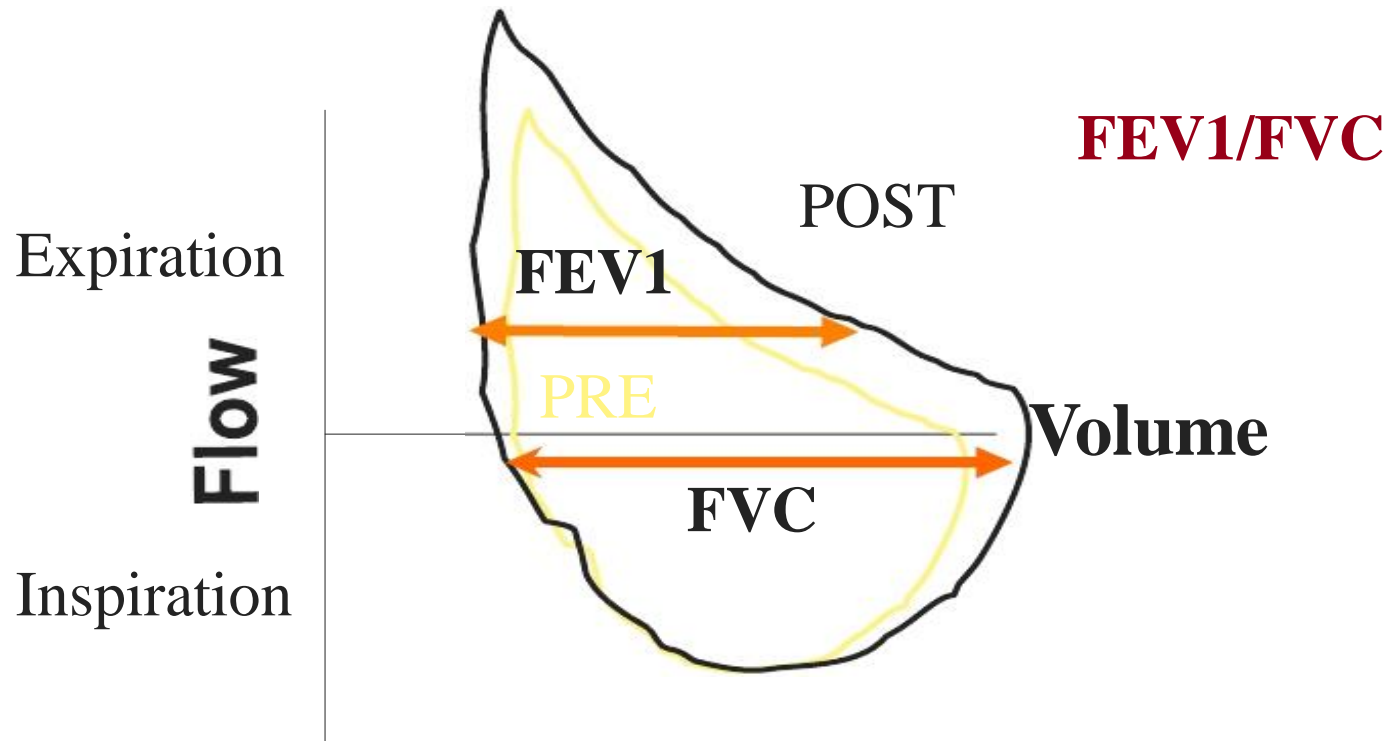
- **Continuous exercise from 6-8 minutes at 80-90% maximum heart rate**
- **Cold and/or dry weather**
- **Atopy**
- **Air pollution (e.g. ozone, nitrogen oxides, sulfur dioxides)**
- **Poorly controlled asthma**
- **Viral Infection**
- **Sinusitis**
- **Uncontrolled GERD ???**
- **Poorly controlled rhinitis**

(Storms, WW. Medical Science and Sports Exercise (1Suppl):S33-8.1999.)

