

## EXCESS POST- EXERCISE OXYGEN CONSUMPTION- A REVIEW

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### ملخص

منذ مطلع القرن التاسع عشر أشارت تقارير عدة إلى زيادة استهلاك الأوكسجين في الفترة التي تلي أداء نشاطاً بندياً (فترة الاسترداد) هذه الزيادة في استهلاك الأوكسجين سميت بالدين الأوكسجيني لفترة طويلة من الزمن حتى استقر كثير من الباحثين إلى تسميتها بالاستهلاك الأوكسجيني في فترة الاسترداد. يمكن تقسيم منحني الاستهلاك الأوكسجيني في فترة الاسترداد إلى عدة عناصر. العنصر السريع، ويتم التحدر فيه في غضون دقيقتين، بينما العنصر البطيء يبقى لمدة تتراوح ما بين ١٠ - ٩٠ دقيقة، حيث يعتمد ذلك على شدة ومدّة النشاط البدني، بعد ذلك يظل معدل الاستقلاب في فترة الاسترداد أعلى مما هو عليه في فترة الراحة بحوالي ١٠ - ٢٠٪ ويستمر ذلك النشاط إلى ساعتين أو أكثر بعد انتهاء التمرين حيث يطلق على هذه الفترة بالعنصر البطيء جداً ويمكن معرفة السبب في ارتفاع استهلاك الأوكسجين في فترة الاسترداد بالنظر إلى التغيرات الكيميائية والفسيولوجية التي تحدث في الخلايا أثناء النشاط البدني والذي تستمر لفترة الاسترداد وتسبب ارتفاع الاستهلاك الأوكسجيني بخلايا العضلات وبما أن الميتوكوندريا هي المكان الذي يستهلك فيه الأوكسجين في الخلية فإن أي محاولة لتفسير هذا الارتفاع في استهلاك الأوكسجين أثناء فترة الاسترداد يجب أن يكون مردها إلى الخلية. هذه الورقة سوف تستعرض معظم العوامل التي تساهم في ارتفاع الاستهلاك الأوكسجيني أثناء فترة الاسترداد. كما أن هذه الورقة سوف تطلع القاريء على الأهمية والخلفية التاريخية للاستهلاك الأوكسجيني أثناء فترة الاسترداد.

### Abstract

Since 1910 numerous investigators have reported an increase in oxygen consumption above resting levels in the period after exercise. This extra oxygen consumption after exercise has been referred to as excess post-exercise oxygen consumption (EPOC). Two principal components identified by the rate of decay in oxygen consumption following exercise were called fast and slow. The decline of the fast component is complete in about 2 minutes, whereas the slow component can last anywhere from 10 to 90 minutes depending on the intensity and duration of exercise. Also, the metabolic rate could be 10 to 20% above the pre-exercise value for 1.5 to 2 hours after the cessation of physical activity. This is referred to as the "ultra-slow" component of EPOC. The EPOC can be explained by the chemical and physical changes that occur in tissues during exercise and persist into recovery, and that cause the muscle cells (and cells in other tissues) to elevate oxygen consumption. Explanation of the elevated post-exercise oxygen consumption rests with mitochondria. Direct control of mitochondrial respiration might be exerted by the concentrations of ADP, ATP, inorganic phosphate, and creatine phosphate. Indirect control of mitochondrial respiration include many factors such as catecholamines, thyroxine, glucocorticoids, fatty acids, calcium ions, and temperature. This paper reviews all these factors along with a discussion on the historical background and significance of EPOC.

### Historical background and significance

Studies examining the increase in metabolic rate following acute exercise date back to the early 1900s. According to Mole (1), the first to study the time course of oxygen consumption during recovery from exercise were Krogh and Lindhard (2,3). Gasser and Brooks (4) stated that since 1910 numerous investigators have reported an increase in oxygen consumption ( $\text{VO}_2$ ) above resting levels in the period after exercise. This extra oxygen consumption after exercise has been referred to as oxygen debt (5), recovery energy expenditure (1,6,7), and excess post-exercise oxygen consumption (EPOC) (4). Gasser and Brooks (4) indicated that the term "O<sub>2</sub> debt" has the advantages of recognition and implicit reference to a vast scientific literature; however, continued use of this term has several limitations. Gasser and Brooks (4) suggested that the term "O<sub>2</sub> debt" should not be used as it implies a causality that is contrary to what is known about post-exercise metabolism. They also argued that some factors influencing the post-exercise  $\text{VO}_2$  such as catecholamines, substrate cycling, and body temperature, may not represent recovery per se, but rather may be a part of the metabolic disturbance. Therefore, Gasser and Brooks proposed the use of the alternative term "excess post-exercise oxygen consumption". They argued that this term avoids any implication of causality in identifying the elevation in metabolic rate above resting levels after exercise. Furthermore, they added that the descriptive term EPOC does not bias the hypothesis that the EPOC must be understood in terms of those factors that influence mitochondrial respiration.

Although it is a controversial topic, EPOC may have important and significant implications for the control of body mass (8). In fact, EPOC is often cited as playing an important role in significantly increasing energy expenditure in weight loss programs that employ exercise (9). It is clear that the energy expended during physical work is only a fraction of the total increase in energy