Validation of Veterans Specific Activity Questionnaire to assess exercise tolerance of Chinese elderly with coronary heart disease

Yan WANG\textsuperscript{1}, Jing-Jing SHI\textsuperscript{2}, Bo-Zhong WANG\textsuperscript{1}

\textsuperscript{1}Department of Cardiac Rehabilitation, Zhejiang Hospital, Hangzhou, Zhejiang, China
\textsuperscript{2}Department of Cardiology, Cixi No.6 Peoples’ Hospital, Cixi, Zhejiang, China

Abstract

**Objective** The Veterans Specific Activity Questionnaire (VSAQ) has been used to assess exercise tolerance. Nevertheless, there is no validated Chinese version. The aim of this study is to determine whether a questionnaire-based method using the Chinese version of VSAQ (the modified VSAQ) is a practical tool to assess exercise tolerance of Chinese elderly with coronary heart disease.

**Methods** One hundred thirty consecutive elderly patients who were diagnosed with coronary heart disease (CHD) (mean age 68.9 ± 6.0 years) referred for treadmill exercise testing (TET) for clinical reasons were included in the study. They were asked to complete a questionnaire for clinical characteristics information on age, sex, history, exercise habits, medications, the original VSAQ and the modified VSAQ. We investigated the relationship between exercise tolerance in metabolic equivalents (METs) estimated by VSAQ and that obtained by TET.

**Results** The METs by the original VSAQ and the modified VSAQ did not differ significantly ($P = 0.528$). The modified VSAQ scores were significantly correlated with the METs obtained by TET ($r = 0.819$, 95% CI: 0.753–0.873, $P < 0.01$), and the scores of original VSAQ also correlated with the METs by TET ($r = 0.804$, 95% CI: 0.745–0.854, $P < 0.01$). The Bland-Altman graph analysis showed few values outside the limits of agreement, suggesting good precision between the METs estimated by questionnaire and the METs obtained by TET.

**Conclusions** The Chinese version of the VSAQ confirmed its validity and equivalence to the original version, especially when evaluating individuals with coronary heart disease and older adults. The results showed that the VSAQ is a valuable tool to assess the exercise tolerance.

Keywords: Chinese Elderly; Coronary heart disease; Exercise tolerance; Veterans Specific Activity Questionnaire

1 Introduction

Low levels of exercise tolerance have been considered as a risk factor for mortality.\cite{1,2} Determining exercise tolerance through an exercise test (ET) makes this type of assessment very important, as it is used as an important diagnostic and prognostic tool.\cite{3} In at-risk populations, such as the elderly and those with heart disease, the ET performance is impaired by the lower functional capacity and frailty exhibited by these individuals.\cite{4,5} Thus far, several methods have been used to evaluate individual exercise capacity without performing the exercise test.\cite{6-8} One of the main methods found in literature is the Veterans Specific Activity Questionnaire (VSAQ), which initially developed for the individualization of the ET.\cite{5}\cite{9} Using a predictive equation together with the age variable, the questionnaire has also been used to estimate exercise tolerance of revascularized individuals, as an indicator or mortality risk in male individuals with an ET indication.\cite{10,11}

In the VSAQ developed by Myers, et al.\cite{5} (original VSAQ, Appendix 1), certain daily activities were unfamiliar to Chinese elderly. Therefore, we made a few modifications to the original VSAQ in order to evaluate exercise capacity of Chinese elderly precisely (Appendix 2). In the original VSAQ, 13 MET items were enumerated for each MET. In the modified VSAQ, two doctors, two physical therapists reviewed the questions and then changed certain activity items to make those familiar to Chinese elderly. These newly added activities were in agreement with each MET and were chosen on the basis of Chinese experts consensus on Rehabilitation and secondary prevention of Coronary heart disease.\cite{12}

The purpose of the current study was to determine the ability of the Chinese version VSAQ obtained just before the test to estimate exercise tolerance in elderly with coronary heart disease (CHD).
2 Methods

