Åstrand Bike Test

SkillsLab
6 minute submaximal exercise test
(Video and Manual)

Group members: Alison Cheevers
                Cathrine Pettersen

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1. Introduction
Submaximal testing is an important tool in physiotherapy. It is commonly used in practical settings and across different subject groups. This manual is designed to be used in conjunction with the digital video found in the HvA Mediatheek, Digital Library Service. Both the video and this manual were produced by third year ESP students for their Professional Assignment Project.

2. What is submaximal testing, when and how is it used?
The ability to do aerobic exercise is very important for activities of daily living and maintaining a healthy lifestyle. Aerobic capacity can be tested to measure the ability to do exercise specifically by measuring the amount of oxygen required (VO₂). Unlike anaerobic power, which is related to local muscular strength and to the amount and rate of ATP produced by the anaerobic metabolic pathways (ATP-PC system and anaerobic glycolysis), aerobic power reflects the ability of the lungs, blood, heart, muscles, and other organs and organ systems to transport and utilise O₂ via the aerobic metabolic pathways; determining a person’s level of cardiorespiratory fitness has therefore both general and clinical applications (Foss M.L. & Keteyian S.J., 1998).

The measurement of maxVO₂ can be used in a variety of different settings: elite athlete, healthy individuals in the fitness setting, and persons with known diseases or classified as high risk (for example, heart disease and obesity). In the latter group, persons with chronic disease or disability, it is vital to know their maxVO₂ as many of these people have a very low ability to consume and utilise oxygen. Maximal steady-state oxygen consumption (VO₂MSS) is in the usual range of 40% to 70% of maxVO₂. Many people with a chronic disease or disability have a maxVO₂ that is below the 40% maxVO₂ that is required for

3. **Direct measurement of maxVO$_2$**

Determining an individual’s aerobic power (cardiorespiratory fitness) can be best achieved through the direct measure of maxVO$_2$ while the individual is exercising. MaxVO$_2$ reflects the body’s ability to transport and utilise O$_2$, with changes in ventilation, perfusion, heart rate and stroke volume, and/or peripheral utilisation of O$_2$, all having an influence on maxVO$_2$. Therefore, the measurement of maxVO$_2$ is considered to be the best measure of cardiorespiratory fitness (Foss M.L. & Keteyian S.J., 1998).

Measuring maxVO$_2$ directly is usually done through graded exercise tests and selecting a test protocol that best fits the fitness level of the person being tested. Usually the test requires that the individual reaches voluntary fatigue within 6 to 12 minutes. The maxVO$_2$ is reached when one or more of the following criteria have been achieved:

1. A further increase in work rate results in no further increase in VO$_2$ (a plateau);
2. The Respiratory Exchange Ratio (R) exceeds 1.10 to 1.15;
3. If measured, post-exercise blood lactate exceeds 8 to 10mM (Foss M.L. & Keteyian S.J., 1998).

Whilst the direct measure of maxVO$_2$ is considered the best and most accurate, there are a number of disadvantages:
• The test is difficult and stressful. Many persons, especially with chronic disease or disability, do not achieve a ‘true’ maxVO$_2$. Instead, they reach a point at which they cannot continue not because of limitations in the supply of oxygen but through some other limiting factor such as mental fatigue, fear, lack of motivation or symptoms such as chest pain and light-headedness. If this is the case, the individuals are said to reach symptom-limited exhaustion and this is referred to as peak VO$_2$ (Durstine J.L. & Moore G.E., 2003);

• Direct testing requires the use of expensive equipment and trained staff and is therefore prohibitive in many settings;

• The presence of a cardiologist or physician is required;

• Due to above reasons it is not a practical test for general health screening and testing of large groups (Maud P.J., & Foster C., 1995).

4. **Indirect estimation of maxVO$_2$**

4.1 *Estimation of maxVO$_2$*

To overcome the difficulties in performing a direct test indirect measures of maxVO$_2$ have been devised. Two of the most well-known tests are the Åstrand Bike Test and the Harvard Step Test. These are called submaximal tests and are based on the linear relationship between heart rate (HR) and VO$_2$: the greater exercise intensity or VO$_2$ the higher the heart rate. In other words, if you plot the results of a submaximal test on a graph (graph 1, heart rate against workload) a linear line, representing VO$_2$ used, emerges because physiological theory tells us that as workload increases so does the heart rate and therefore VO$_2$. Indirect estimates work by extrapolating information from this graph to
predict maxVO\textsubscript{2} (Maud P.J., & Foster C., 1995). It does this by continuing the linear relationship line towards the maximum.

