# Cardiorespiratory Fitness, Oxygen Uptake Efficency Slope and Endothelial Function in Male Adolescents

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## Introduction

Cardiorespiratory fitness (CRF) is a independent risk factor for CVD and all-cause mortality. Maximal oxygen uptake ($VO_{2max}$), is considered the gold standard measurement of CRF. Due to its effort dependency, a true plateau in $VO_2$ during incremental exercise is often not attained, particularly in overweight and obese pediatric populations [1]. The oxygen uptake efficiency slope (OUES) has been proposed as an objective and effort independent submaximal measure of cardiopulmonary reserve. Studies in healthy and obese children have reported a strong positive relation between OUES and $VO_{2max}$. Children with high CRF have higher OUES values than those with low CRF [2]. Furthermore, improvements in CRF following exercise training, are associated with restoration of endothelial function (EF) in obese children [3]. The purpose of this study was to examine the relation between OUES, $VO_{2max}$ and EF in healthy male adolescents.

## Results

Table. Physical and physiological characteristics of the study participants

| | Low Fit (n=19) | Mod Fit (n=21) | High Fit (n=23) |
|---|---|---|---|
| Age (y) | 15.32 ± 0.89 | 15.67 ± 0.58 | 15.78 ± 0.52 |
| Height (cm) | 176.40 ± 6.48 | 175.72 ± 7.18 | 173.34 ± 5.54 |
| Weight (kg) | 82.93 ± 17.53 | 64.95 ± 10.09 ‡ | 64.50 ± 6.60 ‡ |
| BMI ($kg{\cdot}m^{-2}$) | 26.82 ± 6.24 | 20.98 ± 2.61 ‡ | 21.47 ± 2.02 ‡ |
| Body fat (%) | 21.48 ± 9.36 | 9.64 ± 4.71 ‡ | 8.40 ± 2.95 ‡ |
| Body fat (kg) | 19.04 ± 10.02 | 6.57 ± 4.05 ‡ | 5.48 ± 2.22 ‡ |
| Fat free mass (kg) | 63.89 ± 9.33 | 58.38 ± 7.33 | 59.01 ± 5.61 |
| Body surface area ($m^2$) | 2.02 ± 0.23 | 1.77 ± 0.17 ‡ | 1.76 ± 0.11 ‡ |
| $VO_{2\ max}$ ($ml{\cdot}kg^{-1}{\cdot}min$) | 40.19 ± 4.91 | 52.44 ± 3.79 ‡ | 63.36 ± 3.78 ‡ |
| $VO_{2\ max}$ ($L{\cdot}min^{-1}$) | 3.31 ± 0.55 | 3.39 ± 0.49 | 4.09 ± 0.46 ‡ [c] |
| $VO_{2\ max}$/BSA | 1636.69 ± 165.16 | 1905.59 ± 134.60 ‡ | 2322.90 ± 156.67 ‡ |
| $VO_{2\ max}$ /FFM | 52.03 ± 6.75 | 58.01 ± 3.28 ‡ | 69.36 ± 3.78 ‡ [c] |
| OUES | 4146.86 ± 943.41 | 3779.54 ± 750.37 | 4653.16 ±778.40 [b] |
| OUES/kg | 50.57 ± 8.80 | 58.89 ± 12.68 * | 72.22 ± 10.47 ‡ [c] |
| OUES/BSA | 2046.34 ± 359.05 | 2135.73 ± 414.02 | 2640.78 ± 382.96 ‡ [c] |
| OUES/FFM | 65.16 ± 13.26 | 65.14 ± 13.20 | 78.91 ± 11.60 † [b] |
| HR max (bpm) | 197.39 ± 11.82 | 198.80 ± 5.45 | 199.22 ± 5.18 |
| RPE max | 18.94 ± 1.39 | 18.95 ± 1.28 | 18.91 ± 1.24 |
| RER max | 1.10 ± 0.07 | 1.10 ± 0.05 | 1.13 ± 0.03 |
| VE max ($L{\cdot}min^{-1}$) | 83.27 ± 17.34 | 93.48 ± 13.78 | 104.83 ± 14.03 ‡ [a] |
| EDD (Absolute change) | 0.02 ± 0.01 | 0.04 ± 0.01 ‡ | 0.05 ± 0.01 ‡ [b] |
| EID (Absolute change) | 0.07 ± 0.02 | 0.08 ± 0.02 | 0.08 ± 0.02 |

Values are means ± SD; * p<0.05 vs. Low fit; † p<0.01 vs. Low fit; ‡ p<0.001 vs. Low fit;
[a] p<0.05 vs. Mod fit; [b] p<0.01 vs. Mod Fit; [c] p<0.001 vs. Mod Fit

