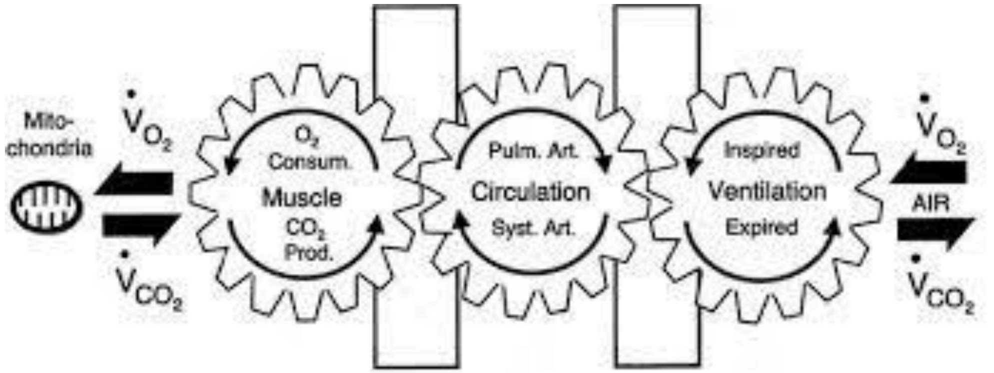
# The Lung Lab

**Dept of Respiratory & Sleep Medicine**
**Women's & Children's Hospital**




(Wasserman et al., 2005)

# Paediatric CPET – A comparison with adult CPET

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Instructor
Tim Takken

Category
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# Pediatric Exercise Testing (English)

52 Weeks | All Levels | 16 Lessons | 6 Quizzes | 37 Students


€200.00

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Overview | Curriculum | Instructor

Welcome,

This is the e-learing Pediatric Exercise Testing. During this course you will learn how to conduct a cardiopulmonary exercise test (CPET) in children and how to analyze and report CPET data. Furthermore you will learn about the exercise physiology of children and its application in healthy and diseased children. You will also learn about how to perform field tests for measuring fitness in children. The tutor for this course is Dr Tim Takken, PhD.

The course consists of 14 pre-recorded lectures, 4 quizzes and 2 case studies with pediatric CPET data. You can ask questions after every lecture. The study credit is 8 hours.

The course is completed when the student has completed at least 80% of the lessons. After completing the course the student will receive a certificate of completion. The course content is available to the students for 52 weeks.

The course is created using a professional Learning Management System.

# Common reasons for CPET referral @ WCH

Investigation of unexplained breathlessness

- Breathlessness on exercise
- Struggling with physical activity,
- Decreased exercise tolerance
- Limitation to exercise in athletes