![Graph 1](image)

**Graph 1** Sample graph for the extrapolation method of estimating maxVO\textsubscript{2} (Maud P.J., & Foster C., 1995).

Using this linear relationship, the Åstrand Ryhming Nomogram (appendix 1) was designed to estimate maxVO\textsubscript{2} from the results of a submaximal test. It simply estimates how the heart rate would continue increasing, in line with the workload, as a direct maxVO\textsubscript{2} test would do. This is how the indirect measure of maxVO\textsubscript{2} is calculated and for example, the use of the Åstrand Ryhming Nomogram gives a ±15\% standard deviation from a directly measured maxVO\textsubscript{2} (Foss M.L. & Keteyian S.J., 1998).

4.2 *Calculating the intensity of exercise*

With indirect estimates of maxVO\textsubscript{2} the individual exercises submaximally (as opposed to bringing the individual to their maximal aerobic output) and to ensure that the test is being performed at the correct level of intensity and avoiding the expense of direct VO\textsubscript{2} measurement, various indirect techniques that correlate well with measured VO\textsubscript{2} can be used to guide exercise intensity.
These are heart rate measurement, the blood lactate threshold or rating of perceived exertion (Foss M.L. & Keteyian S.J., 1998). The heart rate techniques are practical and easy to use and can be used for elite athletes, the general population and for persons with chronic disease or disability; training intensity is judged mainly by the degree of stress placed on the cardiorespiratory system. The blood lactate threshold method is more difficult to perform and is mainly used with elite athletes and the study of training intensity, and the degree of stress placed on the metabolic systems within skeletal muscle. The third technique, a rating of perceived exhaustion (Borg scale), is highly applicable to persons with chronic disease or disability where teaching the heart rate methods becomes difficult and where medication, such as beta blockers, render pulse taking less accurate (Foss M.L. & Keteyian S.J., 1998).

4.3 Karvonen method

In this manual we use one of the heart rate methods for calculating exercise intensity for a submaximal exercise test. This is know as the Karvonen method (or heart rate reserve method). The other method, the straight percentage method is not discussed here.¹ In the Karvonen method the increase in heart rate that occurs above the resting heart rate is taken into consideration.

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¹ The straight percentage method is calculated using the formula 220 minus age and multiplied by a percentage of maximal heart rate that is usually between 60 to 90% of maximum. A target heart rate of 60 to 90% of maximum corresponds to a VO2 that is between 50 and 85% of maximum. One of the problems with this method is that exercising at the lower end of exercise intensity the heart rate is very low in comparison to the Karvonen method and falls outside of the parameters of the Åstrand Ryhming Nomogram when calculating maxVO2.
The formula is as follows:

Target heart rate (THR) = (heart rate reserve) x percentage of HRR + restHR

= (max HR (220-age) – restHR) x intensity + restHR

So, a 60 year old exercising with a 60% rate of heart rate reserve (intensity) and with a resting heart rate of $70^2$ b.p.m would have a THR of 124 b.p.m:

$$(160 – 70) \times 60\% + 70 = 124 \text{ b.p.m.}$$

For an initial submaximal baseline test, level of intensity should be set between 40 and 60%. Using the above example, a 60 year old male would need to exercise with a target heart rate of between 106 b.p.m and 124 b.p.m.

Physiological theory says that in training for endurance type sports a training effect will be enjoyed if intensity is set between 50 and 85% of maxVO$_2$. This is because of the *progressive load principle* where improvements in fitness are seen when intensity is progressively raised during the training programme. However, in untrained persons a training effect may be as low as 40 to 50% of maxVO$_2$. With well-trained or elite athletes the intensity could be as high as 90% of maxVO$_2$ for an effect to be seen (Foss M.L. & Keteyian S.J., 1998). Although it is more accurate to measure maxVO$_2$ directly the prohibitive nature of maximal testing means that submaximal testing is an attractive alternative; it is cheap and easy to use, patients are comfortable with it as it is less stressful, and it can be used in many different setting to carry-out baseline, intermittent and end results of a training programme.