Asthma – Unrecognized Severity

- **364 exercise tests performed between 9/87 and 10/88 on patients with possible EIA.**
 - **Positive test defined as fall in FEV1 of 20%**
 - **173/364 were positive tests**
 - **21/173 exhibited a fall in FEV1 of over 50%**
 - **4/21 exhibited cyanosis, general malaise, hypertension or impairment of speech (2.3% of positive tests)**
 - **These four patients did not differ from the group of 21 in terms of baseline FEV1**

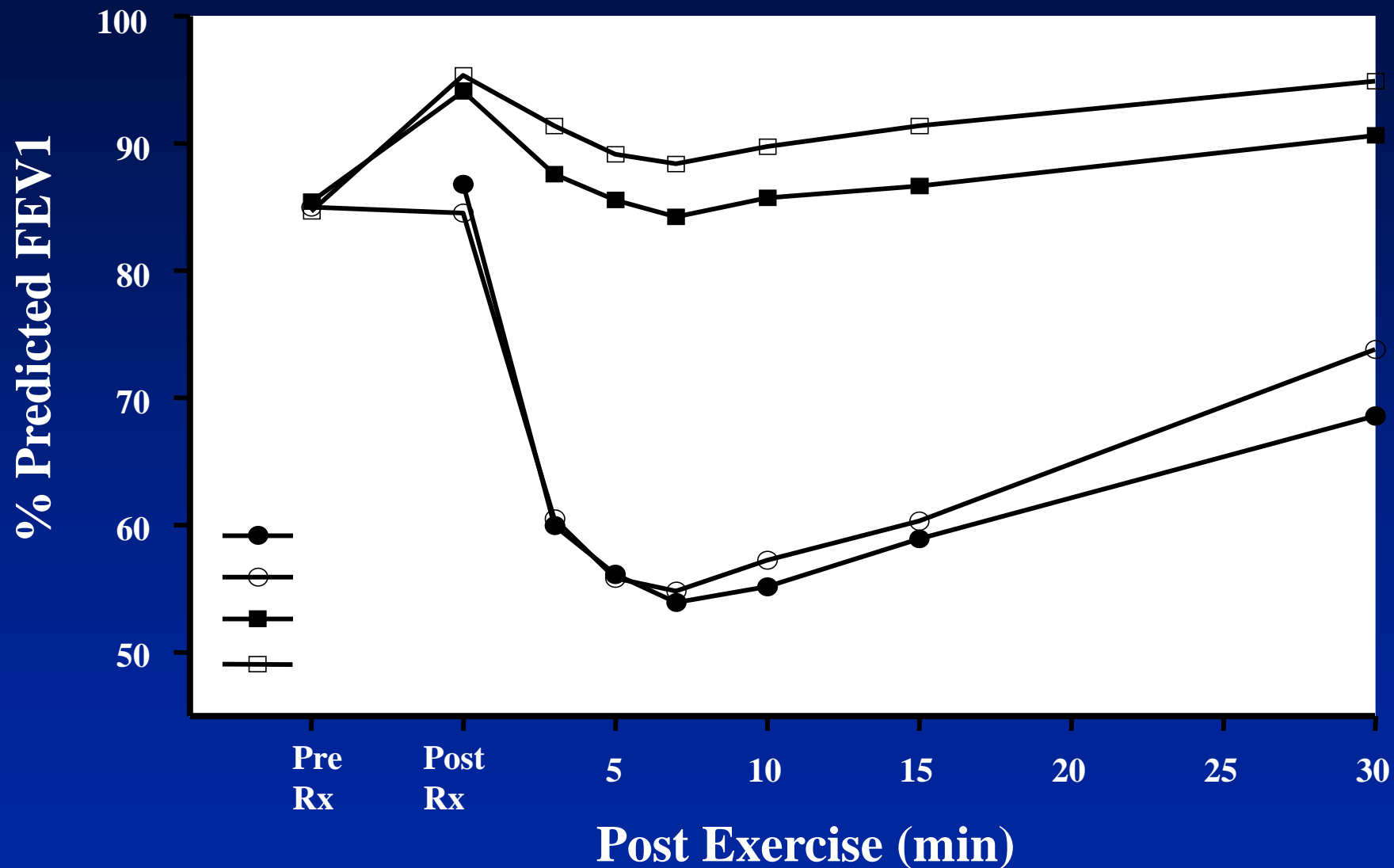
CRUCIAL testing: pre and post bronchodilator spirometry



Spirometry

- Confirm the diagnosis
- Assess both risk and impairment
- Assess response to therapy – whether asthma is controlled

Changes in FEV1 Before & After 8 minutes Cycling Exercise in 27 adult asthmatics



Anderson SD et al Med Sci Sports Exere 2001; 33:893-900.