2.1 Patients

A total of 130 elderly patients who were diagnosed with CHD were evaluated with an ET indication. The mean age was 68.9 ± 6.0 years with male predominance (70.8%). The following inclusion criteria were established for participating in the present study: all participants had stable heart disease, were asymptomatic, had been followed for at least six months at the outpatient clinic. They were in stable clinical condition with NYHA functional classes from I to III. Their mean body mass index was < 30 kg/m², resting left ventricular ejection fraction > 45% on transthoracic echocardiography, and had no history of pulmonary disease, renal failure, or orthopedic or neurologic disorders that limited physical exercise. The participants were asked to complete a self-administered questionnaire for information on age, sex, exercise and physical activities, and so on. Clinical characteristics of the study group are listed in Table 1. The test was interrupted due to maximum voluntary exertion. Patients were excluded if their exercise test was sub-maximal (e.g., post–myocardial infarction with a predetermined sub-maximal end point) or terminated by the supervising physician for reasons other than symptom or sign limits. The study protocol was approved by The Ethics Committee of Zhejiang Hospital. There was no conflict of interest related to the present study.

2.2 Questionnaire

Before exercise testing, the original VSAQ (Appendix 1) and the Chinese version of VSAQ (Appendix 2) were given to each patient. VSAQ is a very simple and easy questionnaire-based method that enables the evaluation of the exercise capacity of middle-aged and elderly people, and it has been used widely in the USA. The use of VSAQ allows the determination of different intensities of daily activities with corresponding MET in an increasing order. The scale ranges from 1 MET to 13 METs. The participants were asked to choose the MET that reflected the activity with the highest intensity that the participants are able to do routinely, and this MET was expressed as “VSAQ maximum”. Then, we substituted this value for the following regression equation developed by Myers, et al. to predict the exercise capacity of the participants.

\[
\text{METs} = 4.74 + 0.97 \times \text{VSAQ maximum} - 0.06 \times \text{age}
\]

In this study, we used the interviewer-administered Chinese version of VSAQ. We explained the meaning of each question to the participants orally and let them reply to it after understanding the questionnaire sufficiently. The participants were asked to identify the activities in a list categorized in term of their MET (1–13) (the original VSAQ and the modified VSAQ) into that they are able to do routinely or they are unable to do.

We examined the relationship between the METs estimated by the modified VSAQ and the original VSAQ and the METs obtained by TET.

2.3 Exercise testing

All patients underwent maximal exercise testing using a treadmill protocol (Bruce) in a GE treadmill. The professionals that conducted the tests were blinded to the results estimated at the VSAQ. This test individualizes both warm-up and peak walking speeds and ramp rate (rate of change in speed and grade) to yield a test duration of approximately 10 min. The maximum measured METs obtained from the final speed and grade on the treadmill. Blood pressure was recorded in alternate min throughout the test, whereas a 12 lead electrocardiogram was recorded each minute. The patient’s subjective level of exertion was assessed by the Borg 6–20 scale. Standard clinical criteria for terminating the tests were followed, but no heart rate or time limit was imposed and a maximal effort was encouraged. Patients were discouraged from holding onto the handrails for support as much as possible.

2.4 Statistical analysis

Statistical analysis was performed by using the Statistical Package for the Social Sciences, version 17 (SPSS Inc, Chicago, IL, USA). Continuous variables are presented as mean ± SD, categorical variables are presented as percentages or as the number of subjects.

Table 1. Baseline clinical characteristics.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yrs</td>
<td>68.9 ± 6.0</td>
</tr>
<tr>
<td>Male/female</td>
<td>92/38</td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td>24.6 ± 3.1</td>
</tr>
<tr>
<td>Resting heart rate, beats/min</td>
<td>71 ± 10</td>
</tr>
<tr>
<td>Resting systolic blood pressure, mmHg</td>
<td>136.9 ± 16.0</td>
</tr>
<tr>
<td>Resting diastolic blood pressure, mmHg</td>
<td>77.6 ± 9.8</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>32 (24.6%)</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>15 (11.5%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>46 (35.3%)</td>
</tr>
<tr>
<td>History of myocardial infarction</td>
<td>14 (10.8%)</td>
</tr>
<tr>
<td>Coronary angioplasty</td>
<td>48 (36.9%)</td>
</tr>
<tr>
<td>Smoking</td>
<td>18 (13.8%)</td>
</tr>
<tr>
<td>Medications</td>
<td></td>
</tr>
<tr>
<td>Beta-blockers</td>
<td>54 (41.5%)</td>
</tr>
<tr>
<td>Calcium antagonist</td>
<td>46 (35.4%)</td>
</tr>
<tr>
<td>Nitrates</td>
<td>22 (16.9%)</td>
</tr>
</tbody>
</table>

