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Short sprints (30 s) attenuate post-prandial blood glucose in young healthy males

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ABSTRACT

Aims: Low-volume, high-intensity exercise is a time-efficient method of inducing physiological responses and may also improve glucose homeostasis. Therefore, effects of two different volumes of sprint-interval cycling on post-prandial blood glucose were assessed.
Methods: Twenty healthy young males undertook two Wingate anaerobic tests (2WAT), four Wingate anaerobic (4WAT) and without-exercise (CON) 90 min after eating a standard meal. Blood glucose was examined at 60, 90, 105, 120, 135 and 150 min post-prandially.
Results: 2WAT and 4WAT both accelerated the decrease of blood glucose compared with CON ($P < 0.05$). There were significant reductions at 120 (4.45 ± 0.64 vs. 4.93 ± 0.9 vs. 5.68 ± 0.69), 135 (4.28 ± 0.50 vs. 4.48 ± 0.75 vs. 5.54 ± 0.6) and 150 min (4.64 ± 0.71 vs. 4.71 ± 0.73 vs. 5.36 ± 0.48, all $P < 0.05$). Blood glucose at 120 min was lower after 2WAT than 4WAT (4.45 ± 0.64 vs. 4.93 ± 0.9, $P < 0.05$), this producing a significant statistical interaction between groups and post-exercise time ($P < 0.005$).
Conclusions: 2WAT and 4WAT tests both accelerate the post-prandial decrease in blood glucose in young healthy males, 2WAT being superior to 4WAT in producing this response, even though 2WAT is easier to perform and less time consuming.

1. Introduction

Evidence has shown the risks of cardiovascular disease and diabetes can reduce by taking exercise regularly [1]. Myocardial (cardiac muscle) function can be improved by aerobic activities [2], power of skeletal muscles can increase by anaerobic exercise training, which improves glycemic metabolism and insulin sensitivity, and its use is strongly recommended for the prevention of diabetes and control diabetic patients [3].

Even though high-volume endurance exercise is a useful method for improving glycemic control [4], low-volume, high-intensity interval exercise (also known as short-duration sprint interval exercise) is a more time-efficient strategy for improving metabolic control [5,6]. Moreover, low-volume, high-intensity exercise has been suggested to be similar in effectiveness to high-volume endurance exercise [7,8] and to produce better glycemic control in diabetic patients [9,10]. Therefore, low-volume, high-intensity exercise might be a better option for people with certain health conditions or chronic

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diseases. However, the optimum amount of exercise needs to be established.

Short-duration sprint interval tests often use the Wingate anaerobic test (WAT), which is a common method for giving low-volume, high-intensity activity to assess all-out peak anaerobic power and capacity. Performing this form of exercise elicits anaerobic metabolism, which use anaerobic glycolysis to replenish the adenosine triphosphate (ATP) and creatine phosphate (CP) levels that have been used by the active muscles. This use of anaerobic mechanism is different from the source of energy in low-intensity exercise, when glucose is broken down aerobically, the maximum rate of this being determined by the muscle's oxidative capacity, and glycolytic mechanisms replenish glucose levels in the muscle [11].

Accepting that different volumes and intensities of exercise will result in different metabolic responses in muscles and affect their glucose homeostasis differently, and that high-intensity exercise might play a useful role in improving glycemic metabolism, the effectiveness of different volumes of high-intensity exercise upon glycemic metabolism remains to be established. The purpose of this study was to determine the effects of two different volumes of sprint interval cycling on the time-courses of post-prandial blood glucose concentration in young, healthy participants.

2. Methods

Twenty young, healthy males (age: 22 ± 2 years; height: 174 ± 6.6 cm; weight: 63 ± 7.1 kg) participated in the study. They were designated as "non-active" – not taking regular exercise or training (formal exercise/training less than twice per week), but occasionally participating in recreational sports activities such as basketball or badminton, etc. Before the test, all participants reported no previous family history of diabetes or recent illnesses. Participants had the protocol explained to them and provided written informed consent. The experiment protocol was approved by the Institution's Ethics Committee for the use of human & animal subjects in research.

