Chapter 3
Impairment of exercise capacity and peak oxygen consumption in patients with mild left ventricular dysfunction and coronary artery disease

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ABSTRACT

Aims
Most studies in chronic heart failure have included only patients with marked left ventricular systolic dysfunction (i.e. ejection fraction \( \leq 0.35 \)), and patients with mild left ventricular dysfunction are usually excluded. Further, exercise capacity strongly depends on age, but age-adjustment is usually not applied in these studies. Therefore, this study evaluated, whether (age-adjusted) peak VO\(_2\) was impaired in patients with mild left ventricular dysfunction.

Methods
Peak VO\(_2\) and ventilatory anaerobic threshold were measured in 56 male patients with mild left ventricular dysfunction (ejection fraction 0.35-0.55; study-population) and in 17 male patients with a normal left ventricular function (ejection fraction \( >0.55 \); control-population). All patients had an old (>4 weeks) myocardial infarction. By using age-adjusted peak VO\(_2\) values, a “decreased” exercise capacity was defined as \( \leq \) predicted peak VO\(_2\)-1x SD (0.81 of predicted peak VO\(_2\)), and a “severely decreased” exercise capacity as \( \leq \) predicted peak VO\(_2\)-2x SD (0.62 of predicted peak VO\(_2\)).

Results
Patients in the study-population (age 52±9 yr; ejection fraction 0.46±0.06) were mostly asymptomatic (NYHA class I; n=50, 76%), while 16 patients (24%) had mild symptoms, i.e. NYHA class II. All 17 controls (age 57±8 yr) were asymptomatic. Mean peak VO\(_2\) was lower in patients with mild left ventricular dysfunction (23.6±5.7 vs. 27.1±4.6 ml/min/kg in controls, \( p<0.05 \)). In 75% of the study-population patients (n=42) age-adjusted peak VO\(_2\) was “decreased” (NYHA I/II: n= 29/13) and in 18% of them “severely decreased” (n=10; NYHA I/II: n=6/4). In contrast, only 3 patients (18%) in the control-population had a “decreased” and none of them a “severely decreased” age-adjusted peak VO\(_2\).

Conclusion
In patients with mild left ventricular dysfunction, who have either no or only mild symptoms of chronic heart failure, a substantial proportion has an impaired exercise capacity. By using age-adjustment, impairment of exercise capacity becomes more evident in younger patients. Patients with mild left ventricular dysfunction are probably underdiagnosed, and this finding has clinical and therapeutic implications.
INTRODUCTION

Impairment of exercise capacity is one of the hallmarks of chronic heart failure, and it has been shown to be strongly correlated with the severity of the disease\textsuperscript{1,2}. Still, most chronic heart failure trials use left ventricular ejection fraction as inclusion criterium rather than a parameter of exercise capacity. The ejection fraction is a reliable parameter of systolic left ventricular function and can be easily determined by radionuclide techniques, ventriculography during coronary angiography, or echocardiography. Left ventricular ejection fraction, however, does not directly reflect symptoms of chronic heart failure and exercise incapacity, and particularly patients with chronic heart failure due to diastolic dysfunction are often overlooked when only ejection fraction is examined\textsuperscript{3-6}. As a consequence, assessment of exercise capacity, and in particular determination of peak VO\textsubscript{2} is increasingly used in heart failure studies\textsuperscript{1,2,6-8}. Determination of peak VO\textsubscript{2} allows objective assessment of exercise tolerance, and has been shown to correlate significantly with NYHA functional class, and to predict mortality in chronic heart failure\textsuperscript{1,2}. Further, it is often used to assess the effect of drug interventions\textsuperscript{8,9}.

Peak VO\textsubscript{2} is strongly influenced by both age and gender\textsuperscript{10-12}, but in most heart failure studies this relation is not taken into account. Adjustment for age and gender would overcome this problem, and has been shown to improve the prognostic value of peak VO\textsubscript{2}\textsuperscript{13,14}. Especially in younger patients sensitivity of peak VO\textsubscript{2} to detect an impaired exercise tolerance may be lower, if not corrected for age. For example, any peak VO\textsubscript{2}-value of > 20 ml/min/kg (Weber class A) would be regarded as normal by many physicians, while a peak VO\textsubscript{2} of 20 ml/kg/min is at least a 40% reduction of the predicted value in patients younger than 50 years\textsuperscript{7,15}. This underestimation of severity of disease may have a substantial impact, both from a medical and a socio-economic point of view, and age-adjustment is therefore important. Since there is now increasing evidence that left ventricular dysfunction and chronic heart failure should be treated as soon as possible, in order to prevent progression of disease, early detection and management of these patients might be needed.