# Common reasons for CPET referral @ WCH

If known disease – determine aerobic capacity

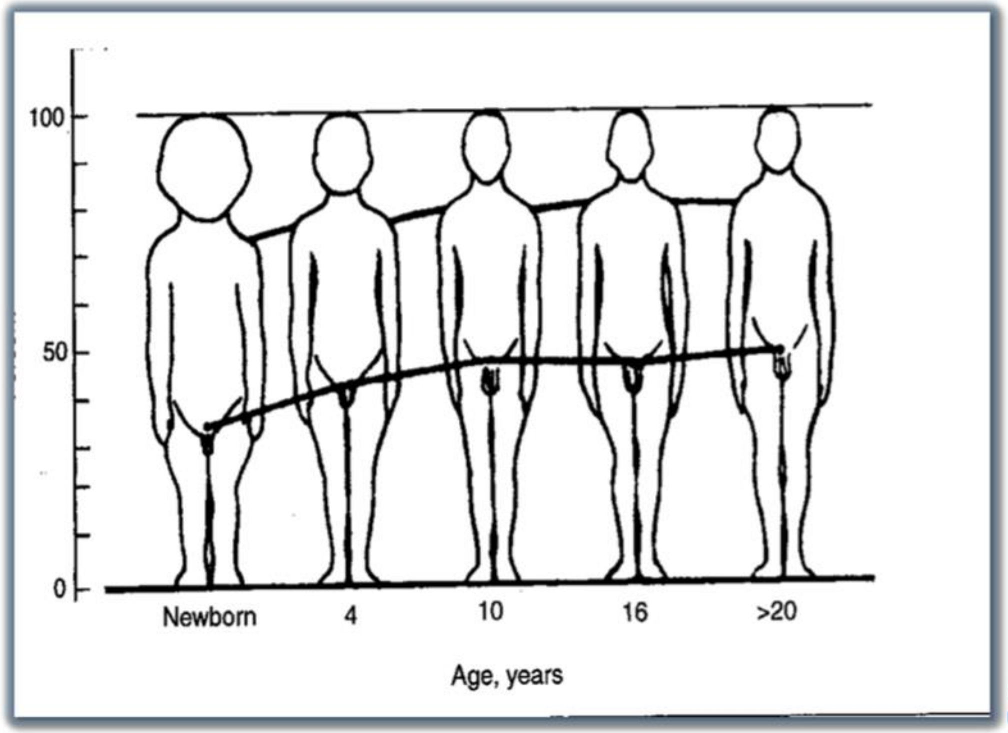
- Is their VO2 peak lower than normal?