2.1. *Experiments*

Prior to the experiments, participants performed an incremental cycling test (Ergomedic MONARK839, Sweden) to assess their peak power and maximal oxygen uptake (VO_2max; METAMAX 3B-Cortex, Germany). The VO_2max test was performed as a graded exercise test. Before the test, participants had a 3-min warm-up at 25 W on the ergometer bike. Power output was then increased to 50 W and increased a further 25 W every 2 min until participants reached exhaustion. VO_2max was defined as the value when there was no further increase in oxygen uptake despite increasing the severity of exercise. The cycling workload that produced VO_2max levels was duplicated in the 2WAT and 4WAT tests. Borg scores were assessed during each test for monitoring the perceived exertion during the bout of exercise.

All participants undertook the two different volumes of sprint interval exercise (2WAT and 4WAT) in a controlled laboratory environment (21.2 °C, 66.9% relative humidity) in the late afternoon (18:00 h), a time that was convenient to all participants. Each test was performed on a computerized cycle training system (Ergomedic MONARK839, Sweden), with the participant producing all-out effort (pedaling as fast as possible). Prior to each test, participants refrained from strenuous exercise for 24 h. The protocol used a crossover and randomized design with regard to the order of the three tests of 2WAT, 4WAT and Control (without exercise). Tests were separated by at least 72 h and the three tests were completed within a month. The power of workload index (resistance) was set at 7.5% of the participant's body mass (kg) [12]. Participants' peak power, mean power and fatigue index (decline of power) were recorded as measures of exercise capacity.

On each of the three days of the tests, the individuals were provided with the same meals (breakfast, lunch and dinner) that consisting of approximately 60% carbohydrate, 25% fat and 15% protein. No extra food or drink was allowed. The short-duration sprint interval exercise started 90 min after participants had eaten a standard dinner (1 McDonald's cheeseburger and 250 ml of water). Whilst this protocol does not guarantee full hydration, it does mean that the same food and fluid status was present for all days of the tests. Before the test, all participants had two opportunities to become familiar with the tests. Each part of the first familiarization trial took 20 s, and was repeated 3 times with 4 min interval. Each part of the second familiarization trial took 30 s, and was repeated 4 times with 4 min interval. In addition, to reduce learning effects, the 2WAT, 4WAT and Control parts of the experiment were performed in random order. A low-resistance warm-up was performed for 2–4 min followed by a rest of 2–3 min before each test. The three tests were: (1) Two 30-s bouts of high-intensity interval-cycling on a cycle ergometer at the individual's maximum power workload (2WAT, all-out cycling efforts interspersed with 4 min of active recovery, a total of 5 min); (2) four 30-s bouts of high-intensity interval-cycling at the individual's maximum power workload (4WAT, all-out efforts interspersed with 4 min of active recovery, a total of 14 min); and (3) without exercise (CON, control group).

2.2. *Glucose concentrations*

Blood samples were collected before the meal (pre-prandial, 0 min) and 60, 90 (just before the exercise), 105, 120, 135 and 150 min after the meal (post-prandial) in each test. Capillary blood from a finger prick was collected to determine the blood glucose concentration by using glucose strips (Accu-Chek® Active test strips, Roche, Germany) and a blood glucometer (WM9341TT, Accu-Chek® Active Blood Glucose Monitoring System, Roche, Germany), which showed the readings on a screen.

2.3. *Statistical analysis*

Experimental data were compared across time and between groups (Time: 0, 60, 90, 105, 120, 135, 150 min; groups: 2WAT, 4WAT, CON) using two-way repeated measures analysis of variance (ANOVA). Bonferroni's method was used to assess post hoc pair-wise differences in main effects and their interaction (group × time), comparing blood glucose levels between the 2WAT, 4WAT and CON groups at specific times. A power calculation (beta = 0.8) indicated that the sample size and