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Superior Running Economy in Obese Compared to Normal-  
Weight Males at Metabolically Comparable Work Rates.

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## Abbreviations

AT – Anaerobic Threshold

%BF - body fat percentage

BLa – Blood Lactate Accumulation

BMI - body mass index

CRF – Cardiorespiratory Fitness

CVD – Cardiovascular Disease

EE – Exercise Economy

FFM - Fat free mass

GET – Gas exchange threshold

GXT- graded exercise test

HDL – high density lipoprotein cholesterol

HR – Heart rate

HRmax – maximum heart rate

LT – Lactate Threshold

NWU- Normal Weight Unfit

OB - Obese

OBF – Obese Fit

RE – Running Economy

RPE - ratings of perceived exertion

TC - total cholesterol

$\dot{V}O_2$  - oxygen consumption

$\dot{V}O_{2peak}$  - peak oxygen consumption (85% HRmax in GXT)

$\dot{V}O_{2max}$  - maximal oxygen consumption

% $\dot{V}O_2$  - percent of  $\dot{V}O_2$  in proportion to maximal value

$\dot{V}_E$  - Minute ventilation

VT - ventilatory threshold

40%  $\Delta$  - 40% of the difference between VT and  $\dot{V}O_{2peak}$

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## Abstract

**Introduction:** During weight bearing physical activities such as walking or running, obese individuals generally expend more total energy than their lighter counterparts. Running economy (RE) is an important physiological measure in the sports performance field and is defined as the aerobic capacity per kilogram of body mass required to sustain a given submaximal running speed. RE can also help us assess how other individuals would cope with a certain intensity of activity. Superior RE is seen in elite endurance athletes by using less oxygen per kilogram of body mass at a given speed. Fit/trained individuals display a superior RE compared to unfit/untrained individuals. Normal weight subjects have previously been shown to display a superior RE than obese individuals; furthermore, low cardiorespiratory fitness (CRF) is an important reversible cardiovascular disease risk factor, while obesity is a major risk factor for non-communicable diseases. Although RE has previously been assessed at absolute exercise intensities to compare between groups, (i.e. obese vs. normal weight) individuals exercise at a metabolic rate that is scaled to body size and relativised for fitness level. **Purpose:** To assess RE and the physiological responses of normal weight-unfit (NWU) and obese-fit (OBF) adult males during treadmill running when relative exercise intensities are selected. It was hypothesised that the RE of OBF would be superior to that observed for NWU. **Methods:** Healthy NWU ( $n = 12$ ,  $38.2 \pm 9.1$  yrs,  $77.3 \pm 6.4$  kg,  $24.0 \pm 1.3$  kg·m<sup>-2</sup>) and OBF ( $n = 11$ ,  $38.5 \pm 6.0$  yrs,  $103.8 \pm 8.0$  kg,  $33.3 \pm 2.2$  kg·m<sup>-2</sup>) volunteered for the study. Following risk stratification assessment for coronary artery disease and a treadmill walking ECG, participants completed two laboratory based tests. Participants firstly completed a submaximal incremental graded exercise test up to 85% HR<sub>max</sub> (age predicted) on a treadmill. Individual linear regression analysis was then used to predict maximal aerobic power ( $\dot{V}O_{2max}$ ) for each participant. Following a minimum 72 hour recovery period, participants then completed a further test at two independent intensities: ventilatory threshold (VT) and 40% delta ( $\Delta$ ) as identified from the GXT. Each independent intensity was sustained for 6 minutes duration, separated by 5 minutes of standing recovery. Physiological markers (Heart Rate [HR], oxygen uptake [ $\dot{V}O_2$ ], minute ventilation [ $\dot{V}_E$ ] and respiratory exchange ratio [RER]) were continuously monitored, while the ratings of perceived exertion (RPE) and stride rate were recorded at 3 minutes and at the completion of each exercise stage. **Results:** OBF elicited a significantly higher running speed at VT ( $8.5$  vs.  $7.6$  km·h<sup>-1</sup>;  $P < 0.01$ ) and at 40%  $\Delta$  ( $10.1$  vs.  $8.8$  km·h<sup>-1</sup>;  $P < 0.01$ ) compared to NWU

respectively. OBF displayed a significantly superior (lower) RE ( $210.7 \pm 8.0$  vs.  $253.2 \pm 7.6$  mL·kg<sup>-1</sup>·km<sup>-1</sup>;  $P = 0.001$ ), than in NWU respectively. No significant differences were observed between VT and 40%  $\Delta$  ( $P > 0.05$ ). When RE was assessed relative to fat free mass (FFM), no differences were found between OBF and NWU ( $P > 0.05$ ). However, a significant difference in RE was observed at VT compared to 40%  $\Delta$  ( $322.3 \pm 7.3$  &  $368.8 \pm 8.9$  mL·FFM<sup>-1</sup>·km<sup>-1</sup>, respectively;  $P < 0.001$ ). **Conclusion:** Despite running at a faster speed, fit and obese individuals displayed a superior running economy compared to normal weight unfit individuals during treadmill running at relative moderate and heavy exercise intensities when expressed as mL·kg<sup>-1</sup>·km<sup>-1</sup>. When expressed relative to fat free mass (mL·FFM<sup>-1</sup>·km<sup>-1</sup>) no differences in RE were observed between groups. Fitness and training status rather than weight status may be more of an important moderating factor when examining differences in RE between individuals. The proposed mechanisms for the results remain unclear. It is acknowledged that greater subject numbers including obese unfit and normal weight fit would have allowed for a more valid interpretation of the present findings. From a public health perspective these results indicate that increasing physical activity and fitness level should be a priority for adults engaging in an exercise programme more so than weight loss, as superior economy could reduce the relative level of physical exertion during everyday tasks.