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Age-specific affective responses and self-efficacy to acute high-intensity interval training and continuous exercise in insufficiently active young and middle-aged men

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ABSTRACT

Background/objective: High-intensity interval training (HIIT) has been recognized as an emerging trend in public health promotion, but its age-specific differences in psycho-perceptual responses have yet to be investigated. This study compared the psycho-perceptual responses after a single session of HIIT versus moderate-intensity continuous exercise (MICE) and vigorous-intensity continuous exercise (VICE) in twelve young and twelve middle-aged insufficiently active males respectively.

Methods: Using a randomized cross-over design, participants undertook three main trials consisting of: HIIT (10 x 1-min run at 100% VO_{2max} interspersed with 1-min active recovery), MICE (40-min run at 65% VO_{2max}) and VICE (20-min run at 80% VO_{2max}). Affective responses, self-efficacy and exercise preference were assessed for each trial.

Results: Both HIIT and VICE showed more positive in-task affective responses than MICE in young adults, while middle-aged adults reported more positive responses in both HIIT and MICE than in VICE. However, middle-aged adults displayed significantly lower exercise task self-efficacy scores towards HIIT (42.7 ± 25.3) and VICE (49.2 ± 23.9) than MICE (63.4 ± 18.3, both $P < 0.01$). Additionally, only 17% of participants in the middle-aged group reported a preference to engage in HIIT as opposed to either MICE (50%) and VICE (33%).

Conclusion: Our finding revealed distinct affective and self-efficacy responses to acute HIIT versus both MICE and VICE in the two age groups which assists in our understanding of how individuals in various age populations perceive HIIT. This information will assist in the design and implementation of effective exercise programs for public health, especially for insufficiently active individuals.

Introduction

Physical inactivity has been identified as a global pandemic and increases the risk of non-communicable diseases (NCD's) including cardiovascular diseases, cancer and diabetes.[1] In an attempt to reduce premature mortality from NCD's, the World Health Organization (WHO) has set a global target to decrease physical inactivity by 10% by 2025.[1] Current physical activity (PA) guidelines recommend that individuals accumulate at least 150-min of moderate-intensity continuous exercise (MICE), 75-min of vigorous-intensity continuous exercise (VICE), or a combination of both per week.[2] Despite the well-documented health benefits associated with regular PA, epidemiological evidence suggests low worldwide compliance to these guidelines[2] with "lack of time" the most commonly cited barrier to exercise participation.[3] An effective exercise protocol with minimal time commitment is therefore warranted to increase PA among the general population.

High-intensity interval training (HIIT), also commonly referred to as "high-intensity interval exercise" (HIIE), has been recognized as an emerging trend in public health promotion.[4] Historically used

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as a training method by athletes, its recent popularity among the general population is demonstrated in its consistently high rankings in the American College of Sports Medicine Annual Fitness Trend over the past 5 years.[5] HIIT typically involves repeated bouts of high-intensity workout, interspersed with active or inactive recovery periods and compared to the traditional continuous training approach, involves a substantially reduced training volume and lower time commitment.[6] For instance, one of the most common models of low volume HIIT (20 min), utilizing 10 intervals of 60 s conducted at maximal/near maximal aerobic capacity interspersed with 60 s recovery at very low intensities, has been shown to be both feasible and efficacious in improving cardiometabolic health in sedentary adults[7] and in individuals with type 2 diabetes.[8]

Despite the well-documented physiological health benefits of HIIT, research investigating the psycho-perceptual responses to this type of exercise is still in an early stage. Since psycho-perceptual responses can have significant behavioral implications,[9] a typical public health concern is how the general population, particularly insufficiently active and less fit individuals, perceive HIIT and whether they can comply with it in the long term.[10] Findings to date have been conflicting with some studies reporting positive psycho-perceptions to a single bout of HIIT compared to MICE[11–13] and VICE,[14] while others reported contradictory findings.[15] In addition, to the best of our knowledge, relatively few studies have been conducted in insufficiently active adults,[14] a primary target of PA health promotion initiatives.[10] Furthermore, the majority of research to date has been conducted in a single age or heterogeneous age group. The age-specific differences in psycho-perceptual responses to HIIT have yet to be investigated. Age has been shown to be an independent predictor to exercise behavior.[2] Advancing age is associated with a decline in physical capacity which could in turn affect psycho-perceptual responses towards vigorous exercise.[16] Hence, differentiating how individuals in various age populations perceive HIIT is of paramount importance for the design and implementation of effective exercise programs by fitness professionals in public health. The purpose of the present study was to evaluate the age-specific psycho-perceptual responses to a single bout of HIIT versus both MICE and VICE in young and middle-aged insufficiently active adults respectively. It was hypothesized that the psycho-perceptual responses to the trials would differ between the two groups.