Relationship between Airway Obstruction & Respiratory Symptoms

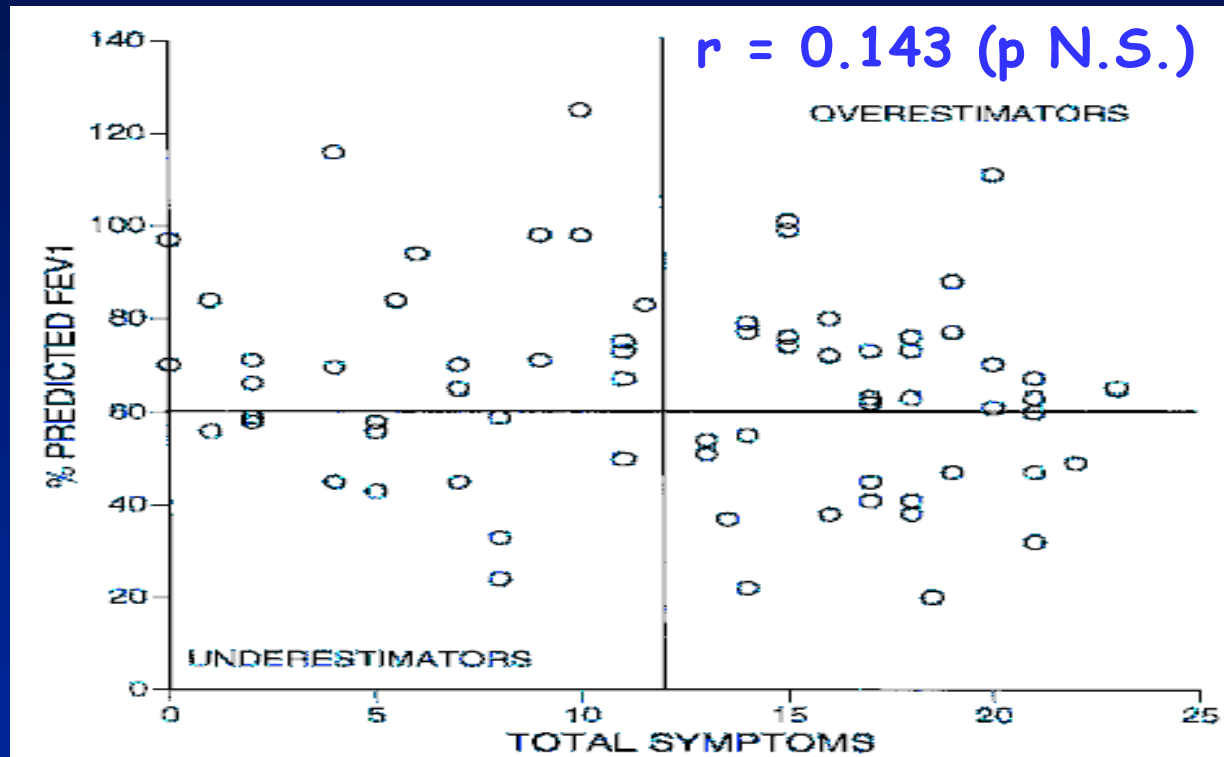
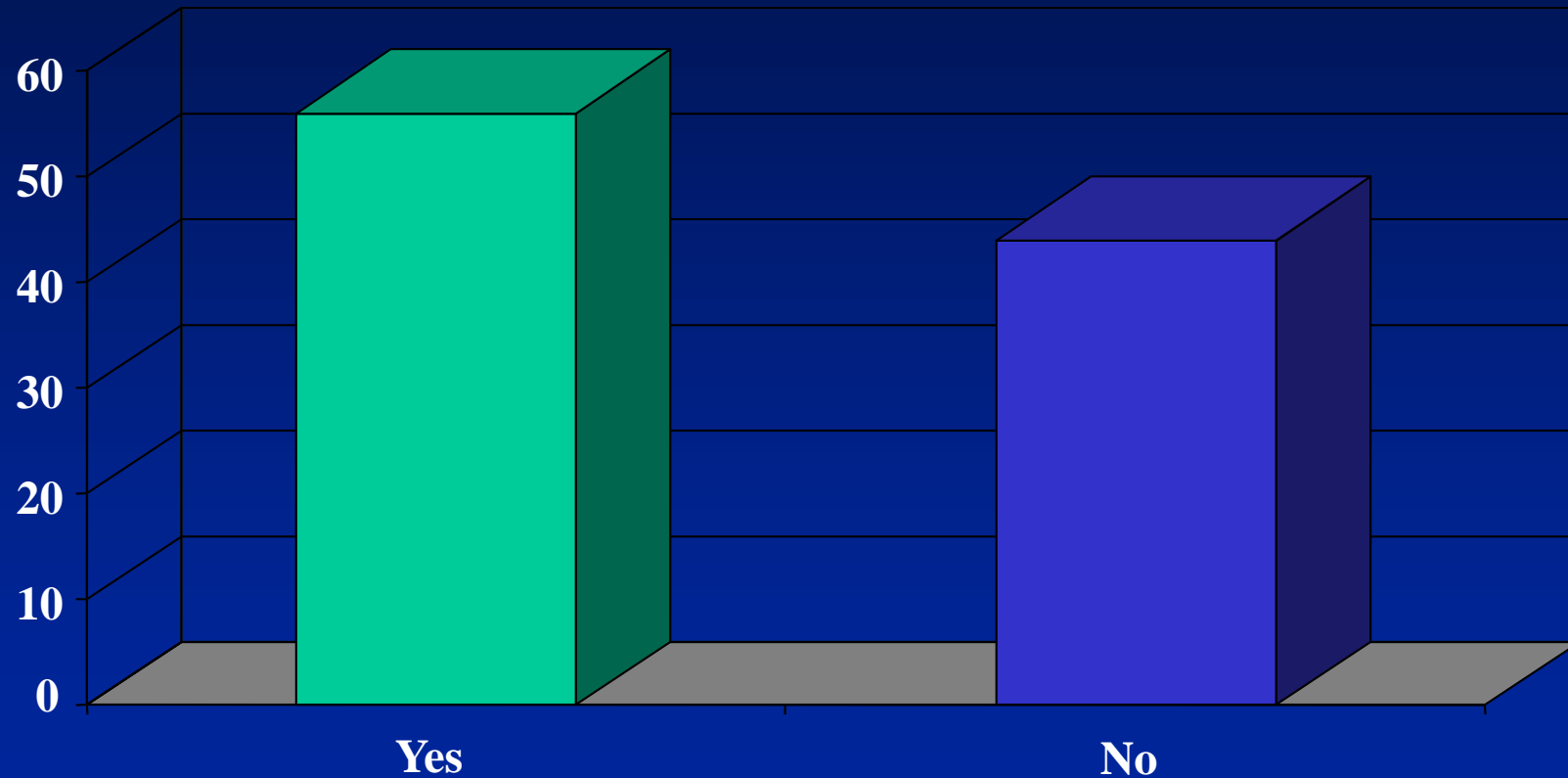