Data are presented as mean ± SD, n (%) or n.
To identify a possible difference between the original VSAQ and the modified VSAQ, we used the paired $t$ test. For the validation of the questionnaire, the Pearson correlation coefficients were used to explore the relationships between the METs estimated from the VSAQ and the METs obtained from treadmill. The Bland-Altman plot was constructed to visually evaluate the agreement between the VSAQ and ET. Ninety-five percent limits of agreement were calculated from the mean difference between the 2 methods $\pm$ 1.96 times the standard deviation of the differences.

3 Results

Exercise test results are listed in Table 2. The mean peak heart rate was 133 ± 19 beats/min, which was 87.2% ± 13% of the maximum predicted heart rate. The mean peak rating of perceived exertion was 17.2 ± 0.7, suggesting that a maximal effort was achieved by most patients. The mean exercise test duration was 9.6 ± 3.2 min, which fell within the current exercise testing recommendations.

**Table 2. Responses to exercise testing.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak heart rate, beats/min</td>
<td>133 ± 19</td>
</tr>
<tr>
<td>Maximum predicted heart rate, %</td>
<td>87.2 ± 13.0</td>
</tr>
<tr>
<td>Peak rating of perceived exertion</td>
<td>17.2 ± 0.7</td>
</tr>
<tr>
<td>METs obtained by TET</td>
<td>9.46 ± 2.59</td>
</tr>
<tr>
<td>METs estimated by original VSAQ</td>
<td>7.88 ± 2.35</td>
</tr>
<tr>
<td>METs estimated by modified VSAQ</td>
<td>7.95 ± 2.49</td>
</tr>
<tr>
<td>Treadmill time, min</td>
<td>9.6 ± 3.2</td>
</tr>
</tbody>
</table>

Data are presented as mean ± SD. METs: metabolic equivalents; TET: treadmill exercise testing; VSAQ: the Veterans Specific Activity Questionnaire.

The METs by the original VSAQ and the modified VSAQ did not difference significantly ($P = 0.528$) and were significantly correlated with the TET data ($P < 0.01$). The correlations obtained between the METs estimated by original and modified VSAQ and the METs obtained by TET were shown in Figure 1. The Bland-Altman plots (Figure 2) showed few values outside the limits of agreement. As dotted lines, the 95% CI values, which were respectively, $-1.48$ and $4.64$ between the METs by original VSAQ and the METs by TET, and $-1.44$ and $4.40$ between the METs by modified VSAQ and the METs by TET.

4 Discussion

Several aerobic fitness questionnaires which instead of exercising test, have been designed and validated to assess cardiovascular population over years,[15,16] whereas the measurement of aerobic fitness in older adults is also of extreme importance for assessing clinical status, and therapeutic interventions. The New York Heart Association (NYHA), Canadian Cardiovascular Society (CCS), and Specific Activity Scales (SAS) can estimate a patient’s exercise capacity. The advantages of these approaches include their ease of use, time and expenses saving, and avoidance of risk associated with maximal exercise. Their disadvantages include the fact that they are subjective, were limited by classification into only 4 functional groups, by the fact that they generally provided only modest associations with exercise tolerance measured by exercise testing.[17–21]

Except for the study by Myers, et al.[22] carried out in individuals with heart failure, which found a correlation of 0.73 between the VSAQ and the maximum oxygen consumption (VO2 peak) during the test. The studies of Rankin, et al.[18] Pierson, et al.[23] Maranhão-Neto Gde, et al.[24] and Kojima, et al.[25] showed that high correlations of 0.56–0.71

