Cardiorespiratory Fitness, Cardiovascular Disease Risk Factors and Subclinical Atherosclerosis in Male Adolescents

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Coronary Artery Disease

• Begins early in life due to exposure to risk factors
• Lag time between onset of CAD in childhood and clinical manifestation in middle and late adulthood
Atherosclerotic Progression Review

CVD begins early in life - long asymptomatic phase

Age
Gender
Family Hx
Race
Modifiable
Cigarette smoking
High blood pressure
High LDL (bad) cholesterol
Impaired fasting glucose
Obesity
Low Cardiorespiratory Fitness

Women
46%

Men
62%
Coronary Artery Disease

- Begins early in life due to exposure to risk factors
- Lag time between onset of CAD in childhood and clinical manifestation in middle and late adulthood
- Duration of risk factor burden is a major factor governing the development of CVD
- CVD risk factor levels and health behaviours for an individual tend to persist or track over time
Endothelium
Vascular Endothelium Functions

- Platelet Aggregation and Adhesion
- Thrombosis
- Monocyte and Leukocyte Adhesion
- Vascular Tone
- Inflammation
- Lipoprotein Metabolism and Uptake
- Vessel remodeling and growth
Assessment of Endothelial Function
Takase B, Am J Cardiol 1998:82:1535; Comparison of Brachial and Coronary Flow-Mediated Vasodilation
Cardiorespiratory Fitness

Considered a stronger predictor for CVD and all-cause mortality than traditional risk factors
1 MET Increase in CV Fitness Comparable Benefits

-13
-15
-7
-12
-8
-4
0
4
8
12
16

All cause mortality (%)
CV events (%)

33 studies
103,000 participants

Kodama et al JAMA 2009
Exercise Training Normalizes Vascular Dysfunction and Improves Central Adiposity in Obese Adolescents

Katie Watts, BSc(Hons), Petra Beye, MD, Aris Siafarikas, MD, Elizabeth A. Davis, FRACP, Timothy W. Jones, FRACP, Gerard O’Driscoll, FRACP, Daniel J. Green, PhD
Crawley, Subiaco, and Perth, Western Australia

Effects of Diet and Exercise on Obesity-Related Vascular Dysfunction in Children
Kam S. Woo, Ping Chook, Chung W. Yu, Rita Y.T. Sung, Mu Qiao, Sophie S.F. Leung, Christopher W.K. Lam, Con Metreweli and David S. Celermajer

Circulation. 2004;109:1981-1986; originally published online April 5, 2004; doi: 10.1161/01.CIR.0000126599.47470.BE

INFLAMMATION, INSULIN, AND ENDOTHELIAL FUNCTION IN OVERWEIGHT CHILDREN AND ADOLESCENTS: THE ROLE OF EXERCISE
Aaron S. Kelly, PhD, Rachel J. Wetzsteon, BS, Daniel R. Kaiser, PhD, Julia Steinberger, MD, MS, Alan J. Bank, MD, and Donald R. Dengel, PhD
Purpose

Compare selected CVD risk factors and subclinical atherosclerosis in male adolescents with low, moderate and high cardiorespiratory fitness.
• Differences in CVD risk factors, cIMT and EF
• Relation between CRF level and EF &cIMT
Study Research Design

Experimental Design

School Visit 1

School Visit 2

Vascular Research Unit
Study
Vascular Research Unit Visit

Blood Biomarkers
- Total cholesterol
- LDL-C
- HDL-C
- Non-HDL-C
- Triglycerides
- Glucose

N= 66
15-17 yrs
Non Smokers
Endothelial Dependent Dilation

- Rest in supine position (10 min)
- Pneumatic Cuff 250mmHg (5 min)
- Post-occlusion diameter (0-5 min)

Baseline
Doppler
Endothelial Independent Dilation

Post-occlusion rest interval
(15 min)

New baseline
(0.4 μg)