- Pectus excavatum
- Cardiology
- Post COVID or post COVID vaccine

# Children are not mini adults

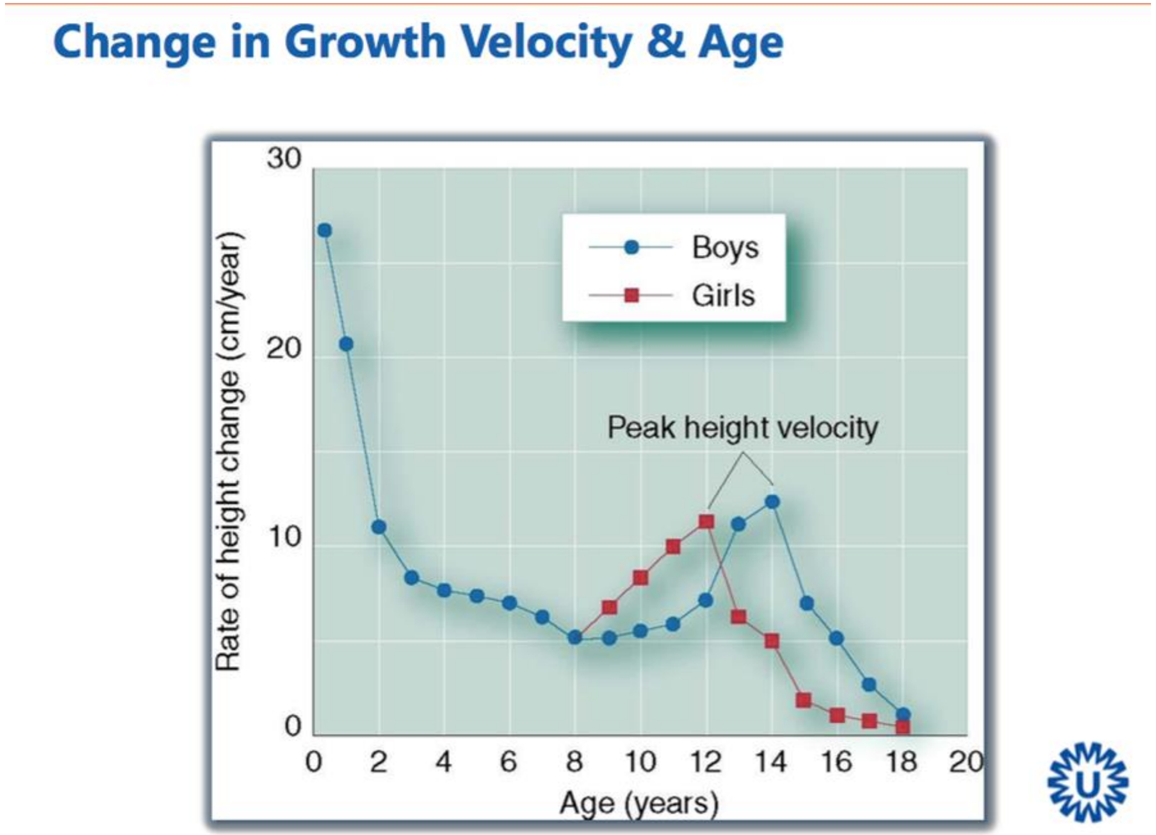
– they have different physiology

**Body Proportions**




Åstrand 2003

# Childhood and adolescence is a of period life with significant growth and physiological changes



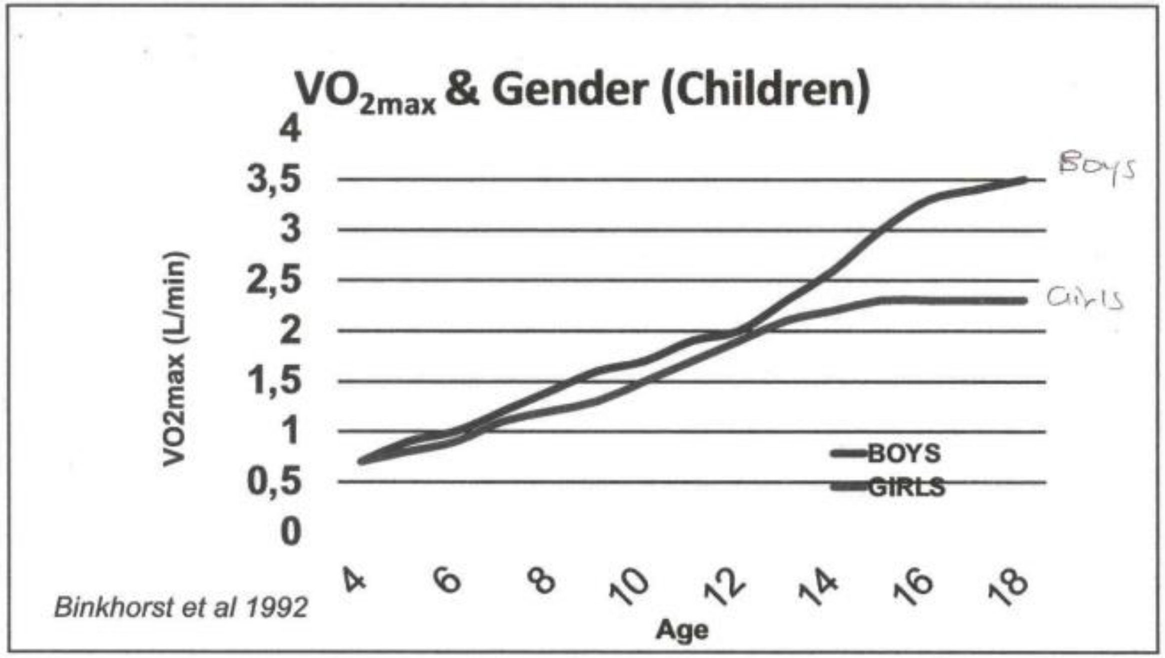
# Differences in Child Physiology For CPET Compared with Adults