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2 It is best to take the resting heart rate first thing in the morning just after waking-up. Otherwise, take it after a 30 minute sleep or rest
5. When not to use submaximal testing

Although stated above that submaximal testing can be used in a variety of settings, including elite athletes and persons with chronic disease or disability, it is most probable, with these groups, that direct baseline measurement of maxVO$_2$ is more appropriate. For the elite athlete working to improve their performance at the margins means that accurate information of maxVO$_2$ is required to set and finely tune training programmes. For persons with chronic disease and disability it is equally important to have a correct measure of maxVO$_2$ so as to set a safe training programme. For example, a heart patient on beta blockers will have a lower heart rate than normal and indirect estimates of maxVO$_2$, using the heart rate measures, will lead to false test parameters.\(^3\) Therefore, the physiotherapist has to judge whether submaximal testing for baseline measurement of maxVO$_2$ is appropriate for the patient and may wish to refer the patient for a direct test to measure maxVO$_2$. Once accurate maxVO$_2$ is known submaximal testing can always be used to follow-up with intermittent and end measurements, if considered safe.

6. The Åstrand Bike Test

The Åstrand Bike Test (also known as the Åstrand-Ryhming test) was first developed by P.O. Åstrand in 1956. It is a 6 minute test that uses a cycle ergometer (a fixed exercise bike), can be used in both men and women of various ages and relies on the linear relationship between heart rate and VO$_2$, as described above to predict maxVO2. The test enjoys a ± 15% standard deviation from a directly measured maxVO2 (Foss M.L. & Keteyian S.J., 1998).

\(^3\) This level of information is hard to reference. The authors have been taught this on the ESP Programme at the HvA.
6.1 Subject
Before starting the test the subject must give informed consent and therefore must understand the procedure, potential risks and benefits of the test.

6.2 Health history
It is necessary to determine the current health status and lifestyle of the subject before the test. An example of a health history questionnaire can be found in appendix 2.

6.3 Contraindications to exercise testing
When exercise testing there are a number of conditions that could render the test dangerous and these are therefore contraindicated. Some are more serious than others and a distinction is made between absolute and relative contraindications. You will find a list of contraindications in appendix 3. Where a subject has a condition that is considered a relative contraindication, and where it is possible to test, it is more likely that this person will be advised to take a direct measure of maxVO$_2$ and this will be done in the presence of specially trained staff and a cardiologist.

6.4 Indications when to stop a test
As with contraindications, indications to stop a test can be split between absolute and relative indications. You will find a comprehensive list in appendix 4. However, below is a list of indications for stopping a test for “low-risk” persons:

- Dizziness and/or nausea (headache);
- Heart problems (angina-like symptoms;
- Irregular heart beat;

-
- Subject requests to stop;
- Physical or verbal manifestations of severe fatigue;
- Breathlessness or a feeling of a lack of air;
- Fainting;
- Orthosympathetic responses (sweating or pallor);
- Leg cramps or claudication;
- Failure of the test equipment.

6.5 Pre-test preparation

On the morning of the test the subject must take their resting pulse on awakening. The procedure for taking a pulse should be explained and practiced with the subject, for example taking a wrist pulse for 15 seconds and multiplying it by 4 to reach a per minute resting heart rate. Failing this, the subject must rest (lying down) for 30 minutes before the test and then take their resting pulse.

A primary concern about submaximal testing is the lack of standardisation of the procedures. It is therefore important that the subject understands the instructions and follows them each time that they are tested. They must be told to avoid any strenuous activity for 24 hours prior to testing and to avoid a heavy meal, caffeine, or nicotine within 2 to 3 hours of testing. Any medications taken before testing should be noted and if possible there use should be consistent from one test to another. It is also important that the subject becomes familiar with the testing equipment and test procedures, before the test is done for real. Also, it makes sense that there must be enough of a rest period between practice of the test and the real test (Noonan V. & Dean E., 2000).
6.6 Tools needed to perform the test

1. Cycle ergometer (fitness bike)  
2. Heart Rate Monitor  
3. Weight Scale  
4. Pen and paper  
5. Nomogram (appendix 1)