Methods

Participants

Twelve young (aged 18–25 yr) and twelve middle-aged (aged 40–59 yr) healthy, insufficiently active males were recruited through advertisements in the university, partner institutions, community centers, and online to participate in the study (see Table 1 for participant demographic characteristics). Inclusion criteria included engaging in less than 150-min of moderate PA or less than 75-min of vigorous PA per week for more than three months,[17] as assessed by the International Physical Activity Questionnaire (IPAQ).[18] Exclusion criteria included severe high blood pressure (≥180/100 mmHg), on medication for chronic disease, myocardial infraction, uncompensated heart failure, or unstable angina pectoris over the previous four weeks, as suggested by the current exercise prescription guidelines.[17] The sample size is a reflection of related research[13] and is based on an anticipated small effect size (i.e., ES = 0.4), with an $\alpha = 0.05$ and a $\beta = 0.20$ (G*Power version 3.0.10). A written informed consent was provided to participants with a detailed explanation of the aim, procedure, benefits and potential risks of the study. The study procedures were submitted and granted by The Ethics Committee at The Chinese University of Hong Kong.

Table 1
Demographic characteristics of participants.

Variable	Young (n = 12)	Middle-aged (n = 12)
Age (yr)	24.3 ± 1.7**	46.8 ± 7.5
Height (cm)	168.3 ± 5.6	168.4 ± 6.8
Weight (kg)	66.8 ± 15.0	66.4 ± 8.1
Body fat (%)	19.5 ± 6.9	19.9 ± 3.8
BMI (kg m^{-2})	23.5 ± 4.6	23.4 ± 2.1
VO_{2max} (mL min^{-1} kg^{-1})	44.9 ± 6.6*	39.5 ± 5.6

Significantly different between groups based on independent sample t-tests: **P < 0.01; *P < 0.05.
BMI: Body mass index; VO_{2max}: Maximal oxygen uptake.

Preliminary testing

During the first laboratory visit, participants' height was measured using a stadiometer (Seca, Leicester). Body weight, body mass index (BMI) and body fat percentage were determined by a body composition analyzer (MC-780MA, Tanita, Japan). Maximal oxygen uptake (VO_{2max}) was determined by a continuous, incremental, graded uphill treadmill running test to volitional exhaustion based on the protocol demonstrated previously by our laboratory.[19] VO_{2max} was considered to be attained when the following standardized criteria were met: (1) a respiratory exchange ratio of greater than or equal to 1.10; (2) failure of heart rate (HR) to increase with increases in workload.[17] HR was recorded continuously during the test using HR telemetry (H7 Sensor, Polar, Finland). Data collected from the VO_{2max} test was used to determine the speed required for the experimental trials.

Familiarization trial

The second visit to the laboratory was a familiarization trial to enable the participants to familiarize with the experimental procedures and to confirm whether the individually prescribed running intensity met the designated percentage VO_{2max} thresholds of each protocol.[14,20] Participants completed the familiarization trial one week after the VO_{2max} test. This trial required them to complete half of each protocol used in the main trials, with a 30-min rest between protocols. The protocol sequence for the familiarization trial was randomized.

Experimental trials

One week after the familiarization trial, participants completed one of the three experimental trials on a standardized treadmill (Pulsar 3p, h/p/cosmos, Germany) in a randomized and counterbalanced order. The HIIT protocol consisted of 10 bouts of 1-min run at 100% VO_{2max} separated by 1-min active recovery at 50% VO_{2max}. The total exercise trial time was 20-min in duration. The MICE protocol consisted of 40-min running at 65% VO_{2max}. The VICE protocol consisted of 20-min running at 80% VO_{2max}. The energy expenditure (EE) was estimated via indirect calorimetry assuming a non-protein respiratory exchange ratio.[21] EE of HIIT and VICE were matched, whereas MICE was not (Table 2). It should be noted that the current methodological approach was adapted from a number of previous studies[11,13,22] to reflect on the relative low-volume and time-efficient nature of HIIT and VICE as compared to the traditional high-volume and long-duration nature of MICE, providing greater real-life implications. HR was monitored continuously during the exercise using heart rate telemetry (H7 Sensor, Polar, Finland). All participants performed a 2-min warm up at 50%