## Adult-Child differences in response to exercise

| Variable | Difference with Adults |
|---|---|
| Cardiovascular | |
| $\dot{V}O_{2peak}$, L·min$^{-1}$ | Lower |
| $\dot{V}O_{2peak}$, ml·kg$^{-1}$·min$^{-1}$ | Higher |
| Submaximal HR, beats·min$^{-1}$ | Higher |
| $HR_{peak}$, beats·min$^{-1}$ | Higher |
| Stroke volume (sub)max, ml·beat$^{-1}$ | Lower |
| Cardiac output (at %$\dot{V}O_{2peak}$) | Lower |
| Arteriovenous oxygen difference (at %$\dot{V}O_{2peak}$) | Higher |
| Blood flow to muscle | Higher |
| Systolic and diastolic blood pressure, mm Hg | Lower |
| Myocardial ischemia | Rare |
| Pulmonary | |
| Tidal volume, L | Lower |
| Breathing frequency, breaths·min$^{-1}$ | Higher |
| $\dot{V}E_{peak}$, L·min$^{-1}$ | Lower |
| Ventilatory drive, $\dot{V}E/\dot{V}CO_2$ slope | Higher |
| Ventilatory efficiency, $\dot{V}E/\dot{V}O_2$ | Lower |
| Metabolic | |
| Fat oxidation | Higher |
| Carbohydrate oxidation | Lower |
| Peak blood lactate | Lower |
| Glycolytic capacity | Lower |
| A-lactic capacity | Lower |
| Lactate clearance | Same |
| Recovery after high-intensity exercise | Faster |

*Definition of abbreviations*: HR = heart rate; $HR_{peak}$ = peak heart rate; $\dot{V}E_{peak}$ = peak $\dot{V}E$; $\dot{V}O_{2peak}$ = peak $\dot{V}O_2$.

Pre puberty there are no differences in CPET parameters between males and females but post puberty there are.



# CPET requirements for paediatric patients

> For small children
  - Need a smaller cycle ergometer (WCH pt needs to be 135cm tall)
  - Small face masks, BP cuffs
  - Sensitive flow meter
  - Testing protocols adapted to the ability / fitness of the patient

# Aim for length of test

- 6-10 minutes for a child
- 8-12 minutes for an adolescent

**"Keep going!"**

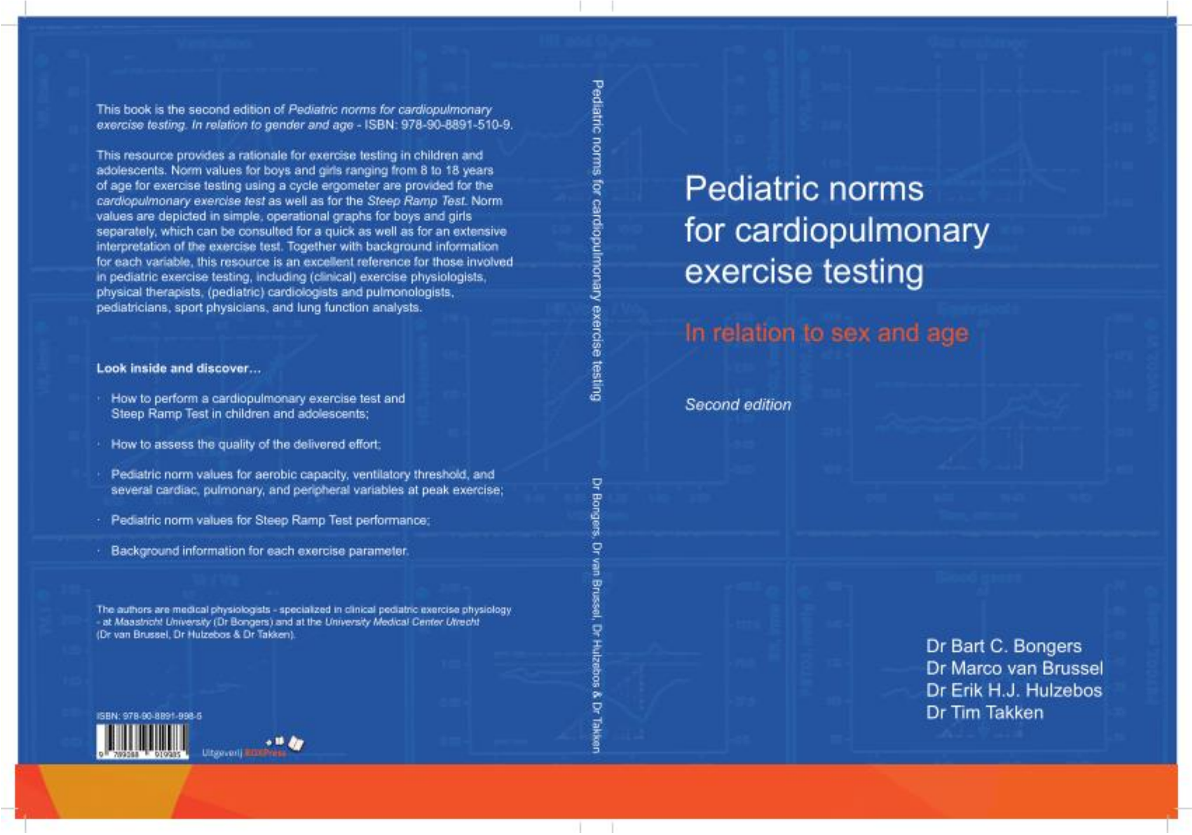
# Criteria for a maximal paediatric CPET

