

Best Practice Cardiopulmonary Fitness Assessments in Children

08/30/2021

Written by: Sarah Lessila, Undergraduate Student in Exercise Science

Mentor: Michael Danduran

Edited by: Dr. Sandra Hunter, Mike Haischer, Toni Uhrich

Key Points:

- **Aerobic fitness is an important determinant of present and future health status in children.**
- **Field assessments are more engaging and familiar to most children.**

Aerobic fitness is a significant determinant in overall health. Cardiopulmonary exercise assessment provides important diagnostic, prognostic, and evaluative health information. In children, high physical fitness has been linked to reduced risk for obesity, cardiovascular disease, and improved musculoskeletal and mental health¹. However, testing can be challenging due to developmental and physiologic differences that are unique to children. Because of the wide range in growth and maturation, a single approach to testing may not be possible and normative data can be difficult to collect and extrapolate.

Cardiopulmonary fitness testing involves the measurement of an individual performing sustained physical activity with emphasis on their circulatory and respiratory systems' ability to perfuse and supply oxygen to the body. The amount of vigorous physical activity (VPA) has been shown to have a relationship with peak oxygen consumption ($\dot{V}O_{2PEAK}$) (Figures 1 & 2)². $\dot{V}O_{2PEAK}$ can be defined as the maximal amount of oxygen a subject can consume. Therefore, $\dot{V}O_{2PEAK}$ can give indication to a subject's level of aerobic fitness.

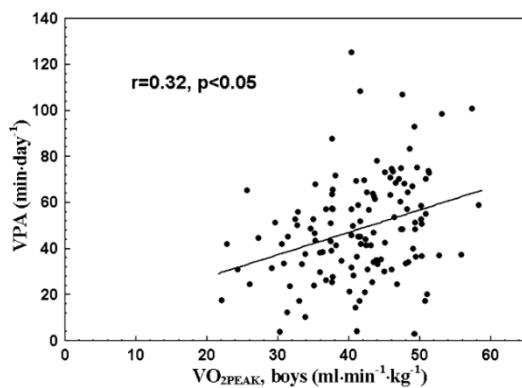


Figure 1: Relation between minutes of vigorous physical activity (VPA) per day and aerobic fitness $\dot{V}O_{2PEAK}$ ($\text{ml min}^{-1} \text{kg}^{-1}$) for boys ($n=127$)

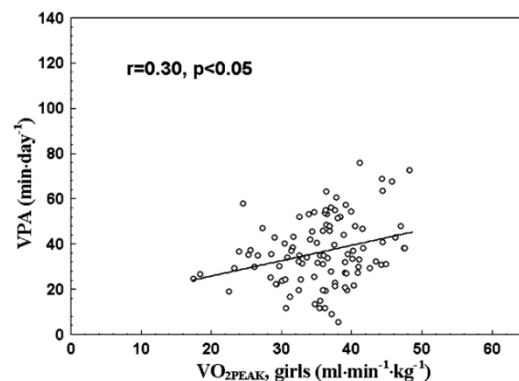


Figure 2: Relation between minutes of VPA per day and aerobic fitness $\dot{V}O_{2PEAK}$ ($\text{ml min}^{-1} \text{kg}^{-1}$) for girls ($n=101$)

Direct measures of aerobic fitness beyond the assessment of VPA can be made through non-invasive progressive exercise tests that directly measure oxygen consumption ($\dot{V}O_2$) or allows for its prediction with regression equations. Testing in a laboratory or field-based environment each pose their own advantages and limitations.

Best Practice Cardiopulmonary Fitness Assessments in Children

The laboratory setting offers sensitive high-tech equipment that provides direct measurement of $\dot{V}O_2$. However, lab testing is costly, requires trained technicians, may be limited by the availability of equipment, can present challenges regarding subject fit and familiarity, and can be time-consuming³. Yet, when performed, laboratory protocols like the Bruce treadmill protocol and the Godfrey cycle protocol are the gold standards of aerobic testing and offer high reliability and reproducible measurements¹.

Field testing provides an accessible testing environment with fewer resources needed and lower costs. Many children are familiar with field tests such as the 20-meter shuttle (also known as the PACER) and the 1-mile run/walk⁴ as they are routinely performed in the school setting; this makes testing easier to understand and complete. Field tests can be organized to complete in large groups, allowing for low operating costs and ease of application⁵. Additionally, being able to complete the assessments in group settings may have the added benefit of providing a fun and motivating experience. However, these assessments produce estimates of $\dot{V}O_2$ through equations and do not allow for the direct measure of $\dot{V}O_2$ that is possible within a lab setting.

In conclusion, there exist multiple laboratory and field protocols that are able to assess cardiopulmonary fitness in children. While laboratory testing provides a more comprehensive testing option, it can be intimidating, and can present challenges based on a child's age and abilities. Field testing has considerable advantages and application to real life activities. Easily accessible spaces and the ability to perform these assessments in large groups at minimal cost make them the most utilized. Overall, it is important to have the ability to measure aerobic fitness in children to assess health status to prevent or diagnose illness.

References

1. Takken, T., Bongers, B. C., van Brussel, M., Haapala, E. A., & Hulzebos, E. (2017). Cardiopulmonary Exercise Testing in Pediatrics. *Annals of the American Thoracic Society*, 14(Supplement_1), S123–S128. <https://doi.org/10.1513/AnnalsATS.201611-912FR>
2. Bianco, A., Jemni, M., Thomas, E., Patti, A., Paoli, A., Ramos Roque, J., Palma, A., Mammina, C., & Tabacchi, G. (2015). A systematic review to determine reliability and usefulness of the field-based test batteries for the assessment of physical fitness in adolescents - The ASSO Project. *International journal of occupational medicine and environmental health*, 28(3), 445–478. <https://doi-org.libus.csd.mu.edu/10.13075/ijomeh.1896.00393>
3. Dencker, M., Thorsson, O., Karlsson, M.K. et al. Daily physical activity and its relation to aerobic fitness in children aged 8–11 years. *Eur J Appl Physiol* 96, 587–592 (2006). <https://doi.org/10.1007/s00421-005-0117-1>
4. Plowman, S.A. (2013). Aerobic Capacity Assessments. In S. A. Plowman & M.D. Meredith (Eds.), *Fitnessgram/Activitygram Reference Guide* (4th Edition) (pp. Internet Resource). Dallas, TX: The Cooper Institute, 6-1 - 99.
5. Batista, M. B., Romanzini, C., Castro-Piñero, J., & Ronque, E. (2017). Validity Of Field Tests to Estimate Cardiorespiratory Fitness in Children and Adolescents: A Systematic Review. *Validade De Testes De Campo Para Estimativa Da Aptidão Cardiorrespiratória Em Crianças E Adolescentes: Uma Revisão Sistemática. Revista Paulista De Pediatria : Orgao Oficial Da Sociedade De Pediatria De Sao Paulo*, 35(2), 222–233. <https://doi.org/10.1590/1984-0462/2017;35;2;00002>