The aim of the present study was to study exercise capacity, including measurement of peak VO\textsubscript{2} and ventilatory anaerobic threshold, in a homogenous cohort of patients with mild left ventricular dysfunction and old myocardial infarction, and to compare them with control patients with a normal left ventricular function.

METHODS

Patients

Patients were selected from a population who were referred to cardiac rehabilitation. Male patients were eligible for the study if they met the following criteria: A) age 30-70 years, B) left ventricular ejection fraction 0.35-0.55 (study-population) or > 0.55 (control-population), C) reliable peak VO\textsubscript{2} (criteria: respiratory exchange ratio [RER] > 1.00 and blood lactate concentration > 4.0 mmol/l at peak exercise; exercise tests limited by dyspnea or general fatigue, but not by angina or
hypertension), D) old (>4 weeks) myocardial infarction, and E) sinus rhythm. Further, they had no contraindications for exercise testing nor any exercise limiting concurrent condition (e.g. chronic obstructive pulmonary disease, orthopaedic, vascular and/or neurologic disease). The study protocol was approved by the institutional review board and written informed consent was obtained from all patients.

**Procedures**

All patients were familiarized to the exercise testing protocol by a preliminary exercise test with respiratory gas exchange measurement one to three days before the exercise test. Graded symptom-limited exercise testing was performed on an electromagnetically braked cycle ergometer (Lode Excalibur, Groningen, the Netherlands). The protocol consisted of a three minute warm-up period at a workload of 20 Watt; in the next stage workload was increased to 50 Watt and subsequently every minute with 10 Watt. A complete 12-lead electrocardiogram was monitored continuously. Patients breathed through a mask with a turbine volume transducer, measuring the volume of inspired and expired air. Respired gases were withdrawn from the mask for determination of O₂ and CO₂ and were analyzed breath by breath (Jaeger Oxycon Champion, Breda, the Netherlands). The gas-analysers as well as the volume transducer were calibrated before each test. Peak VO₂ was defined as the mean VO₂ of the last minute of the exercise test. Patients were encouraged during exercise test to reach maximal effort (subjective criteria: exhaustion; objective criteria: RER>1.00, maximal blood lactate concentration > 4.00 mmol/l). Anaerobic threshold was determined using the ventilatory equivalent method¹⁶ (i.e. increase of VE/VO₂ without a simultaneous increase of VE/VCO₂) by visual inspection of three experienced observers, independently. In addition, anaerobic threshold was also determined using the V-slope method (i.e. disappearance of the linear relation between VCO₂ and VO₂) and using the RER=1 method (i.e. the moment VCO₂=VO₂).

Echocardiographic measurements were performed with a Vingmed CFM 800 (Vingmed Sound, Horten, Norway). Left ventricular dimensions were measured with two dimensional echocardiography at rest using standard parasternal and apical views¹⁷. Endocardial contours of the left ventricle at end-diastole and end-systole were traced in two orthogonal apical views. End-diastolic and end-systolic left ventricular volumes were calculated; ejection fraction was derived from these volumes. Regional wall motion abnormalities were evaluated using the wall motion score index¹⁸.