Motivation is important to reach maximal values.

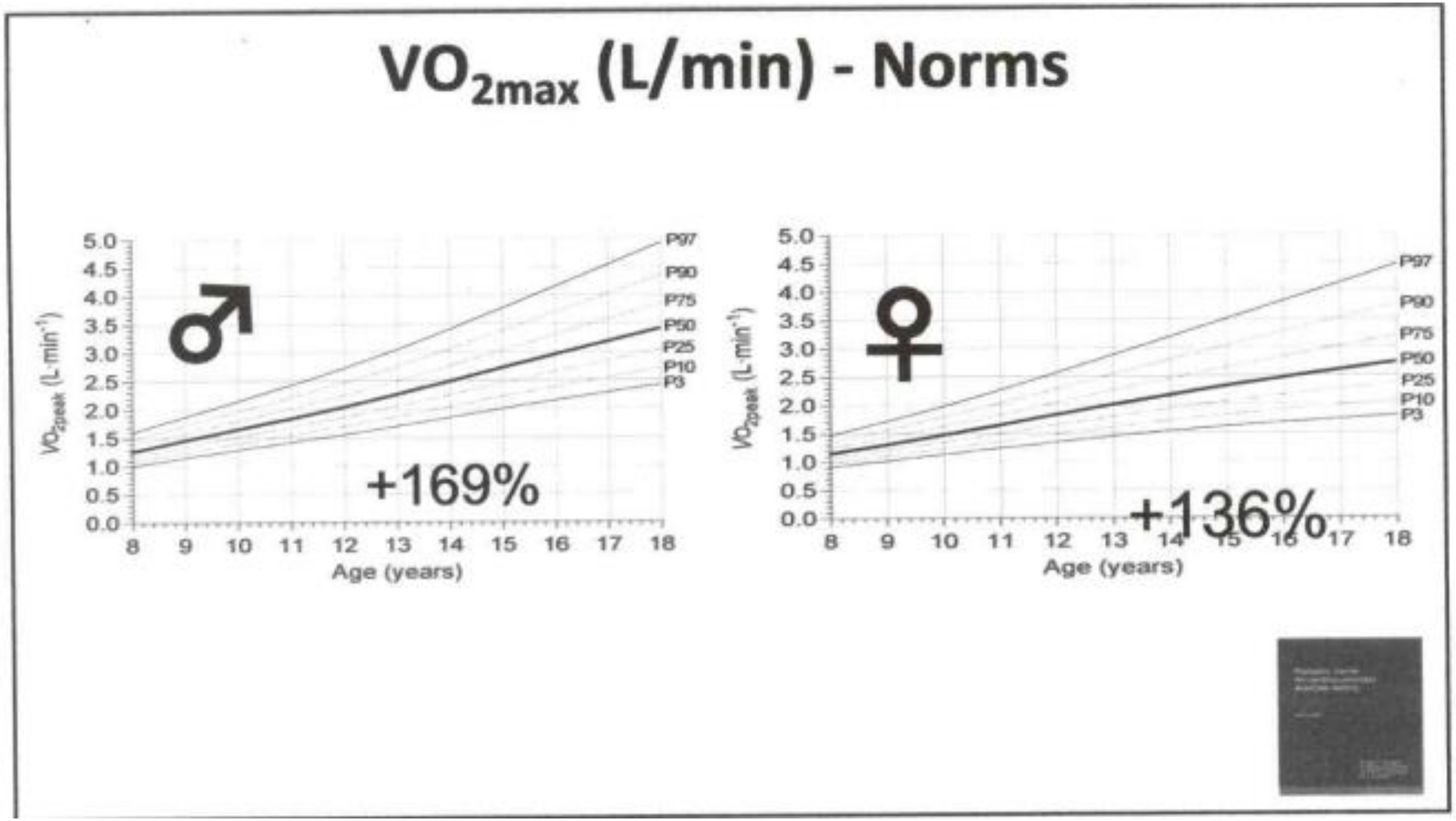
| Subjective | Objective |
|---|---|
| Unsteady on bike / running | RER peak > 1.0 (1.1 for adolescents) |
| Sweating | Heart rate >180 beats/min |
| Facial flushing | $VO_2$ plateau in final minute (infrequently observed in children) |
| Unwilling to continue despite encouragement | |

