

ABSTRACT

Purpose: Cardiorespiratory fitness (CRF) is generally regarded as an objective and reproducible measure of recent habitual physical activity (PA). Considering that the majority of daily PA is performed at light intensity, it is likely that CRF benefits will be detected at submaximal rather than maximal exercise. The purpose of this study was to evaluate daily minutes of light (LIPA), moderate (MIPA) and vigorous (VIPA) intensity physical activity among men with cardiovascular disease (CVD), and to determine the relation between PA and submaximal (oxygen uptake efficiency slope (OUES)) and maximal (VO_2 peak) indices of CRF.

Methods: A total 32 male participants (mean (\pm SD): age of 60.0 ± 8.7 yr, VO_2 peak (L/min) 2.0 ± 0.45 , VO_2 peak (mL/kg/min) 23.3 ± 5.7 , were recruited during an induction to a community based exercise referral program following completion of phase 2 cardiac rehabilitation. Participants underwent a graded exercise test on a cycle ergometer with breath by breath open circuit spirometry after which they wore a wrist worn accelerometer (Actigraph) for 7 d. Absolute and relative submaximal OUES were calculated by plotting VO_2 in mL/min on the x axis, and the log transformed VE on the y axis ($VO_2 = a \log_{10} VE + b$). Exercise data up to the ventilatory anaerobic threshold was included in the analysis.

Results: Participants performed 589.05 ± 69.41 min of daily LIPA, 161.38 ± 66.16 min of MIPA and no daily min of VIPA. There was no significant relation between peak VO_2 and either LIPA or MIPA. There was a significant correlation between submaximal OUES ($r=0.44$; $p<0.01$) and LIPA. The relation between submaximal OUES/kg and LIPA min almost reached statistical significance ($r=0.33$; $p<0.07$). There was no significant relation between MIPA and OUES or OUES/kg.

Conclusion: Men with CVD spend the majority (78%) of their day performing LIPA. OUES, a submaximal measure of CRF was related LIPA whereas no relation was found between VO_2 peak and LIPA.

Introduction

Physical activity (PA) is defined as any bodily movement produced by skeletal muscle that results in the expenditure of energy and can be classified as LIPA (1.6-2.9 METs), MIPA (3.0-5.9 METs) and VIPA (≥ 6.0 METs). Habitual PA reduces morbidity and mortality in patients with established CVD.

A high level of CRF measured as VO_2 peak is associated with a significant reduction in cardiovascular mortality in individuals with established atherosclerotic CVD. However, changes in VO_2 peak are relatively small in CVD patients following participation in cardiac rehabilitation (CR). A number of submaximal CRF indices may improve independent of changes in VO_2 peak and are also used to assess functional capacity.

OUES is an effort independent submaximal CRF parameter that is derived from the linear relation of VO_2 (y-axis) versus the logarithm of VE (x-axis) during incremental exercise (Fig 1.). OUES provides an estimation of the efficiency of ventilation with respect to VO_2 , with greater slopes indicating greater ventilatory efficiency. It is relatively independent of patient-achieved effort levels and reflects the absolute rate of increase in VO_2 per 10-fold increase in ventilation and thereby indicates how effectively oxygen is taken in by the lungs, transported and used in the periphery.

Participants

Men ($n=32$) with documented CVD were recruited during an induction to a community based exercise referral program after completion of phase 2 (hospital based) CR program. Physiological and physical characteristics and cardiovascular events and medications are summarized in the table.

Table. Physiological and physical characteristics, cardiovascular events and medications

Variable	Values
Age (y)	60.0 ± 8.70
VO_2 peak (L·min ⁻¹)	2.00 ± 0.45
$\dot{V}O_2$ peak (mL·kg ⁻¹ ·min ⁻¹)	23.30 ± 5.70
VE (L·min ⁻¹)	65.68 ± 21.56
Peak workrate (watts)	135.71 ± 40.49
Peak heart rate (b·min ⁻¹)	134.21 ± 19.58
BMI (kg·m ⁻²)	29.24 ± 4.10
Waist:Hip	0.97 ± 0.040
Systolic blood pressure (mm Hg)	136.66 ± 17.37
Diastolic blood pressure (mm Hg)	84.98 ± 10.99
Resting heart rate (b·min ⁻¹)	68.24 ± 11.36
Cardiovascular Event	
MI	16 (50)
STEMI	9 (28)
NSTEMI	6 (19)
PCI	25 (78)
CABG	2 (3)
Medications	
Statins	24 (75)
Anti-platelets	24 (75)
Beta blockers	22 (68)
ACE inhibitors	16 (50)
ARB's	3 (9)

Values are mean \pm SD and total number (percentage)

Methods

Participants made a single visit to Dublin City University.

