Exercise-Induced Bronchoconstriction

Celebrating 50 Years

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• Airway cooling • Refractory period • Athletes

The study of exercise-induced bronchospasm (EIB), alternatively called exercise-induced asthma (EIA), by many investigators over 50 years provides an outstanding example of how the techniques of classical physiology were applied in an attempt to determine the mechanisms underlying a troublesome clinical problem. Following the trail of this research in a more or less historical order enables the acknowledgment of the contributions of these investigators and follows the manner in which physiologic research was logically applied.

Perhaps the earliest description relating asthma to exercise was by Arataeus the Cappadocian around end of first century AD, as related by Brewis[1]:

> *If from running, gymnastic exercises, or any other work, the breathing become difficult, it is called Asthma (αστμα)*

The initial classical description of EIB was published in 1717 in a book by Sir John Floyer,[2] himself an asthmatic, who wrote:

> *All violent exercise makes the asthmatic to breathe short—and if the exercise be continued it occasions a fit.*

IS EIB A PROBLEM THAT NEEDS ATTENTION?

The practical implications of EIB were that 50 to 60 years ago, many asthmatics avoided exercise either from past personal experience of EIB or because parents restricted their children's involvement in sports and exercise. Such avoidance of

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physical activity was unfortunate because the lower a person's aerobic fitness, the higher the percentage of their maximum oxygen consumption ($V_{O_2\ max}$) that is required to perform an exercise task.[3] Because the onset and severity of EIB is related to exercise intensity,[4] improved aerobic fitness allows asthmatics to undertake the same exercise at a lower percentage of their $V_{O_2\ max}$ and thus reduce the resultant EIB.[5] Conversely, in the very unfit, EIB is likely to appear even at low levels of exercise. However, although unaware of these principles of exercise physiology, there was a minority who had an alternative view that somehow exercise would benefit asthmatics and demonstrated this admirably. Theodore Roosevelt, who was President of the United States from 1901 to 1908, was a sickly child because of severe asthma. During adolescence, on advice from his physician, he undertook a program of vigorous exercise to grow into a fine athlete when he entered Harvard, only mildly inconvenienced by asthma.[6] Others would emulate Roosevelt and achieve great sporting success. One notable person was Dawn Fraser, from Australia, who commenced swimming "to lick asthma" and won the 100-m freestyle at 3 consecutive Olympic Games in 1956, 1960, and 1964, despite being troubled with asthma before her 1964 race.[7] Subsequently, the better understanding of the physiology of EIB and the benefit of a range of effective preventer medications has allowed those prone to EIB to achieve a level of fitness and enjoy a physical lifestyle comparable to their counterparts without EIB.[8]

1946–1970: EARLY MODERN ERA—ESTABLISHING BASIC FEATURES OF EIB

In 1946 Herxheimer[9] described 6 asthmatics with hyperventilation asthma, but in fact he meant hyperventilation induced by exercise. He made a most important observation, namely that the asthma (EIB) usually occurred after stopping exercise and not during the exercise.

A series of definitive studies of EIB were undertaken by a Liverpool, UK pediatrician, R.S. Jones,[10,11] and his colleagues from 1962 onwards,[12] which outlined almost all the important physiologic features. Brief exercise (running) of 1 to 2 minutes produced a rise in forced expiratory volume in 1 second (FEV_1) within 1 minute after stopping exercise, whereas prolonged exercise of 8 to 12 minutes produced a decrease in FEV_1, reaching its lowest level 1 to 5 minutes after exercise, which then rapidly returned to the resting level. **Fig. 1** shows an exercise challenge in a child with marked EIB in which there was a decrease of 55% in FEV_1 after exercise. They noted that the

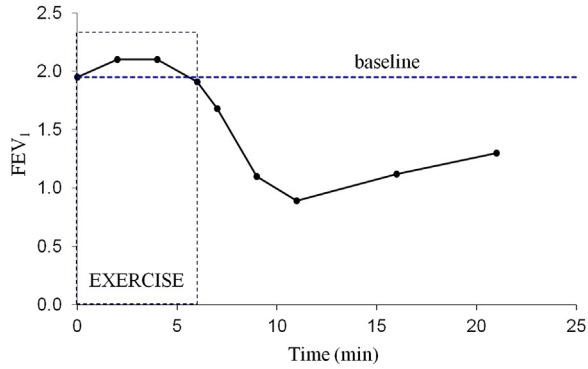

Fig. 1. Exercise-induced bronchoconstriction in a child who ran for 6 minutes on a treadmill. During the exercise there was a small rise in FEV_1. After stopping exercise, FEV_1 decreased to its lowest level 12 minutes after the end of exercise and then began to return to baseline.