# Because of the differences in physiology, paediatric reference values for CPET parameters should be used

This book gives absolute and relative normative values for 8-18 yo



# Graphs for males and females across the age groups, with upper and lower limits.



14 yo girl, investigation for exertional breathlessness and chest pain, had several investigations done leading to a CPET.

ERJ open research

# The risks of applying normative values in paediatric cardiopulmonary exercise testing: a case report

*To the Editor:*

We present a clinical case that highlights an important issue surrounding the limitations of normative reference values (NRV) for the interpretation of cardiopulmonary exercise testing (CPET). The patients gave written consent for their anonymised data to be presented. At present, for CPET there are many NRV available from different authors for both adult and paediatric populations [1–3]. Nevertheless, there is no single NRV available that encompasses both adult, paediatric and adolescent populations [1]. We highlight these issues in a paediatric subject and the urgent requirement for standardised age- and sex-related reference values for CPET, akin to the global lung initiative reference values for lung function [4].

CPET is utilised to assist with determining the underlying cause of exercise intolerance and/or symptoms of dyspnoea and fatigue, to assess the response to therapies and to better understand the risks associated with surgical interventions [2]. CPET results are interpreted using NRV to determine disease severity and cardiovascular fitness. As outlined previously, a number of NRV are available, but the majority of these studies from which the NRV are derived use small sample sizes, heterogeneous exercise protocols, variable normalisation strategies and inadequate adjustment for confounding variables [3]. The choice of NRV used impacts on the interpretation of CPET and clinical outcomes, as we demonstrate.

A 14-year-old girl was initially referred to Norfolk and Norwich University Hospital NHS Trust (NNUH) for investigation of exertional breathlessness and chest pain. Following an echocardiogram, computerised tomography pulmonary angiogram and magnetic resonance imaging (MRI), a subacute/chronic right main pulmonary artery thromboembolism was diagnosed with no apparent clear provoking factors. CPET results were consistent with a gas exchange defect with only a mild reduction in aerobic capacity (see table 1). Subsequently she was referred to the National Chronic Thromboembolic Pulmonary Hypertension multidisciplinary team meeting at Royal Papworth Hospital NHS Foundation Trust (RPH) where her case was reviewed and deemed technically suitable for pulmonary endarterectomy (PEA) surgery, but the risks of the operation outweighed the benefits. The decision was based on reduced thromboembolic load in a physically active patient with normal functional status for her age and no signs of pulmonary hypertension on noninvasive tests. Anticoagulation therapy was continued and followed up in her local hospital.