6.7 The Test

Step 1: As described above take the subject’s health history and determine if there any contraindications;

Step 2: Ask the subject for their self-measured resting pulse as described above;

Step 3: Using the Karvonen formula calculate the heart rate, at a given intensity (set usually between 40 and 60% for the baseline test),
that you want the subject to reach in the test (the target heart rate). The subject (in the video) is a 49 year old female working at an intensity of 60%, and with a resting heart rate of 70 b.p.m, her target heart rate is:

\[
(\text{maxHR} - \text{RHR}) \times 60\% + 70 = \text{THR}
\]

\[
(171 - 70) \times 60\% + 70 = \text{THR} \quad 131 \text{ b.p.m}
\]

Step 4: Take the weight of the subject. This is necessary later when calculating ml per kg;

Step 5: Place the heart rate monitor on to the skin of the subject using the contact gel. It must be placed around the chest and over the heart, as shown in the video (please note that it must be on the skin; in the video it is placed over clothing but this was due to the subject’s wishes for privacy). Fix the watch to the subject’s wrist and set the watch on to heart pulse mode – check that the pulse signal from the monitor is being picked up by the watch. One of the reasons that it might not work is that the strap may not be tight enough (please note that the subject needs to be a few metres away from another person using a heart monitor otherwise incorrect signals can be picked up);

In this test, the heart rate can be taken both from the watch and the cycle ergometer. The bike has an in-built heart monitor that takes the pulse from the subject’s monitor around their chest.

Step 6: Adjust the seat of the bike to the subject. This is usually at hip height. When the subject begins to cycle the knee should not be
fully stretched but a little bent. Ask if the subject feels comfortable;

Step 7: Have ready a piece of paper and pen to take note of the subject’s heart rate during the test;

Step 8: Ask the subject to begin cycling. Enter into the bike the workload (watts) that you want the subjects to begin with. The standard protocol is 150 watts for males and 100 watts for females, although this is based on young, healthy subjects. If the subject is older, very unfit, has a chronic disease or disability then you can start at a lower level. Tell the subject to cycle with an rpm (rotation per minute) of 60 and set the bike to 6 minutes.

Below are pictures of the bike settings found in the gym at the HvA:

Choose “oefening”:

![](image)

4 Elsewhere, workloads are set at 150, 100, or 75 watts for well-trained, moderately trained and untrained subjects respectively (Maud P.J. & Foster C., 1995)
Choose “vermogen”:

Adjust “tijd” to 6 minutes:

Adjust “vermogen” watts:
THE TEST HAS BEGUN!!

Step 9: At the end of each minute take note of the subject’s heart rate;

Step 10: In the first two minutes the idea is that the subject should reach a steady-state of exercising (it is not an all out maximal test don’t forget!). To reach a steady state you may need to adjust the watts so that the subject is working at a level that keeps their heart rate steady. Do this in small steps so as their heart rate does not fluctuate too much. By the end of minute 2 you want the subject to be working close the target heart rate;

Step 11: You must watch the subject throughout the test for any indications to stop the test as discussed above and in appendix 4. Signs of sweating and red cheeks are normal of course.

Subject is biking after 3 mins with 60 rpm and 65 watts:
Step 12: Throughout the test make sure that the subject does not talk as this has an upward effect on the heart rate. On the other hand, you the physiotherapist must help motivate the subject so that they reach the end of the test safely. For standardisation it is important from one test to another (within the same subject and group testing) that your verbal encouragement is the same, otherwise the tests cannot be compared honestly.

Step 13: After minute 6 the subject must cool-down so ask them to continue to cycle, at a lower intensity (drop the watts) for 1 minute.

Step 14: At the end of the test you should have a list of the subject’s heart rate for 6 minutes, for example:

<table>
<thead>
<tr>
<th>Minute</th>
<th>HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>138</td>
</tr>
<tr>
<td>2</td>
<td>123</td>
</tr>
<tr>
<td>3</td>
<td>125</td>
</tr>
<tr>
<td>4</td>
<td>128</td>
</tr>
<tr>
<td>5</td>
<td>130</td>
</tr>
<tr>
<td>6</td>
<td>130</td>
</tr>
</tbody>
</table>

Now, take an average of minutes 5 & 6. Using the above example the average is:

\[ 130 + 130 / 2 = \text{avg.} 130 \text{ b.p.m} \]
Step 15: Using the Nomogram (next page and appendix 1), mark the average heart rate and mark the rate of watts that the subject trained at. Draw a line between the two marks and where this line dissects the VO$_2$ line in the middle, take the reading. If the subject is above 35 years you will have to apply a correction factor, which is written in the bottom left corner of the Nomogram.