FIGURE 1. Relationship between total asthma symptoms and FEV₁ ($r=0.143$; $p=0.237$; $n=70$). Lines are drawn at a total asthma symptom score of 12 and FEV₁ of 60% predicted (see text).

Symptoms and Lung Function:

“If you felt this way at home, would you use your inhaler?”

Intermittent Asthma: FEV₁: 97.5 %



Mecholyl Challenge: PC₃₀

Asthma – Poor control

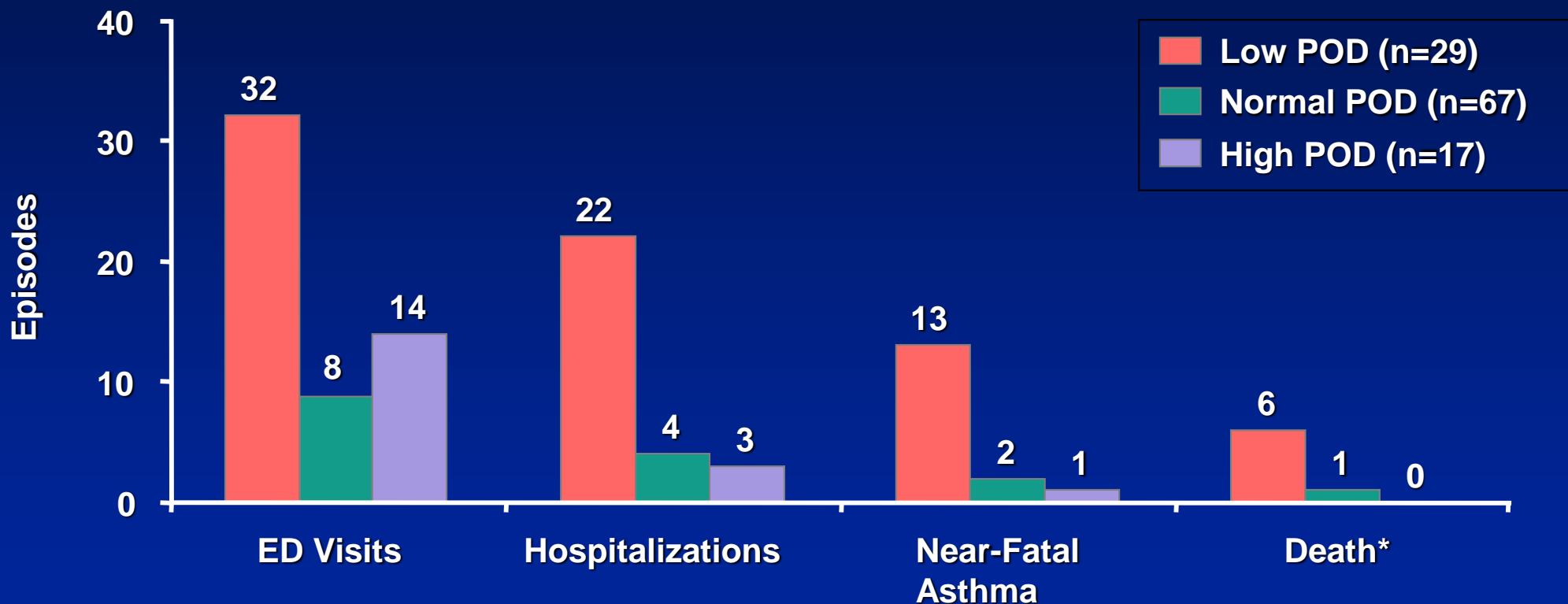
- **Without spirometry, providers often overestimate the degree of asthma control of their patient**
 - Nair SJ et al. J Pediatr 2005;147:797-801
- **Control of asthmatics with the diagnosis is often suboptimal**
 - **85% of known asthmatic athletes, using their recommended medication, failed their free running test by a >15% drop in PEFr**
 - Hammerman SI et al. Ann Allerg Asthma and Immunol 2002;88:380-84

Factors Complicating Measures of Control: Poor Perception of Dyspnea (POD)

113 Asthmatics Evaluated

- Breathe against 2-way valve load of 0-, 5-, 10-, 20-, and 30-cm H₂O for 1 minute
- Dyspnea defined as modified Borg scale versus 100 controls (normal = mean +/- 1 SD)
- POD
 - Low 29 (26%)
 - Normal 67 (59%)
 - High 17 (15%)
- β_2 -Agonist use in 4 weeks*
 - Low 1.7 puffs/day
 - Normal 2.4 puffs/day
 - High 4.1 puffs/day
- Patients with asthma and a low POD had tendency toward
 - Older age
 - More females
 - Longer duration
 - More severe
- Documented events over 2 years

Factors Complicating Measures of Control: POD



ED = emergency department.

*Of deaths, 4 were asthma related, 2 were unknown.

$P < .01$ for low POD vs normal and high POD for all 4 end points.

Adapted with permission from Magadle R et al. *Chest*. 2002;121:329-333.

Screening and Diagnosis

- **Most studies not shown history to reliably distinguish individuals with or without EIB**
 - 39% of those with positive challenge had no symptoms
 - 45% with a negative challenge did have symptoms
- **Empiric treatment will will treat a high number of patients without EIA**
- **Personal history of asthma strongly correlates to a likelihood of a positive test**
- **Less correlation in highly trained individuals**

Screening and Diagnosis

- **Patient with baseline mild intermittent asthma as defined by NHLBI definitions**
 - Could forego testing – FEV1 drop usually low
 - If testing is done it should be either
 - Exercise provocation
 - Indirect challenge
- **Patients with persistent asthma**
 - Obtain exercise testing to assess level of control on medication during activity
- **Asymptomatic athletes**
 - Exercise testing to detect significant drop in FEV1

Screening and Diagnosis

- **Testing symptomatic athletes without an asthma diagnosis and no symptoms otherwise**
 - **Exertion challenge or other indirect test to establish reactivity to exercise**
 - **Methacholine challenge test to determine generalized bronchial hyper-responsiveness and atopy**
 - **A positive test here would guide you toward use of an inhaled corticosteroid if needed to control symptoms**

Differential Diagnosis

- **Paradoxical Vocal Cord dysfunction**
 - Paradoxical closure of the vocal cords with exercise
 - Inspiratory stridor
 - Throat tightness
 - Symptoms resolve within minutes of stopping exercise
 - Should consider testing at initial patient presentation or at follow-up testing if patient is not progressing as expected

