International Journal of Art, Culture, Design, and Technology
Volume 11 • Issue 2

New Notes on the Cardiorespiratory Capacity of Dancers:
A Narrative Review

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ABSTRACT

Cardiorespiratory capacity is one of the most important components of our physical fitness. How much this ability is required in dance depends on factors such as dance mode, duration, and intensity of step sequences and choreographies, and even the hierarchical position that the dancer occupies within a company. Although far from the values found in athletes, the cardiorespiratory capacity of dancers is good compared to the general population. Although the theme was explored in the 1980s, there are many points that still need further investigation, such as the relationship between this capacity and the performance of a dancer, how to include in the routine of a dancer, isolated workouts. Still, the evaluation of this ability in dancers seems not yet to happen in the dance routine, even with field tests, such as Dance Specific Aerobic Fitness Test (DAFT), already validated and presented in the literature. Why? These are some of the issues addressed in this narrative review.

KEYWORDS

Aerobic Capacity, Aerobic Fitness Test, Ballet, Cardiorespiratory Fitness, Contemporary Dance, Dance, Oxygen Consumption, Performance

INTRODUCTION

Cardiorespiratory Capacity

The cardiorespiratory capacity is the capacity to sustain moderate and high-intensity dynamic efforts for a prolonged duration. It is also the ability to resist fatigue during an exercise. The cardiorespiratory capacity is related to the body's ability to capture, transport and use oxygen (O_2) to produce the energy needed for the muscles to tolerate effort (Pescatello et al., 2014; Albouaini et al., 2007).

Thus, for an excellent cardiorespiratory capacity is fundamental the integrated work between 1) the pulmonary system, responsible for the capture of O_2 in the air through ventilation; 2) the cardiovascular system, responsible for transporting O_2 to the muscles; and 3) the muscle system,

DOI: 10.4018/IJACDT.305795 *Corresponding Author

where O_2 will contribute to energy production, making possible the maintenance of physical exertion (McArdle et al., 2015; Kraemer et al., 2000).

The oxygen volume (VO_2) consumed during exercise is usually measured in ml/kg/min or L/min. The maximum oxygen volume (VO_{2max}) is the highest value of VO_2 reached, with the development of a plateau in the VO_2 curve during a progressive effort. In 1923 Hill and Lupton noticed a limit to the maximum oxygen consumption that an individual could achieve even in the face of an exercise load implement (Hawkins et al., 2007). The VO_{2max} commonly represents cardiorespiratory fitness. The higher the VO_{2max}, the greater the cardiorespiratory capacity of the subject (Brito et al., 2002).

Another essential concept is the metabolic transition thresholds, which are specific points where changes occur in metabolism to maintain the energy production demanded at a certain intensity of exercise. During each threshold, individuals present an aerobic or anaerobic predominance of metabolism for energy production. These transition points can be directly evaluated by blood or indirect lactate concentration by ventilatory and gas exchange responses (Ribeiro, 2005; Binder et al., 2008).

The first metabolic threshold (threshold 1) corresponds to exercise intensity before the exponential lactate increase in the blood. According to this reference, terms such as OPLA *(onset of plasma lactate accumulation)* and lactate threshold (LT) or anaerobic threshold (AT) can be found in the literature. For the threshold definition, the concentrations of lactate in the blood can be considered, which should at this point be varying between approximately 1.5 - 3.0 mMol. Although there is no consensus on the mechanisms that control lactate production in the blood, it is suggested that lactate levels do not vary much in exercises practised at intensities below 50 – 75% of $VO_{2max,}$ and after this intensity range, the lactate levels tend to grow abruptly (Denadai, 1995; Kindermann et al., 1979) (Figure 1).

At this first threshold, ventilation increases in response to a higher concentration of carbon dioxide (CO_2) in the blood; it is a body attempt to eliminate CO_2 by expiration. In a graphical illustration, the VO_2 line no longer accompanies the VCO_2 line (volume of carbon dioxide), and a “V” appears on the slope of the line (V-Slope), which represents the intersection between the behaviour of VO_2 to VCO_2 (Wasserman et al., 1990).

The second threshold appears when the blood lactate concentrations reach approximately 4mMol. The CO_2 increases exponentially, and from this point, hyperventilation can no longer compensate for the increase in Hydrogen (H^+) adequately. There is a drop in end-tidal carbon dioxide ($PETCO_2$), which is the final pressure of expired carbon dioxide. This moment can be called “the maximum stable lactate phase” (MSSLAC), or “anaerobic threshold”, or “aerobic-anaerobic threshold”, or “onset of blood lactate accumulation” (OBLA), or compensation point of metabolic acidosis, which indicates the highest aerobic power of an individual. Although the intensities of these threshold are highly variable and no limit concept can accurately predict the intensity at this point, MSSLAC has a high correlation with athletic performance (Beneke et al., 2011) (Figure 1).

Compared the tolerance time, a progressive exercise slightly above threshold 1, with a constant blood lactate increase, would be endured for extended periods (~ 4 hours) and an exercise in the intensity of the MSSLAC threshold, would betolerated for 45 to 60 minutes (Faude et al., 2009). The difference in time is due to the higher intensity in the latter. Whilst in the first the subjective perception of exertion is mild, in the second, it is perceived as severe, thus the difference in the tolerated time (Binder et al., 2008).

Cardiorespiratory capacity is perceived as one of the most critical components of physical fitness. It is a strong predictor of death; hence a low cardiorespiratory capacity is associated with a higher risk of death. This factor seems to be independent of other important factors for the risk of death, such as age, ethnicity, obesity, smoking, alcohol consumption and other health conditions (Kodama et al., 2009; Lee et al., 2010; Carbone et al., 2020; Wang et al., 2020). Therefore, it is a binding capacity related to health for athletes, dancers and the general population.

Given the importance of the cardiorespiratory capacity for physical conditioning, this narrative review aims to raise what the scientific literature points out about respiratory capacity and dance,

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