Below, you can see the results, using the Nomogram, for the 49 year old female in the video, training at 60% intensity with a target heart rate of 130 b.p.m:

- Age = 49
- Weight = 61kg
- THR = 130 b.p.m (intensity 60%)
- Average heart rate = 130 b.p.m
- Workload (watts) = 65 approx
- MaxVO$_2$ = 2.5 l/min
- Age correction = $2.5 \times 0.78 = 1.95$ l/min
- MaxVO$_2$ per kg = $1.95 \times 1000 = 1950$
  
  $1950$ ml / 61kg = 31.97 ml/kg/min
<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Factor (x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1.2</td>
</tr>
<tr>
<td>16</td>
<td>1.1</td>
</tr>
<tr>
<td>17-35</td>
<td>1.0</td>
</tr>
<tr>
<td>35</td>
<td>0.87</td>
</tr>
<tr>
<td>40</td>
<td>0.83</td>
</tr>
<tr>
<td>45</td>
<td>0.78</td>
</tr>
<tr>
<td>50</td>
<td>0.75</td>
</tr>
<tr>
<td>55</td>
<td>0.71</td>
</tr>
</tbody>
</table>
6.8 Interpreting results

Norms
There are established normative values for maxVO$_2$. A general overviews of normal values can be found in Maud P.J. & Foster C. (1995). A more comprehensive list can be found in appendix 5 from the Western Australian Department of Industry and Resources (Dec 1997).

Taking the above results from the test of the 49 year old, female subject, the values are considered average when compared to normative data.

Confounding factors
It is also important when looking at the results of a test to take into consideration any confounding factors that may have had an impact on the results of a test or a series of tests (test reliability). As explained earlier there is a need for standardisation when testing and many of these confounding factors relate to this problem in submaximal testing. Here is a list of possible confounding factors that might be experienced:

- The room temperature, noise level and humidity between tests;
- The amount of sleep the subject had prior to testing;
- The subject’s emotional state;
- Medication the subject may be taking;
- The time of day;
- The subject’s caffeine intake;
- The time since the subject’s last meal;
- The test environment;
- The subject’s prior test knowledge/experience;
• Accuracy of measurements;
• Inappropriate warm-up;
• Talking of subject during test;
• The personality, knowledge and skill of the tester are the same for each test that the subject undertakes.

7. Conclusion

Submaximal testing is an integral part of physiotherapy. It is relatively easy to perform, it is cheap, safe and the reliability is good in comparison to direct testing of maxVO2. Therefore, submaximal testing is a practical way in which health experts can carry-out an exercise test to determine maximal aerobic power.

This manual is a step-by-step guide in how to perform the Åstrand Bike Test. It supports the digital video and provides a reference list for further reading.
8. References


Åstrand, PO "Human Physical Fitness with Special Reference to Sex and Age," *Physiological Review*, 36: 307-335 (1956).


Gov’t of Western Australia, Dept. of Industry & Resources, *Fitness for Mine Rescue Personnel Guideline*, Issue December 1997


**Websites:**
www.americanheart.org
www.acc.org
www.kngf.nl
9. Appendices

1. Åstrand Ryhming Nomogram

2. Health history questionnaire

3. Contraindications to exercise testing

4. Indications when to stop an exercise test

5. Normative data for submaximal exercise testing
Appendix 1  The Åstrand Ryhming Nomogram

### ÅSTRAND-ÅSTRAND NOMOGRAM

<table>
<thead>
<tr>
<th>age (yrs)</th>
<th>factor (x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1.2</td>
</tr>
<tr>
<td>16</td>
<td>1.1</td>
</tr>
<tr>
<td>17-35</td>
<td>1.0</td>
</tr>
<tr>
<td>35</td>
<td>0.87</td>
</tr>
<tr>
<td>40</td>
<td>0.83</td>
</tr>
<tr>
<td>45</td>
<td>0.78</td>
</tr>
<tr>
<td>50</td>
<td>0.75</td>
</tr>
<tr>
<td>55</td>
<td>0.71</td>
</tr>
</tbody>
</table>
Appendix 2  Health history questionnaire

Below is an example of a typical health questionnaire from a sports clinic:

Health Status Questionnaire

Instructions
Complete each question accurately. All information provided is confidential if you choose to submit this form to your fitness instructor.