Vocal Cord Dysfunction

- **Vocal Cord adduction is best diagnosed via direct visualization immediately after exercise**
- **Often will see erythema or inflammation of the cords from acid reflux**



Exercise-Induced Anaphyllaxis

- Exercise-related respiratory distress
- Pruritis
- Generalized urticaria
- Angioedema
- Can develop vascular advance
- Can be triggered by stress, cold air, aspirin

Other Differential Diagnosis

- **Idiopathic arterial hypoxemia**
 - Affects women more than men
 - Data in children/adolescents lacking
 - Can reduce peak oxygen consumption and thus exercise performance
- **Anxiety/hyperventilation**
- **Cardiac disease**
- **Cystic Fibrosis**

Management – Physical Training

- Fitness levels ($\text{VO}_{2\text{MAX}}$) in people affected with EIA are often suboptimal through self-selection of sedentary activity
- Increasing fitness level does not usually reduce the tendency for bronchospasm at high exercise intensity levels
- EIA is provoked when the anaerobic threshold is passed
- As fitness increases, and the anaerobic threshold increases relative to maximal oxygen consumption, absolute ventilatory demand at a given workload is reduced, reducing overall symptoms and reducing the need for use of rescue medication

Management

Respiratory Muscle Training

- **Some studies have shown this decreases perception of dyspnea and β -2 agonist consumption in patients with mild to moderate asthma**
 - Weiner P et al. Chest 2002. 122(1):197-201
- **Cochrane review noted a definite increase in strength with training but felt that overall data was insufficient to characterize any exercise benefit**
- **More clear-cut benefit in patients with more significant ventilatory limitation (FEV1 between 40% and 60% of normal)**

Management

Use of Refractory Period

- A prolonged submaximal warm-up period (20-30 minutes at 50-60% of maximal heart rate) or 6 minute high-intensity warm-up period
 - Can result in refractoriness to exertional bronchospasm that can last 2-3 hours
 - Occurs in about 50% of asthmatic athletes
 - Has been shown to augment the effect of β -2 agonist medications as well as exert an independent effect.
 - Mickleborough TD et al. Int J Sports Med 2007.28(6):456-62

Management

Rewarming masks

- Prevents both heat and moisture loss during exercise
- Significantly reduces the drop in FEV1 in randomized trials

– Nisar M et al. Thorax 1992. 47(6):446-50

Inhaler Use Checklist and Common Errors

Checklist of steps	Problems & Common Errors
<ol style="list-style-type: none">1. Remove cap2. Hold inhaler upright and shake well3. Breathe out gently4. Put mouthpiece between teeth without biting and close lips to form good seal5. Start to breathe in slowly through mouth and press down firmly on canister6. Continue to breathe in slowly and deeply7. Hold breath for about 10 seconds or as long as comfortable8. While holding breath, remove inhaler from mouth9. Breathe out gently away from mouthpiece10. If an extra dose is needed, wait 1 minute and then repeat steps 2 to 911. Replace cap	<p>Inability to coordinate activation with inhalation</p> <p>Failure to hold breath for a sufficient time</p> <p>Multiple actuations without waiting or shaking in between doses</p> <p>Incorrect position of inhaler</p>

Spacer Effect on Deposition



Management - Medications

- **β -2 agonists (albuterol, formoterol, salmeterol) are smooth muscle relaxants**
 - Dose at least 15 minutes prior to exercise (90 minutes for salmeterol)
 - Prevent or reduce symptoms in 90% of patients
 - Potential for loss of efficacy of meds – should not be regularly used long-term

Management - Medications

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Management - Medications

- **Leukotriene antagonists**
 - **Montelukast has shown benefit as a prophylactic agent in children and adults with EIB**
 - **Leff JA et al. NEJM 1998;339:147-52**
 - **Kemp J et al. J Pediatr 1998;133:424-8**
 - **Effect of these medications does not decrease over time**

Management - Medications

- **Corticosteroids**
 - No benefit conferred in isolated EIB
 - May be beneficial if athlete is atopic
 - Proven to help maintain control (preserve FEV1) in the large proportion of patients with an exertional component to their asthma

Management - Medications

- **Treatment of associated rhinitis**
 - **Uncontrolled rhinitis promotes mouth breathing and less air filtering, warming & humidification**
- **Use of nose breathing when possible**
- **Development of an emergency action plan**