**Statistical analysis**

Predicted peak VO₂ was calculated with the Jones formula [i.e. in male patients: predicted peak VO₂ = 60 - 0.55 x age(ml/kg/min)]¹⁵. A "decreased" exercise capacity was defined as ≤ predicted peak VO₂ -1x SD (≈ 0.81 of predicted peak VO₂); a "severely decreased" exercise capacity as ≤ predicted peak VO₂ - 2x SD (≈ 0.62 of predicted peak VO₂). Patients were also graded according to the Weber classification⁸; class A peak VO₂ > 20 ml/kg/min, class B peak VO₂ ≤ 20 and > 16 ml/kg/min, class C ≤ 16 and > 10 ml/kg/min, class D ≤ 10 ml/kg/min. Age-adjusted maximal heart rate was calculated by dividing the maximal achieved heart rate by 220-age¹⁹.
Statistics were obtained using SPSS/PC\textsuperscript{+}, version 5.01 1992. Differences between groups (study versus control population; NYHA I versus NYHA II) were analyzed using unpaired t-test. Correlation between exercise capacity, echocardiographic measurements (or left ventricular function and dimensions), and three methods of determination of anaerobic threshold were tested; the Pearson product moment correlation coefficient \((r)\) is reported as a measure of strength of association between two variables. A \(\chi\)-square test was used to assess the agreement between Weber classification and a classification based on fraction of predicted peak VO\(_2\). Statistical significance was defined as \(p<0.05\). Group data for each variable are expressed as mean value \(\pm\) SD.

**RESULTS**

*Patient characteristics*

Of a total of 106 patients who enrolled the cardiac rehabilitation program, 56 patients fulfilled all criteria for the study-population and 17 patients for the control-population. Patients were excluded because of an ejection fraction \(<0.35\) (\(n=16\)), or when no reliable exercise test was performed, which was in most cases due to chronic obstructive pulmonary disease, peripheral vascular disease, or arthrosis (\(n=17\)). Most patients of the study-population had no symptoms of chronic heart failure (NYHA I; \(n=50\)) and 16 patients had mild symptoms (NYHA II), while all patients in the control-population were asymptomatic. The mean age of control-population (57.2\(\pm\)7.5) was

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>STUDY-population</th>
<th>CONTROL-population</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>all (n=56)</td>
<td>NYHA I (n=40)</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>51.8 (\pm) 9.1</td>
<td>52.3 (\pm) 9.1</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>81.4 (\pm) 11.0</td>
<td>81.6 (\pm) 11.2</td>
</tr>
<tr>
<td>Length (cm)</td>
<td>177.5 (\pm) 7.8</td>
<td>177.8 (\pm) 8.2</td>
</tr>
<tr>
<td>Localisation myocardial infarction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>anterior</td>
<td>22 (39%)</td>
<td>12 (30%)</td>
</tr>
<tr>
<td>inferior</td>
<td>27 (48%)</td>
<td>22 (55%)</td>
</tr>
<tr>
<td>lateral</td>
<td>2 (4%)</td>
<td>1 (3%)</td>
</tr>
<tr>
<td>non-Q wave</td>
<td>5 (9%)</td>
<td>5 (12%)</td>
</tr>
<tr>
<td>Medication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\beta)-blocker</td>
<td>48 (86%)</td>
<td>36 (90%)</td>
</tr>
<tr>
<td>calcium-antagonist</td>
<td>10 (18%)</td>
<td>7 (18%)</td>
</tr>
<tr>
<td>nitrate (long acting)</td>
<td>9 (16%)</td>
<td>6 (15%)</td>
</tr>
<tr>
<td>ACE-inhibitor</td>
<td>10 (18%)</td>
<td>6 (15%)</td>
</tr>
<tr>
<td>diuretics</td>
<td>8 (14%)</td>
<td>4 (10%)</td>
</tr>
<tr>
<td>digitalis</td>
<td>1 (2%)</td>
<td>1 (3%)</td>
</tr>
</tbody>
</table>

*Table 1. Characteristics of patients.*

Data presented are mean value \(\pm\) SD or the number (percentage) of patients. There were no significant differences between the study- and the control-population.
slightly, but not significantly higher than the study-population (table 1); all other characteristics were comparable. Also there were no significant differences between NYHA class I and II patients of the study-population; only ejection fraction was slightly higher in NYHA class I than in NYHA class II (p=ns) (table 2).

