Assessing Respiratory Function and Metabolic Response: The Importance of Cardiopulmonary Exercise Test (CPET) Parameters

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Abstract

Cardiopulmonary Exercise Test (CPET) is a method for assessing physical performance and aerobic capacity by examining the performance of the cardio-respiratory system, the musculoskeletal system and metabolism by monitoring parameters and reactions under the influence of dosed physical exertion. The following are examined: - ventilation and gas exchange parameters; and - cardiac activity parameters, which allow assessing the work metabolism, which is the basis of physical performance. For this purpose, it is necessary to use a spirometric system - open or closed and a load device that allows dosing physical work. The method was introduced in 1929 by Knipping and Brauer (Hollmann & Prinz, 1997). In CPET testing, loads involving the lower extremities are most often preferred, which can be dosed. The specificity of the sports discipline or the skills of the person being tested are also criteria for the type of load. Key CPET parameters offer valuable information about physiological function. Oxygen uptake (VO_2), particularly maximal oxygen consumption (VO_2 max), is considered the gold standard for assessing aerobic capacity and overall fitness. It reflects the efficiency of oxygen delivery and utilization by the body. Carbon dioxide production (VCO_2) and the respiratory exchange ratio (RER) help determine metabolic activity and substrate utilization, indicating whether energy is derived primarily from fats or carbohydrates during exercise. Ventilatory parameters such as minute ventilation (VE) and the VE/VCO_2 slope are critical for evaluating breathing efficiency. An elevated VE/VCO_2 slope may indicate ventilatory inefficiency and is often associated with cardiovascular and pulmonary diseases, including heart failure and pulmonary hypertension. The ventilatory threshold (VT), also referred to as the anaerobic threshold, marks the point at which lactate begins to accumulate in the blood. This parameter is especially useful for determining endurance capacity and prescribing individualized training intensities (Tsvetkova-Gaberska et al., 2023). Additional indicators, such as oxygen pulse (VO_2/HR), provide insight into cardiac function, particularly stroke volume and cardiovascular efficiency. Breathing reserve helps identify whether exercise limitation is due to pulmonary constraints. Together, these variables allow for a comprehensive assessment of exercise tolerance and the identification of limiting factors. Clinically, it supports early detection of cardiopulmonary and metabolic disorders, risk stratification, and evaluation of treatment outcomes. In sports

science, it aids in optimizing performance and monitoring training adaptations. Furthermore, it is widely used in rehabilitation and preoperative evaluations to assess functional capacity and predict patient outcomes. In conclusion, CPET-derived parameters provide a holistic and integrative view of human physiology under stress. Their ability to simultaneously assess multiple systems makes this method an indispensable tool in modern medicine and exercise science, contributing to improved diagnosis, personalized interventions, and enhanced performance outcomes.

Keywords

Cardiopulmonary Exercise Test (CPET), Gas Exchange, Respiratory Function, Metabolic Response

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