Height, weight, hip and waist circumference were measured and participants performed a maximal cardiopulmonary exercise test (CPET) with a 12-lead ECG.

Breath-by-breath gas collected during the CPET was averaged at 20 s intervals.

OUES was calculated using the equation; $VO_2 = a \log_{10} VE + b$ where the constant 'a' represents OUES, ' $\log_{10} VE$ ' represents the logarithm of VE and the constant 'b' represents the intercept (Figure 1).

The ventilatory breakpoint method was used to determine VAT (Figure 2).

Exercise data up to the ventilatory anaerobic threshold (Figure 2) and VO_2 peak were used to calculate submaximal and max OUES, respectively.

Participants wore an accelerometer (Actigraph) continuously for 7 d.

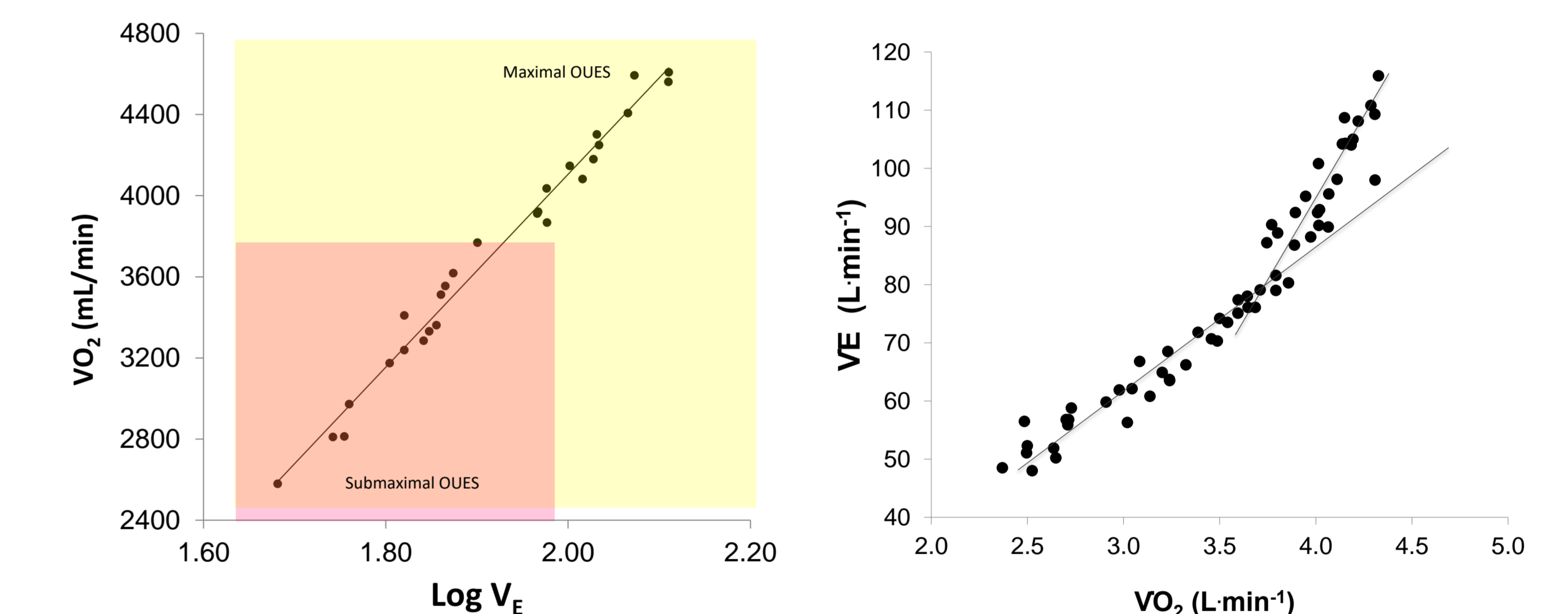


Figure 1. Max and submax OUES calculation

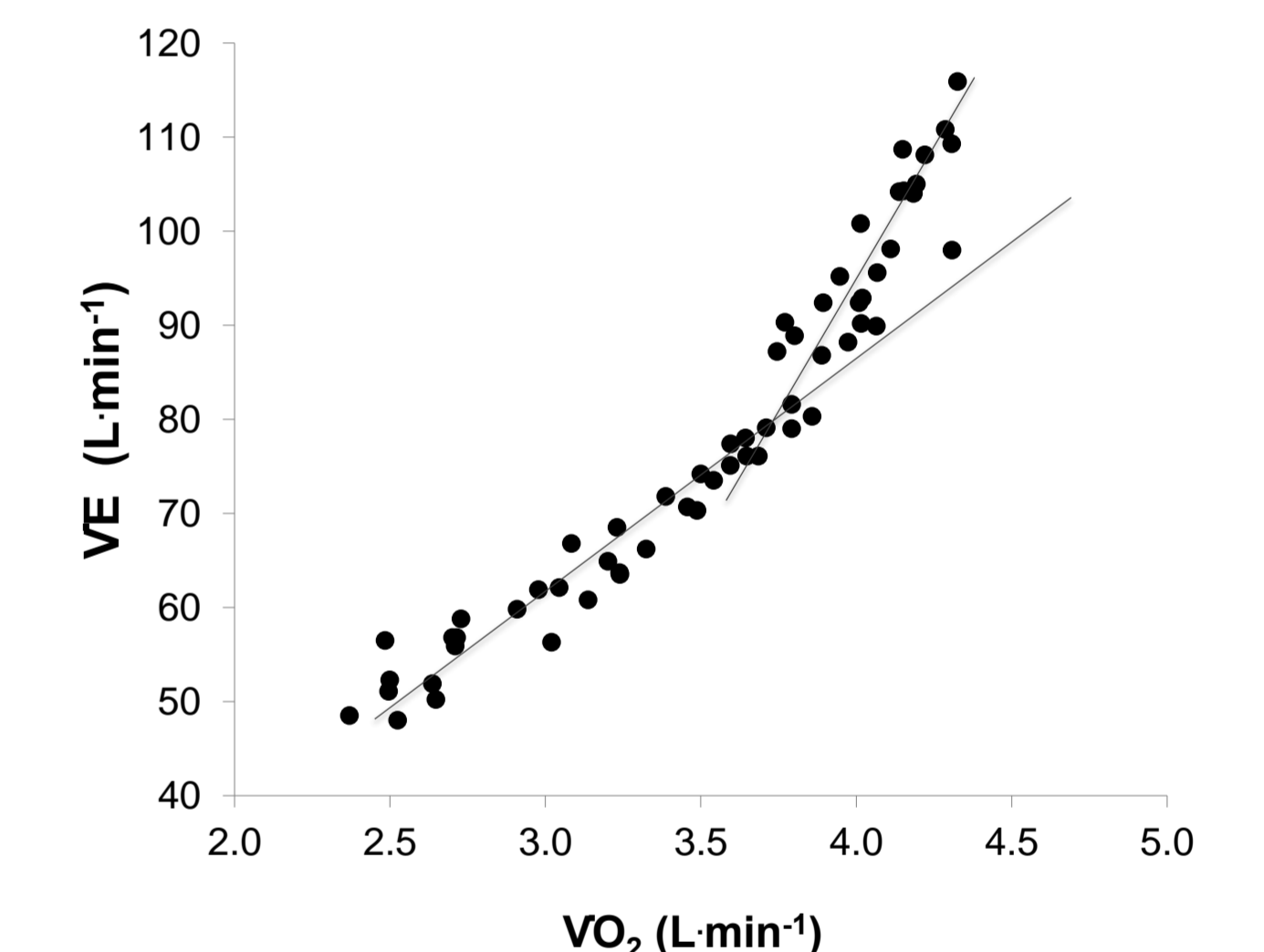


Figure 2. Calculation of VAT

Results

LIPA accounted for 78% of PA undertaken during waking hours.

No VIPA was undertaken during the 7 d period.

There was a sig. relation between submax OUES and LIPA ($r=0.44$; $p<0.01$).

The relation between submaximal OUES/kg and LIPA min almost reached statistical significance ($r=0.33$; $p<0.07$).

No significant relation between VO_2 peak and either LIPA or MIPA.

No significant relation between MIPA and OUES or OUES/kg.

Conclusion

Men with documented CVD accumulate their daily min of PA by undertaking primarily repeated bouts of LIPA. No VIPA was undertaken during the 7 d period. The findings indicate that measures of maximal/peak metabolic rate may lack external validity with the regard to the daily challenges faced by the O_2 transport and utilization pathways in men with CVD and a low functional capacity. OUES may be a more useful parameter for quantifying functional capacity in this cohort.