**Table 2.** Resting left ventricular parameters measured by echocardiography. Data are presented in mean value ± SD; † borderline significant difference between NYHA I and NYHA II (p=0.083); * significant (p<0.05) difference between study- and control-population.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>STUDY-population</th>
<th>CONTROL-population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>all</td>
<td>NYHA I</td>
</tr>
<tr>
<td>LVEF</td>
<td>0.46 ± 0.06†</td>
<td>0.47 ± 0.06†</td>
</tr>
<tr>
<td>WMSI†</td>
<td>1.29 ± 0.24†</td>
<td>1.27 ± 0.24</td>
</tr>
<tr>
<td>LVED (mm)</td>
<td>52.6 ± 5.49</td>
<td>52.7 ± 5.49</td>
</tr>
<tr>
<td>LVES (mm)</td>
<td>38.2 ± 6.35</td>
<td>37.8 ± 5.72</td>
</tr>
<tr>
<td>LVPW (mm)</td>
<td>9.4 ± 1.49</td>
<td>9.4 ± 1.65</td>
</tr>
</tbody>
</table>

**Table 3.** Results of symptom-limited graded exercise tests with gas-exchange measurement. Results of symptom-limited graded exercise tests with gas-exchange measurement.

Data are mean ± SD; † borderline significant (p=0.0081) and ‡ significant (p<0.001) difference between NYHA I and NYHA II; * significant (p<0.05) difference between study- and control-population.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>STUDY-population</th>
<th>CONTROL-population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>all</td>
<td>NYHA I</td>
</tr>
<tr>
<td>W max (Watt)</td>
<td>151 ± 38.8</td>
<td>155 ± 40.4</td>
</tr>
<tr>
<td>(Watt/kg)</td>
<td>1.86 ± 0.46</td>
<td>1.90 ± 0.48</td>
</tr>
<tr>
<td>peak VO$_2$ (ml.min$^{-1}$.kg$^{-1}$)</td>
<td>23.6 ± 5.74*</td>
<td>23.9 ± 6.03</td>
</tr>
<tr>
<td>age-adjusted peak VO$_2$</td>
<td>0.77 ± 0.19†</td>
<td>0.80 ± 0.20†</td>
</tr>
<tr>
<td>AT Watt</td>
<td>97 ± 28.7</td>
<td>106 ± 30.8‡</td>
</tr>
<tr>
<td>VO$_2$</td>
<td>17.3 ± 5.06</td>
<td>18.4 ± 5.42‡</td>
</tr>
<tr>
<td>age-adjusted AT Watt</td>
<td>0.79 ± 0.24</td>
<td>0.87 ± 0.26‡</td>
</tr>
<tr>
<td>RER</td>
<td>1.11 ± 0.04</td>
<td>1.11 ± 0.04</td>
</tr>
<tr>
<td>BPmax. systolic</td>
<td>181 ± 30.0</td>
<td>184 ± 28.0</td>
</tr>
<tr>
<td>diastolic</td>
<td>84 ± 10.9</td>
<td>84 ± 9.7</td>
</tr>
<tr>
<td>HRmax.</td>
<td>133 ± 20.8</td>
<td>134 ± 21.1</td>
</tr>
<tr>
<td>age-adjusted HRmax.</td>
<td>0.80 ± 0.12</td>
<td>0.79 ± 0.12</td>
</tr>
</tbody>
</table>
Exercise capacity

Both mean peak VO\textsubscript{2} and age-adjusted peak VO\textsubscript{2} were significantly lower in the study-population (23.6 ml/kg/min, and 0.77, respectively) compared with the control-population (27.1 ml/kg/min, and respectively 0.96; differences p=0.032 and p=0.004) (table 3). Age-adjusted peak VO\textsubscript{2} was in 75% of patients of the study-population “decreased” (≤ peak VO\textsubscript{2} - 1xSD [=0.81 of predicted peak VO\textsubscript{2}]), and in 18% it was “severely decreased” (≤ peak VO\textsubscript{2} - 2xSD [=0.62 of predicted peak VO\textsubscript{2}]) (fig. 1a). In only 3 patients (=5%) peak VO\textsubscript{2} was > 1xSD above predicted values. In contrast, in the control-population only 3 patients (=18%) had a “decreased” age-adjusted peak VO\textsubscript{2}, and none of them had a “severely decreased” exercise capacity (fig. 1b).