Figure 1. Scatter diagram between the METs by the original VSAQ and the Chinese version of VSAQ and the METs by TET. The METs by the original VSAQ ($r = 0.804, 95\% CI: 0.745–0.854, P < 0.01$) and those by the modified VSAQ ($r = 0.819, 95\% CI: 0.753–0.873, P < 0.01$) correlated relatively well with the METs by TET. METs: metabolic equivalents; TET: treadmill exercise testing; VSAQ: the Veterans Specific Activity Questionnaire.

http://www.jgc301.com; jgc@mail.sciencep.com | Journal of Geriatric Cardiology
Figure 2. Bland-Altman plot between the METs by the original VSAQ and the Chinese version of VSAQ and the METs by TET. Solid line represents mean difference of the two methods, the dotted line is the line of equality, and the dashed lines represent the 95% limits of agreement of the mean differences. METs: metabolic equivalents; TET: treadmill exercise testing; VSAQ: the Veterans Specific Activity Questionnaire.

were observed when the VSAQ was applied to older populations with some cardiovascular impairment.

In our study, the METs by the original VSAQ and the modified VSAQ did not differ significantly. Our results demonstrated that the VSAQ scores have a good relationship with the TET values. The correlation between obtained MET values by TET and the modified VSAQ and the original VSAQ scores is 0.819 and 0.804, respectively ($P < 0.01$). Nevertheless, it can be observed that the METs estimated from the modified VSAQ tended to underestimate the obtained METs from treadmill workload (7.95 and 9.46, Table 2). This can be explained in part by the fact that the treadmill workload is well known to overpredict exercise tolerance in patients with heart disease.[17] The results demonstrated by the Bland Altman graph analysis (Figure 2) show few values outside the ranges established by the 95% CI, which suggests good precision between the result estimated through the VSAQ and the obtained MET values from TET.

In terms of interview compared with self-administered questionnaires, Hlatky, et al.[26] developed the Duke Activity Status Index, a 12-item activity scale, and reported a higher correlation with measured peak VO2 than with other scales (0.80) when the patient was interviewed, but the correlation was only 0.58 when self-administered. Since many Chinese older people are poorly educated or even illiterate, and a previous study had reported that older people had difficulty in completing this scale.[27] So, In this study, the VSAQ was interviewer-administered by one trained physical therapist, blinded to the TET data. She explained the meaning of each question in VSAQ to the participants orally and let them reply to it after understanding the questionnaire sufficiently. The administration of the VSAQ took approximately 10 min.

In our study, there was no significant difference between the METs by the original VSAQ and the modified VSAQ.

It is worth mentioning that the results shown in the present study were obtained in individuals with heart disease, mostly of the male and older than 60 years. Thus, the VSAQ version would have lower external validity for the assessment of samples consisting of younger individuals and a majority of female individuals. Cardiopulmonary exercise testing, with a direct measurement of expired gases, is gold standard to obtain an objective assessment of a patient’s functional status. In the absence of gas exchange techniques, all estimates of exercise capacity should be viewed with caution. Errors in predicting maximal oxygen uptake from treadmill time or work load are well documented. In addition to the shortcomings associated with the METs obtained treadmill as a measure of exercise capacity, the accuracy of a questionnaire such as the VSAQ greatly depends on individual differences in perceptions of, familiarity with and tolerance to similar activities.

In conclusion, our findings confirmed the criterion validity of the Chinese version of the VSAQ. The results obtained in the tool validity were similar to those found from the original version, especially in samples similar to that of the present study (individuals with heart disease and the elderly).