She was referred to the Pulmonary Vascular Disease Unit at RPH 6 months later, as she had become more breathless and was unable to continue with competitive ice skating. On review, several noninvasive tests were carried out and were within the normal range except for oxygen desaturation to 85% during a 6-min walk test (555 m achieved). The investigations included electrocardiogram, echocardiogram, blood results including full blood count, urea and electrolytes, liver function tests and N-terminal pro hormone B-type natriuretic peptide test. Pulmonary function tests demonstrated mild airway obstruction with normal gas transfer.

The decision to perform right heart catheterisation (RHC), the "gold standard" diagnostic tool for pulmonary hypertension [5], was deferred in this paediatric patient (who suffered with severe

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**A clinical case in a paediatric subject highlights the urgent requirement for cardiopulmonary exercise testing age-related reference values to be harmonised, to ensure appropriate clinical interpretation and patient management** https://bit.ly/36WgOSO

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Tim Takken, Hazal Sonbahar Ulu & Erik H. J. Hulzebos (2020) Clinical recommendations for cardiopulmonary exercise testing in children with respiratory diseases, Expert Review of Respiratory Medicine, 14:7, 691-701, DOI: 10.1080/17476348.2020.1752195

# Clinical recommendations for cardiopulmonary exercise testing in children with respiratory diseases

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**ABSTRACT**

**Introduction**: Cardiopulmonary exercise testing (CPET) quantitates and qualitates the integrated physiological response of a person to incremental exercise and provides additional information compared to static lung function tests alone.

**Areas covered**: This review covers rationale for the use of CPET parameters beyond the usual parameters like peak oxygen uptake and peak minute ventilation in children with respiratory disease.

**Expert opinion**: CPET provides a wealth of data from rest, submaximal and maximal exercise and data during recovery from exercise. In this review, an interpretative approach is described for analyzing CPET data in children with respiratory disease.

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**KEYWORDS**
Exercise; physiology; child

# A Systematic Approach to Interpreting the Cardiopulmonary Exercise Test in Pediatrics

in Pediatric Exercise Science

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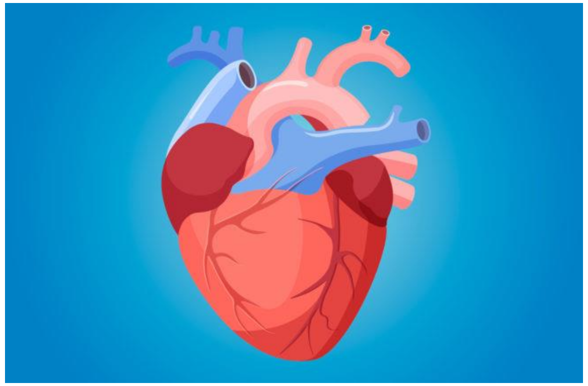
**Abstract** Author Notes

The use of cardiopulmonary exercise testing in pediatrics provides critical insights into potential physiological causes of unexplained exercise-related complaints or symptoms, as well as specific pathophysiological patterns based on physiological responses or abnormalities. Clinical interpretation of the results of a cardiopulmonary exercise test in pediatrics requires specific knowledge with regard to pathophysiological responses and interpretative strategies that can be adapted to address concerns specific to the child's medical condition or disability. In this review, the authors outline the 7-step interpretative approach that they apply in their outpatient clinic for diagnostic, prognostic, and evaluative purposes. This approach allows the pediatric clinician to interpret cardiopulmonary exercise testing results in a systematic order to support their physiological reasoning and clinical decision making.

# Thank you.



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