![figure 1. Scatterplot of peak VO\textsubscript{2} and age. The line represents the predicted peak VO\textsubscript{2} according to Jones’ formula; the dashed lines represent respectively peak VO\textsubscript{2} - 1xSD (=0.81 of predicted peak VO\textsubscript{2}) and peak VO\textsubscript{2} - 2xSD (=0.62 of predicted peak VO\textsubscript{2}).

a. study-population (EF ≥ 0.35 and ≤ 0.55).

b. control-population (EF > 0.55).]
The Weber classification correlated significantly with a classification based on age-adjusted peak VO\textsubscript{2} in the study-population (r=0.48; p<0.001). There was also a relation between age and Weber classification: patients in Weber class A were significantly younger (n=39, 70%; 49 ± 9 yr), than patients in Weber B (n=13, 23%; 57±6 yr) and C (n=4, 7%; 58±7 yr) (p< 0.05). In contrast, when peak VO\textsubscript{2} was adjusted for age, those patients who were classified as “severely decreased” were significantly younger (48±7 yr), than those with a “decreased” (51±10 yr), or with a “normal” peak VO\textsubscript{2} (56±9 yr) (p< 0.05).

In general, there was no significant correlation between exercise parameters and indices of left ventricular function. There were no significant differences between the asymptomatic patients of the study-population (NYHA I) and patients with mild symptoms (NYHA II) with respect to peak exercise parameters. In contrast, anaerobic threshold was significantly lower in the patients with NYHA II. Mean (age-adjusted) anaerobic threshold showed no significant difference between study- and control-population.

Anaerobic threshold was determined with three methods. Correlation between these methods was highly significant (p<0.001) (ventilatory equivalent method versus V-slope and RER=1 respectively r = 0.73 and r = 0.80; V-slope versus RER=1 r = 0.77). Ventilatory-equivalent method was significantly higher than the V-slope method (p<0.001) and significantly lower than RER=1 method (p<0.001). Results of other analyses demonstrated comparable data on all three methods of anaerobic threshold measurement; only the results of the ventilatory-equivalent method are demonstrated.

**DISCUSSION**

There is increasing evidence that treatment of left ventricular dysfunction and early or mild chronic heart failure should be initiated as soon as possible to prevent progression of the disease \textsuperscript{20}. Early intervention is only possible, however, if these patients are identified, which may be difficult if they are asymptomatic (NYHA I) or have only mild signs and symptoms of heart failure (NYHA II). Nevertheless, treatment in these stages is mandatory, since the disease is already progressive at this time, and requires intervention \textsuperscript{21-23}. In most current chronic heart failure trials, an ejection fraction of ≤0.35 is generally used as the inclusion criterium, and in some studies it is employed for stratification of treatment \textsuperscript{23-26}. Patients with an ejection fraction > 0.35 may also have a limited exercise tolerance and chronic heart failure, but this patient category is much less studied, although from an epidemiologic point of view, this may be an important patient group \textsuperscript{27}. The main finding of the present study is, that a large proportion (75%) of patients with only mild left ventricular dysfunction (ejection fraction 0.35-0.55) and either no or minimal symptoms of heart failure have a decreased exercise capacity, while in 18% of these patients exercise capacity is severely decreased. The reduction in (age-adjusted) peak VO\textsubscript{2} appeared to be more prominent in younger patients, and in this patient group, intervention may be particularly useful, also in terms of health-care economics. At this moment, however, patients with an ejection
Other determinants of peak VO\(_2\). A decreased peak VO\(_2\) is not always a sign of heart failure. Non-cardiac conditions, such as chronic obstructive pulmonary disease, anemia or musculoskeletal disorders, or a non-maximal effort during exercise testing might explain a decreased (measured) peak VO\(_2\). Therefore, we excluded these patients in the present study. A comparable RER and heart rate at peak exercise of both study- and control-population indicates that the high percentage of (severely) decreased age-adjusted peak VO\(_2\) in the study-population cannot be explained by not reaching maximal effort. In heart failure patients, a decreased peak VO\(_2\) and quantitative and qualitative abnormalities of skeletal muscles are suggested to be partly caused by deconditioning due to restriction of physical exercise. Deconditioning due to a restriction of exercise after myocardial infarction might have influenced the results of the present study. However, a relatively high anaerobic threshold was observed in the study-population, while a relatively decreased VAT was to be expected in deconditioning. A relatively high anaerobic threshold, especially in patients with a severely decreased peak VO\(_2\), suggests a more central hemodynamic cause of a decreased exercise capacity rather than a peripheral hemodynamic and metabolic cause. Heart failure and a decreased peak VO\(_2\) has been observed in patients with a preserved ejection fraction and has been explained by diastolic dysfunction. Diastolic dysfunction influences exercise capacity, but may be partially reversed by exercise training in patients with heart failure.