Part 1. Information about the individual

1. Social Security number __________________________ Date __________________

2. Legal name __________________________ Nickname __________________

3. Mailing address __________________________
   Home phone __________________________ Business phone __________________

4. EI __________________________
   Personal physician __________________________ Phone __________________
   Address __________________________

5. EI __________________________
   Person to contact in emergency __________________________ Phone __________________

6. Sex (circle one): Female Male (RF)

7. RF Date of birth: __________________________
   Month Day Year

8. Number of hours worked per week: Less than 20 20-40 41-60 Over 60

9. SLA More than 25% of time spent on job (circle all that apply)
   Sitting at desk  Lifting or carrying loads  Standing  Walking  Driving

Part 2. Medical history

10-A. RF Circle any who died of heart attack before age 55:
   Father  Brother  Son

10-B. RF Circle any who died of heart attack before age 65:
   Mother  Sister  Daughter

11. Date of
   Last medical physical exam __________________________
       Year

   Last physical fitness test __________________________
       Year


(continued)
12. Circle operations you have had:

<table>
<thead>
<tr>
<th>Back SLA</th>
<th>Heart MC</th>
<th>Kidney SLA</th>
<th>Eyes SLA</th>
<th>Joint SLA</th>
<th>Neck SLA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ears SLA</td>
<td>Hernia SLA</td>
<td>Lung SLA</td>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. Please circle any of the following for which you have been diagnosed or treated by a physician or health professional:

<table>
<thead>
<tr>
<th>Alcoholism SEP</th>
<th>Diabetes SEP</th>
<th>Kidney problem MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anemia, sickle cell SEP</td>
<td>Emphysema SEP</td>
<td>Mental illness SEP</td>
</tr>
<tr>
<td>Anemia, other SEP</td>
<td>Epilepsy SEP</td>
<td>Neck strain SLA</td>
</tr>
<tr>
<td>Asthma SEP</td>
<td>Eye problems SLA</td>
<td>Obesity RF</td>
</tr>
<tr>
<td>Back strain SLA</td>
<td>Gout SLA</td>
<td>Phlebitis MC</td>
</tr>
<tr>
<td>Bleeding trait SEP</td>
<td>Hearing loss SLA</td>
<td>Rheumatoid arthritis SLA</td>
</tr>
<tr>
<td>Bronchitis, chronic SEP</td>
<td>Heart problem MC</td>
<td>Stroke MC</td>
</tr>
<tr>
<td>Cancer SEP</td>
<td>High blood pressure RF</td>
<td>Thyroid problem SEP</td>
</tr>
<tr>
<td>Cirrhosis, liver MC</td>
<td>Hypoglycemia SEP</td>
<td>Ulcer SEP</td>
</tr>
<tr>
<td>Concussion MC</td>
<td>Hyperlipidemia RF</td>
<td>Other</td>
</tr>
<tr>
<td>Congenital defect SEP</td>
<td>Infectious mononucleosis MC</td>
<td></td>
</tr>
</tbody>
</table>

14. Circle all medicine taken in last 6 months:

<table>
<thead>
<tr>
<th>Blood thinner MC</th>
<th>Epilepsy medication SEP</th>
<th>Nitroglycerin MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetic SEP</td>
<td>Heart rhythm medication MC</td>
<td>Other</td>
</tr>
<tr>
<td>Digitalis MC</td>
<td>High blood pressure medication MC</td>
<td></td>
</tr>
<tr>
<td>Diuretic MC</td>
<td>Insulin MC</td>
<td></td>
</tr>
</tbody>
</table>
15. Any of these health symptoms that occur frequently is the basis for medical attention. Circle the number indicating how often you have each of the following:

5 = Very often
4 = Fairly often
3 = Sometimes
2 = Infrequently
1 = Practically never

a. Cough up blood **MC**

   1 2 3 4 5

b. Abdominal pain **MC**

   1 2 3 4 5

c. Low-back pain **MC**

   1 2 3 4 5

d. Leg pain **MC**

   1 2 3 4 5

e. Arm or shoulder pain **MC**

   1 2 3 4 5

f. Chest pain **RF MC**

   1 2 3 4 5

g. Swollen joints **MC**

   1 2 3 4 5

h. Feel faint **MC**

   1 2 3 4 5

i. Dizziness **MC**

   1 2 3 4 5

j. Breathless with slight exertion **MC**

   1 2 3 4 5

k. Palpitation or fast heart beat **MC**

   1 2 3 4 5

l. Unusual fatigue with normal activity **MC**

   1 2 3 4 5

**Part 3. Health-related behavior**

16. **RF** Do you now smoke (or have smoked in last 6 months)? Yes No

17. **RF** If you are a smoker, indicate number smoked per day:

   Cigarettes: 40 or more 20-39 10-19 1-9

   Cigars or pipes only: 5 or more or any inhaled Less than 5, none inhaled

18. **RF** Do you exercise regularly (i.e., accumulate at least 30 min per day, at least five days/week)? Yes No

19. How many days per week do you accumulate 30 minutes of moderate activity?

   0 1 2 3 4 5 6 7 days per week

20. How many days per week do you normally spend at least 20 minutes in vigorous exercise?

   0 1 2 3 4 5 6 7 days per week

21. Can you walk 4 miles briskly without fatigue? Yes No

22. Can you jog 3 miles continuously at a moderate pace without discomfort? Yes No


(continued)
Part 4. Health-related attitudes

24. These traits have been associated with coronary-prone behavior. Circle the number that corresponds to how you feel:
   6 = Strongly agree
   5 = Moderately agree
   4 = Slightly agree
   3 = Slightly disagree
   2 = Moderately disagree
   1 = Strongly disagree

   I am an impatient, time-conscious, hard-driving individual.
   1  2  3  4  5  6

25. List everything not already included on this questionnaire that might cause you problems in a fitness test or fitness program:

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

Code for Health Status Questionnaire
The following code will help you evaluate the information in the Health Status Questionnaire.
EI = Emergency Information—must be readily available.
MC = Medical Clearance needed—do not allow exercise without physician’s permission.
SEP = Special Emergency Procedures needed—do not let participant exercise alone; make sure the person’s exercise partner knows what to do in case of an emergency.
RF = Risk Factor for CHD (educational materials and workshops needed).
SLA = Special or Limited Activities may be needed—you may need to include or exclude specific exercises.
OTHER (not marked) = Personal information that may be helpful for files or research.

Appendix 3 Contraindications to exercise testing

Below is a list of absolute and relative contraindications for exercise testing:

Absolute

- Acute myocardial infarction (within 2 days)
- High-risk unstable angina
- Uncontrolled cardiac arrhythmias causing symptoms or hemodynamic compromise
- Symptomatic severe aortic stenosis
- Uncontrolled symptomatic heart failure
- Acute pulmonary embolus or pulmonary infarction
- Acute myocarditis or pericarditis
- Acute aortic dissection

Relative

- Left main coronary stenosis
- Moderate stenotic valvular heart disease
- Electrolyte abnormalities
- Severe arterial hypertension
- Tachyarrhythmias or bradyarrhythmias
- Hypertrophic cardiomyopathy and other forms of outflow tract obstruction
- Mental or physical impairment leading to inability to exercise adequately
- High-degree atrioventricular block

Appendix 4  Indications when to stop an exercise test

Below is a list of absolute and relative indications to stop a test. Some indications are relevant to direct testing of maxVO$_2$ and not submaximal testing:

**Absolute indications**

- Drop in systolic blood pressure of .10mm Hg from baseline blood pressure despite an increase in workload, when accompanied by other evidence of ischemia
- Moderate to severe angina
- Increasing nervous system symptoms (e.g. ataxia, dizziness, near-syncope)
- Signs of poor perfusion (cyanosis or pallor)
- Technical difficulties in monitoring ECG or systolic blood pressure
- Subject’s desire to stop
- Sustained ventricular tachycardia
  ST elevation (≥ 1.0mm) in leads without diagnostic Q-waves (other than V$_1$ or a VR).

