Maturitas 69 (2011) 348–353

Contents lists available at ScienceDirect

Maturitas

journal homepage: www.elsevier.com/locate/maturitas

Cardiorespiratory fitness and its association with body composition and physical activity in Hong Kong Chinese women aged from 55 to 94 years

Ruby Yu[a,*], Forrest Yau[b], Suzanne Ho[b], Jean Woo[a]

[a] Department of Medicine and Therapeutics, The Chinese University of Hong Kong, Hong Kong
[b] School of Public Health and Primary Care, The Chinese University of Hong Kong, Hong Kong

ARTICLE INFO

Article history:
Received 20 August 2010
Received in revised form 21 March 2011
Accepted 10 May 2011

Keywords:
Body composition
Cardiorespiratory fitness
Maximal oxygen uptake
Physical activity
Chinese
Elderly women

ABSTRACT

Background: Low levels of cardiorespiratory fitness have proven to be associated with a higher risk of premature death from all causes, specifically from cardiovascular disease. However, there has been no study conducted to describe the cardiorespiratory fitness normative values in Chinese midlife and elderly.
Objectives: To provide normative values of cardiorespiratory fitness expressed as maximal oxygen uptake (VO_{2max}) and its association with body composition and physical activity in Chinese midlife and elderly women in Hong Kong.
Methods: 659 Chinese women aged from 55 to 94 years were recruited from two existing cohorts: the carotid atherosclerosis in women Hong Kong cohort study and the Osteoporotic Fractures in Women (MsOS) Hong Kong cohort study. Symptom-limited maximal exercise testing on an electrically braked bicycle ergometer was performed to assess VO_{2max}, where the subject was connected to a calibrated metabolic cart for gas analysis. Their body composition and physical activity data were also assessed.
Results: The body mass index was 23.4 kg/m^2 and the mean fat mass and lean body mass were 16.6 kg and 37.3 kg, respectively. The mean VO_{2max} was 20.3 ± 4.1 ml/kg/min (range, 7.9–35.7 ml/kg/min). VO_{2max} decreased with age, with the rate of decline 0.25 ml/kg/min/yr (7.1% per decade). In a subgroup of 475 women from the MsOS study, the decline in VO_{2max} was found to depend on ageing ($\beta = 0.31$, $P < 0.001$), body mass index ($\beta = -0.30$, $P < 0.001$) and levels of physical activity ($\beta = 0.02$, $P < 0.001$). Fat mass was also independently associated with VO_{2max} ($\beta = -0.20$, $P < 0.001$).
Conclusions: This study describes the normative values of VO_{2max} in a sample of Chinese midlife and elderly women which provides a valuable reference to assess health and fitness in Chinese elderly. Results from this study also suggested that body composition and levels of physical activity were important determinants of the age-related decline in VO_{2max}.

1. Introduction

Cardiorespiratory fitness refers to the ability of the circulatory and respiratory systems to supply oxygen to muscles during prolonged physical activity and can be measured directly from respiratory gas exchange during an incremental exercise testing, expressed as maximal oxygen uptake (VO_{2max}) [1]. Low levels of cardiorespiratory fitness have proven to be associated with a higher risk of premature death from all causes, specifically from cardiovascular disease [2–4]. Cardiorespiratory fitness declines with age, [5,6] with a steep decline as individuals enter their sixth and seventh decades [7]. This decline has been attributed to changes in maximal heart rate [5] and stroke volume [8]. Increase in fat mass and decline in lean body mass or muscle mass [9,10] and possibly changes in muscle aerobic capacity with age, [9,11] as well as the age-related decrease in physical activity [8,10,12] also contribute to the age-related decline.

With the ageing population, the burden from disease and disability is increasing substantially. It is important to establish normative values of VO_{2max} in order to help health professionals in the risk assessment and lifestyle prescription to prevent diseases and disability in the elderly. Currently available reference values for the ageing population are confined to Caucasian, [13] who may differ significantly from Chinese in terms of lifestyle, diet and body physiology. However, there has been no study conducted to describe the normative values of VO_{2max} in Chinese elderly.

Previously we have described VO_{2max} normative values for younger to midlife group in the Hong Kong Chinese populations, showing differences with Caucasian values [14]. In the present study, a population-based sample of 659 Hong Kong Chinese

Abbreviations: PASE, Physical Activity Scale for the Elderly; VO_{2max}, Maximal oxygen uptake; WC, Waist circumference; WHR, Waist-hip-ratio.

* Corresponding author. Tel.: +852 2632 2190; fax: +852 2637 9215.
E-mail address: rubyyu@cuhk.edu.hk (R. Yu).

0378-5122/$ – see front matter © 2011 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.maturitas.2011.05.003

midlife and elderly women aged from 55 to 94 years was studied to provide normative values of VO_{2max}, and to examine the contributions of body composition and physical activity, which are modifiable factors, to VO_{2max} in this population.