Acknowledgement

This study was supported by Grants from the Zhejiang Medical Science and Technology Project (2015KYB006).
References


http://www.jgc301.com; jgc@mail.sciencep.com | Journal of Geriatric Cardiology
<table>
<thead>
<tr>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MET Eating, getting dressed, working at a desk</td>
</tr>
<tr>
<td>2 METs Taking a shower, walking down eight steps</td>
</tr>
<tr>
<td>3 METs Walking slowly on a flat surface for one or two blocks (150–200 m), performing a moderate amount of work around the house, like vacuuming, sweeping the floors or carrying groceries</td>
</tr>
<tr>
<td>4 METs Light yard work, i.e., raking leaves, weeding or pushing a power mower, painting or light carpentry</td>
</tr>
<tr>
<td>5 METs Walking briskly, i.e., 4 miles per hour (6.4 km/hour), social dancing, washing the car</td>
</tr>
<tr>
<td>6 METs Play nine holes of golf carrying your own club, heavy carpentry, mow lawn with push mower</td>
</tr>
<tr>
<td>7 METs Perform heavy outdoor work, i.e., digging, spading soil, play tennis (singles), carry 60 pounds (27 kg)</td>
</tr>
<tr>
<td>8 METs Move heavy furniture, jog slowly, climb stairs quickly, carrying 20 pounds (9 kg) upstairs</td>
</tr>
<tr>
<td>9 METs Bicycling at a moderate pace, sawing wood, jumping rope (slowly)</td>
</tr>
<tr>
<td>10 METs Brisk swimming, bicycle up a hill, walking briskly uphill, jog 6 miles per hour (9.6 km/h)</td>
</tr>
<tr>
<td>11 METs Cross country ski, play basketball (full court)</td>
</tr>
<tr>
<td>12 METs Running briskly, level ground, 8 miles per hour (12.8 km/h), continuously</td>
</tr>
<tr>
<td>13 METs Any competitive activity, including those which involve intermittent sprinting, running competitively, rowing, backpacking</td>
</tr>
</tbody>
</table>

*The Veterans Specific Activity Questionnaire from Myers, *et al.*[5] Draw one line below the activities, you are able to do routinely with minimal or no symptoms, such as shortness of breath, chest discomfort and fatigue.
<table>
<thead>
<tr>
<th>Activities</th>
<th>METs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting</td>
<td>1</td>
</tr>
<tr>
<td>Eating, getting dressed, working at a desk</td>
<td>2</td>
</tr>
<tr>
<td>Taking a shower, walking down eight steps</td>
<td>3</td>
</tr>
<tr>
<td>Performing light yard work, i.e., raking leaves, weeding, performing a moderate amount of work around the house, like vacuuming, sweeping the floors or carrying groceries</td>
<td>4</td>
</tr>
<tr>
<td>Playing with animals, walking downstairs or standing, carrying objects about 10–20 kg. Walking briskly, i.e., 4 miles per hour (6.4 km/h)</td>
<td>5</td>
</tr>
<tr>
<td>Bicycling 16 km/h, shoveling snow by hand, social dancing, washing the car</td>
<td>6</td>
</tr>
<tr>
<td>Carrying objects about 20–30 kg, jogging in general</td>
<td>7</td>
</tr>
<tr>
<td>Jumping rope slowly, carrying a 10–20 kg load upstairs, climb stairs quickly</td>
<td>8</td>
</tr>
<tr>
<td>Moving household items upstairs, climbing hills with 20 kg load</td>
<td>9</td>
</tr>
<tr>
<td>Running 10 km/h, basketball, sawing wood</td>
<td>10</td>
</tr>
<tr>
<td>Rock climbing, swimming quickly, bicycle up a hill</td>
<td>11</td>
</tr>
<tr>
<td>Jumping rope fast, carrying 30 kg load upstairs, running 12 km/h, bicycling briskly, continuously</td>
<td>12</td>
</tr>
<tr>
<td>Any competitive activity, including those which involve intermittent sprinting, running competitively, rowing, backpacking</td>
<td>13</td>
</tr>
</tbody>
</table>

*The activities corresponding to 1 MET–13 METs were modified partly according to Chinese experts consensus on Rehabilitation and secondary prevention of Coronary heart disease.[12] Draw one line below the activities you are able to do routinely with minimal or no symptoms, such as shortness of breath, chest discomfort and fatigue.