**Relative indications**

- Drop in systolic blood pressure of .10mm Hg from baseline blood pressure despite an increase in workload, in the absence of other evidence of ischemia
- ST or QRS changes such as excessive ST depression (.2 mm of horizontal or downsloping ST-segment depression) or marked axis shift
- Arrhythmias other than sustained ventricular tachycardia, including multifocal PVCs, triplets of PVCs, supraventricular tachycardia, heart block or bradyarrhythmias
- Fatigue, shortness of breath, wheezing, leg cramps, or claudication
- Development of bundle-branch block or IVCD that cannot be distinguished from ventricular tachycardia
- Increasing chest pain
- Hypertensive response

### Appendix 5  Normative data for submaximal exercise tests

#### Astrand Bicycle Ergometer Test VO₂max Normative Data – Females

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Low (l/min)</th>
<th>Below Average</th>
<th>Average</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 - 29 years</td>
<td>&lt;1.69</td>
<td>1.70-1.99</td>
<td>2.00-2.49</td>
<td>2.50-2.79</td>
<td>&gt;2.8</td>
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<tr>
<td></td>
<td>&lt;28</td>
<td>29-34</td>
<td>35-43</td>
<td>44-48</td>
<td>&gt;49</td>
</tr>
<tr>
<td>30 - 39 years</td>
<td>&lt;1.59</td>
<td>1.60-1.89</td>
<td>1.90-2.39</td>
<td>2.40-2.69</td>
<td>&gt;2.70</td>
</tr>
<tr>
<td></td>
<td>&lt;27</td>
<td>28-33</td>
<td>34-41</td>
<td>42-47</td>
<td>&gt;48</td>
</tr>
<tr>
<td>40 - 49 years</td>
<td>&lt;1.49</td>
<td>1.50-1.79</td>
<td>1.80-2.29</td>
<td>2.30-2.59</td>
<td>&gt;2.60</td>
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<tr>
<td></td>
<td>&lt;25</td>
<td>26-31</td>
<td>32-40</td>
<td>41-45</td>
<td>&gt;46</td>
</tr>
<tr>
<td>50 - 65 years</td>
<td>&lt;1.29</td>
<td>1.30-1.59</td>
<td>1.60-2.09</td>
<td>2.10-2.39</td>
<td>&gt;2.40</td>
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<tr>
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<td>&lt;21</td>
<td>22-28</td>
<td>29-36</td>
<td>37-41</td>
<td>&gt;42</td>
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</tbody>
</table>

#### Astrand Bicycle Ergometer Test VO₂max Normative Data – Males

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Low (l/min)</th>
<th>Below Average</th>
<th>Average</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 - 29 years</td>
<td>&lt;2.79</td>
<td>2.60-3.09</td>
<td>3.10-3.59</td>
<td>3.70-3.99</td>
<td>&gt;4.00</td>
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<tr>
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<td>&lt;38</td>
<td>39-43</td>
<td>44-51</td>
<td>52-56</td>
<td>&gt;57</td>
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<tr>
<td>30 - 39 years</td>
<td>&lt;2.49</td>
<td>2.60-2.79</td>
<td>2.80-3.39</td>
<td>3.40-3.69</td>
<td>&gt;3.70</td>
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<tr>
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<td>&lt;34</td>
<td>35-39</td>
<td>40-47</td>
<td>48-51</td>
<td>&gt;52</td>
</tr>
<tr>
<td>40 - 49 years</td>
<td>&lt;2.19</td>
<td>2.20-2.49</td>
<td>2.50-3.09</td>
<td>3.10-3.39</td>
<td>&gt;3.40</td>
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<td>36-43</td>
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<td>&gt;48</td>
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<tr>
<td>50 - 59 years</td>
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<tr>
<td>60 - 69 years</td>
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<td>22-26</td>
<td>27-35</td>
<td>36-39</td>
<td>&gt;40</td>
</tr>
</tbody>
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Government of Western Australia  
Department of Industry and Resources  