2. Methods

2.1. Subjects

Subjects were from two existing cohort studies: the carotid atherosclerosis cohort study [15] and the Osteoporotic Fractures in Women (MsOS) Hong Kong cohort study [16]. Details of these two cohorts have been described elsewhere. In brief, the carotid atherosclerosis cohort study was initiated in 2002 when 518 Hong Kong Chinese in women Hong Kong postmenopausal women aged 50–64 years and without cardiovascular disease or other severe conditions such as cancer or renal failure were recruited by random telephone dialing based on the most recent residential telephone directory, with the aim to study the prevalence of carotid atherosclerosis and its associated risk factors in early postmenopausal women. The MsOS study is the largest cohort study on osteoporosis in Asia women which was established in 2001 when 2000 women aged 65 years and older who were ambulant without assistance from another person were recruited from the community. Stratified sampling was adopted in the MsOS study in order to achieve approximately 33% of subjects in each of the three age groups: 65–69, 70–74 and $\geq$75 years. The method of recruitment consists of notices placed in housing estates and community centers all over Hong Kong. The two cohort studies consisted of questionnaire interviews followed by physical examinations at a hospital-based centre at the Prince of Wales Hospital, Hong Kong SAR, China.

Between 2008 and 2010, the two cohorts were invited to reattend repeat questionnaire interviews and physical examinations. 414 of the 518 subjects (79.9%) from the carotid atherosclerosis cohort study and 889 of the 2000 MsOS subjects (44.5%) returned. Subjects who were ambulant without assistance from another person were subsequently invited for the VO_{2max} assessment. Those who reported that they had leg pain, pace maker implanted, or were taking blood thinning medications were excluded. Subjects were also excluded if they had evidence of abnormal resting or exercise electrocardiogram. A total of 659 subjects were eligible and underwent the VO_{2max} assessment. Written informed consent was obtained from each subject and the study was approved by the Ethics Committees of the Chinese University of Hong Kong.

2.2. Cardiorespiratory fitness

VO_{2max} was assessed with a symptom-limited maximal exercise test on an electrically braked bicycle ergometer (Ergoline 900, Ergoline GmbH, Lindenstrasse, Bitz, Germany). Subjects were instructed to abstain from any strenuous exercise on the day before testing. Each subject was connected to a calibrated respiratory gas analyzer (Fitmate, COSMED Srl, Italy) for gas analysis using a face mask. The respiratory gas analyzer was calibrated before each test. Blood pressure was monitored throughout the exercise test. The test started with a 3-min warm up at a workload of 20 W and continued with 10 W increments every minute, until the subject was exhausted or was not able to maintain the required pedaling frequency of 50 rpm. Subjects were verbally encouraged to reach their maximum. The test was terminated when the subject reached peak VO_2 [17,18] or showed any symptoms that indicated termination of exercise based on the guidelines of the American College of Sports Medicine [19].

2.3. Body composition

Height was measured to the nearest 0.5 cm and weight to the nearest 0.1 kg with subjects in light clothing and without shoes. Body mass index (BMI) was calculated as weight in kg divided by the square of height in m. Waist and hip circumferences were measured twice to the nearest 0.5 cm, and the mean value was used for subsequent analyses. Waist circumference (WC) was measured at the narrowest circumference around the trunk between the rib cage and the pelvis while hip circumference was measured at the level of the greater trochanters with a flexible measuring tape. Waist-hip-ratio (WHR) was then calculated. Body fat percentage was measured using a standard impedance technique (Tanita, Tokyo, Japan). Fat mass was calculated by multiplying body fat percentage times total body weight. Lean body mass was subsequently calculated as the difference between total body weight and estimated fat mass.

2.4. Physical activity

Physical activity data was only available for a subgroup of 475 subjects from the MsOS cohort (MsOS women). Physical activity was measured by the validated Physical Activity Scale for the Elderly (PASE) Questionnaire [20]. It measured the level of physical activity in individuals aged 65 years and older. The instrument is a self report/interview-based measure designed to capture and assess occupational, household, and leisure activities typically performed by older adults. For example, under the category of leisure activities, separate items query the amount of time individuals spend each week (a) walking, (b) in light sport and recreational activities, (c) in moderate sport and recreational activities, (d) in strenuous sport and recreational activities, and (e) exercising to increase muscular strength and endurance. Time spent participating in each activity area was multiplied by a weighted value that reflected the amount of energy expended by an older person engaged in that activity. These weighted values were then summed to yield a composite PASE score. This was adapted in Hong Kong Chinese by adding activity items which were popular in the local culture [20,21].

2.5. Other covariates

Information on a number of covariates was also collected. Marital status, education level, medical history, and smoking status (current, former, or never) were obtained by questionnaire interviews.

2.6. Statistical analysis

Continuous variables are reported as mean and standard deviations, and categorical variables as percentages. Subjects were divided into four age groups: 55–64, 65–74, 75–84, and 85–94 years old. Mean values of body compositions and VO_{2max} were compared for groups of subjects using analysis of variance (ANOVA). *P* values for trend were also determined. Due to the small number of subjects in the oldest age group (85–94 years, $n = 22$), data from the age group of 75–84 years and 85–94 years were pooled before analysis. Linear regression analysis was performed to determine the relations between age and VO_{2max}. Further analyses were limited to 475 MsOS women for whom data for physical activity (PASE score) were available. Pearson correlations and partial correlations were calculated to determine the relationships of age, body compositions, and physical activity with VO_{2max}. Subjects were also categorized based on their BMI and level of physical activity. The associations between VO_{2max} and BMI categories/quartiles of physical activity level were examined using analysis of covariance (ANCOVA). Mul-