Predicted peak VO\(_2\). Peak VO\(_2\) decreases with aging due to factors like quantitative and qualitative changes of skeletal muscles, decreased respiratory function, impaired diastolic relaxation, increased impedance of the left ventricle and vessels and decrease of maximal heart rate. All formulas predicting peak VO\(_2\) indicate that age and gender are the most important factors. Correction for age and gender by using these formulas is therefore important. Comparison between classification based either on absolute peak VO\(_2\) (Weber-classification) or an age-adjusted peak VO\(_2\) demonstrated, that especially younger patients might be underdiagnosed, if peak VO\(_2\) is not adjusted for age. Recently an improved prognostic value for mortality was shown, when achieved peak VO\(_2\) was corrected for age by relating it to the predicted peak VO\(_2\). NYHA-classification. In the present study, the ejection fraction was not significantly different between patients with NYHA I or with NYHA II. Peak VO\(_2\) was also similar in the 2 groups, although the difference was of borderline significance when it was corrected for age. In contrast, the anaerobic threshold significantly separated both NYHA-classes. The anaerobic threshold is an objective parameter of submaximal, endurance exercise capacity. Activities in normal daily life of patients with heart failure are in general at the most in the range of submaximal endurance and parameters of submaximal exercise capacity might be a more sensitive parameter than peak exercise parameters patients with heart failure. The anaerobic threshold proved to be closely linked to symptomatology of patients (NYHA-classification) in the present study. This is in line with other studies in patients with more severe symptomatic heart failure. However, the value of the anaerobic threshold in
measuring effects of therapy on exercise tolerance of patients with heart failure has not been well established yet. This could be explained partly, because measurement is time consuming, especially when the ventilatory equivalent method is used. Therefore the RER=1-method is proposed \(^{41,42}\). Also the V-slope-method might be less time consuming in this era of fast micro-processors. All three methods were highly correlated and, as to be expected, V-slope was reached consistently first, followed by the ventilatory equivalent-method and at last the RER=1-method. In this study the ventilatory equivalent-method was preferred, because at the start of the study we were more experienced with this method.

**Study limitations.** Although the Jones' formula allows adjustment for age of peak VO\(_2\), a clear classification when these values are decreased is not available. Therefore, we chose an objective criterium by subtraction of 1 or 2 times the SD (= 19%) from the predicted value to characterize patients with a decreased, and a severely decreased exercise capacity, respectively. Stelken used a criterium of ≤50% and proposed this criterium for selection of patients for heart transplantation \(^{14}\). However, since the present study-population had much less severe heart failure, and heart transplantation was not considered, this criterium was not applicable in this case.

Second, the study population was rather small, which may have influenced the outcomes. However, we only wanted to select patients with left ventricular dysfunction, and no or only mild symptoms of heart failure, and as a result more than one third of patients were excluded from this analysis. Also referral pattern might have influenced the results, as patients with decreased exercise capacity are more likely to have complaints. On the other hand, patients with a severely decreased exercise capacity and signs of heart failure are usually not referred, because physicians are reluctant to refer these patients to cardiac rehabilitation programs, despite promising results of recent studies \(^{31,34}\).

**CONCLUSION**

In patients with mild left ventricular dysfunction and only few if any symptoms, peak VO\(_2\) is significantly decreased in a large proportion of patients. This patient group is probably underdiagnosed, which may have clinical and therapeutic implications. Evaluation of these patients, in addition to left ventricular ejection fraction, is therefore useful, by performing a cardiopulmonary exercise test to determine (age- and gender-adjusted) peak VO\(_2\). Further, the anaerobic threshold is more closely linked to functional (NYHA) class, than peak VO\(_2\), and may thus potentially be a more sensitive marker for exercise incapacity.
Chapter 3

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References


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