GTN
Post-GTN diameter
(0-5 min)
# Results

## Physical Characteristics and Blood Pressure

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low CRF (n=14)</td>
</tr>
<tr>
<td>Age (y)</td>
<td>15.81 ± 0.65</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>180.01 ± 5.48</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>86.86 ± 27.20</td>
</tr>
<tr>
<td>BMI</td>
<td>26.88 ± 7.43</td>
</tr>
<tr>
<td>Waist Hip Ratio</td>
<td>0.89 ± 0.06</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>135.88 ± 14.77</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>83.13 ± 6.88</td>
</tr>
<tr>
<td>Tanner Stage (I-V)</td>
<td>3.23 ± 1.09</td>
</tr>
</tbody>
</table>

Values are means ± SD

* *p < 0.05 vs. Low CRF; † *p < 0.01 vs. Low CRF; ‡ *p < 0.001 vs. Low CRF
a < 0.05 vs. Mod CRF; b < 0.01 vs. Mod CRF; c < 0.001 vs. Mod CRF
## Results

### Blood Lipids and Glucose

<table>
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</thead>
<tbody>
<tr>
<td></td>
<td>Low CRF</td>
</tr>
<tr>
<td>Triglycerides (mmol/L)</td>
<td>1.41 ± 0.87</td>
</tr>
<tr>
<td>Total cholesterol (mmol/L)</td>
<td>3.88 ± 0.71</td>
</tr>
<tr>
<td>LDL- C (mmol/L)</td>
<td>2.35 ± 0.63</td>
</tr>
<tr>
<td>HDL-C (mmol/L)</td>
<td>1.01± 0.27</td>
</tr>
<tr>
<td>Non HDL-C (mmol/L)</td>
<td>2.87 ± 0.62</td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>4.56 ± 0.34</td>
</tr>
</tbody>
</table>

Values are means ± SD

*p < 0.05 vs. Low CRF; †p < 0.01 vs. Low CRF; ‡p < 0.001 vs. Low CRF
a < 0.05 vs. Mod CRF; b < 0.01 vs. Mod CRF; c < 0.001 vs. Mod CRF
**VO₂max**

![Bar chart showing VO₂max values for different CRF levels with significance markers.](chart1)

**%Body Fat**

![Bar chart showing %Body Fat values for different CRF levels with significance markers.](chart2)

† P<0.001 vs. Low CRF
‡ p ≤ 0.01 vs. Low CRF
‡ P<0.001 vs. LCRF
Endothelial Function

Percentage change

Low CRF  Mod CRF  High CRF

EDD

EID

‡ P<0.001 vs. LCRF

† p ≤ 0.05 vs. MCRF

Endothelial Function
**cIMT**

‡ P<0.001 vs. Low CRF  
† p ≤ 0.001 vs. Mod CRF  
* p ≤ 0.05 vs. Low CRF  

- **Low CRF**  
- **Mod CRF**  
- **High CRF**

<table>
<thead>
<tr>
<th></th>
<th>R Far Wall</th>
<th>L Far Wall</th>
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</thead>
<tbody>
<tr>
<td>Low CRF</td>
<td>[Diag Bar]</td>
<td>[Diag Bar]</td>
</tr>
<tr>
<td>Mod CRF</td>
<td>[Diag Bar]</td>
<td>[Diag Bar]</td>
</tr>
<tr>
<td>High CRF</td>
<td>[Diag Bar]</td>
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</table>
VO$_2$max and Endothelial Dependent Dilation

$r=0.63$

$P<0.001$
cIMT Results

Right Far Wall

\[ R^2 = 0.58162 \]

\[ cIMT \text{ (cm)} - VO_2\text{max (ml/kg/min)} \]

Left Far Wall

\[ R^2 = 0.52097 \]

\[ cIMT \text{ (cm)} - VO_2\text{max (ml/kg/min)} \]
Conclusion

- BMI, BP, TG, LDL-C were higher in Low CRF than Mod and High CRF.
- VO$_2$max was 25% and 41% higher in the Mod and High CRF than Low CRF, respectively.
- EF was reduced in Low CRF compared to Mod and High CRF.
- Positive relation between VO$_2$ and EF.
- R and L Far Wall cIMT was higher in Low CRF than Mod and High CRF.
- Positive relation between VO$_2$max and EF ($r=0.63$).
- Inverse relation between VO$_2$max and R ($r=0.72$) and L (0.76) Far Wall cIMT.