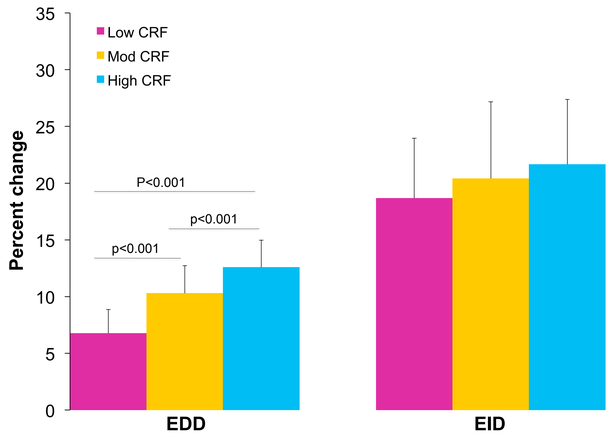



**Figure 1**. Percentage change in EDD and EID

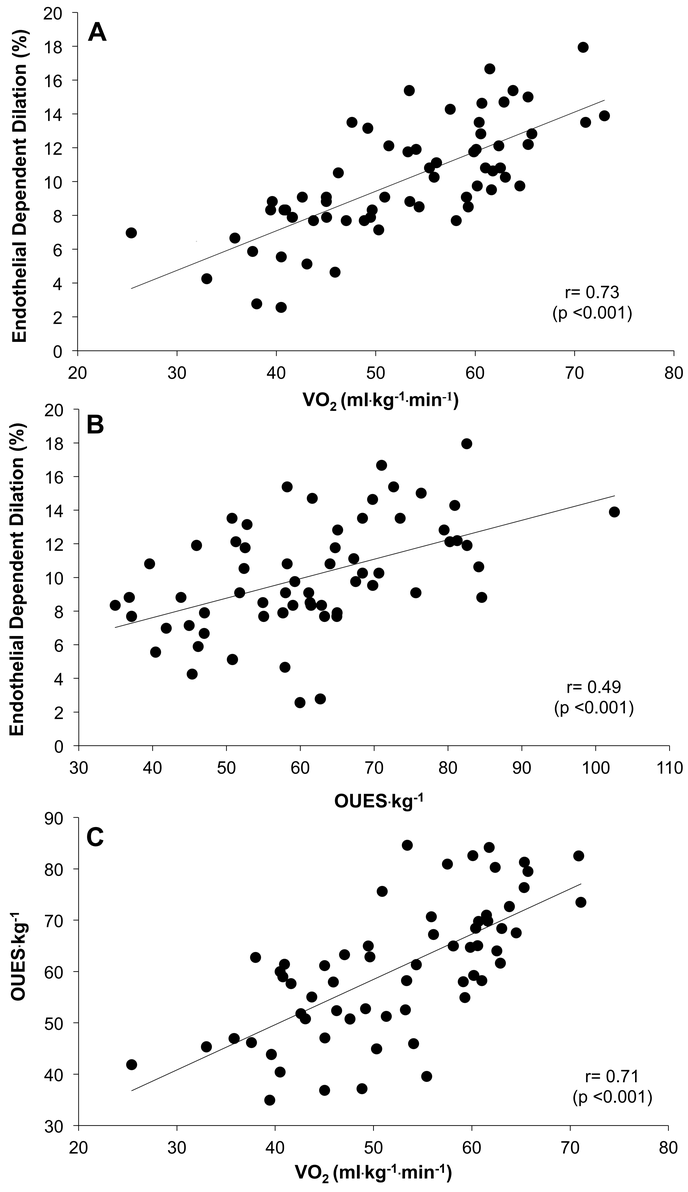
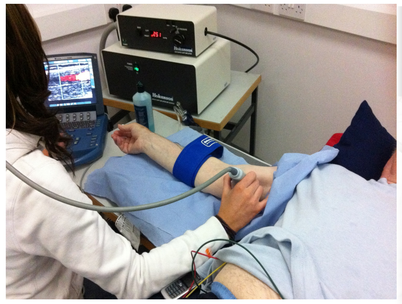
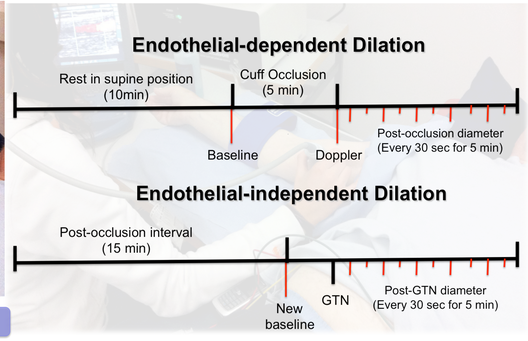



**Figure 2.** Relation between (A) $VO_2$max and EDD, (B) $OUES{\cdot}kg^{-1}$ and EDD and (C) $VO_2$max and $OUES{\cdot}kg^{-1}$

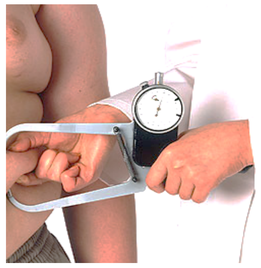
## Methods



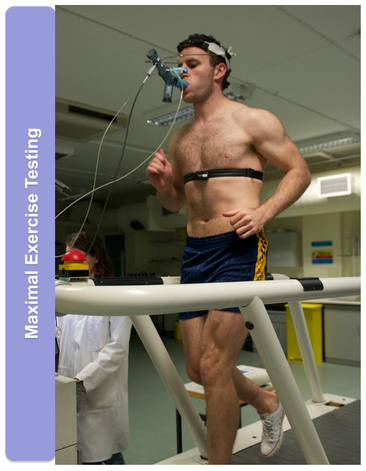
Endothelial Function




Anthropometrics



- Height
- Weight
- BMI
- BSA
- % Body fat
- Fat Free Mass (kg)




- HR (bpm)
- RPE
- RER
- VE ($L{\cdot}min^{-1}$)
- $VO_{2\ max}$ ($ml{\cdot}kg^{-1}{\cdot}min$)
- $VO_{2\ max}$ ($L{\cdot}min^{-1}$)
- $VO_{2max}$/BSA
- $VO_{2max}$/FFM
- Maximal OUES
- Maximal OUES/kg
- Maximal OUES/FFM

## Conclusion

$VO_{2\ max}$ ($ml{\cdot}kg^{-1}{\cdot}min$) and $OUES{\cdot}kg^{-1}$ were significantly related to percentage change (and absolute change) in endothelial dependent dilation in healthy male adolescents. While the OUES was significantly correlated to endothelial function, the relation between $VO_{2\ max}$ and endothelial function was more robust in healthy male adolescents

## Bibliography

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