Harvard Step Test

SkillsLab
6 minute submaximal exercise test
(Video and Manual)

Authors: 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 was 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 (VO$_2$). 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 O$_2$ 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 maxVO$_2$ 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 maxVO$_2$ as many of these people have a very low ability to consume and utilise oxygen. Maximal steady-state oxygen consumption (VO$_2$MSS) is in the usual range of 40% to 70% of maxVO$_2$. Many people with a chronic disease or disability have a maxVO$_2$ that is below the 40%
maxVO₂ that is required for activities of daily living, employment, and maintenance of individual independence, resulting in a lower quality of life (Durstine J.L. & Moore G.E., 2003).

3. Direct measurement of maxVO₂
Determining an individual’s aerobic power (cardiorespiratory fitness) can be best achieved through the direct measure of maxVO₂ while the individual is exercising. MaxVO₂ reflects the body’s ability to transport and utilise O₂, with changes in ventilation, perfusion, heart rate and stroke volume, and/or peripheral utilisation of O₂, all having an influence on maxVO₂. Therefore, the measurement of maxVO₂ is considered to be the best measure of cardiorespiratory fitness (Foss M.L. & Keteyian S.J., 1998).

Measuring maxVO₂ 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 maxVO₂ 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 VO₂ (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, 1998).

Whilst the direct measure of maxVO₂ 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’ maxVO2. 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 VO2 (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 maxVO2

4.1 Estimation of maxVO2

To overcome the difficulties in performing a direct test indirect measures of maxVO2 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 VO2: the greater exercise intensity or VO2 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 VO2 used, emerges because physiological theory tells us that as workload increases so does the heart rate and therefore VO2. Indirect estimates work by extrapolating information from this graph to predict maxVO2 (Maud P.J., & Foster C., 1995). It does this by continuing the linear relationship line towards the maximum.
Using this linear relationship, the Åstrand Ryhming Nomogram (appendix 1) was designed to estimate maxVO2 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 maxVO2 test would do. This is how the indirect measure of maxVO2 is calculated and for example, the use of the Åstrand Ryhming Nomogram gives a ± 15% standard deviation from a directly measured maxVO2 (Foss M.L. & Keteyian S.J., 1998).

4.2 Calculating the intensity of exercise
With indirect estimates of maxVO2 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 VO₂ measurement, various indirect techniques that correlate well with measured VO₂ 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 known 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.

The formula is as follows:

\[
\text{Target heart rate (THR)} = (\text{heart rate reserve}) \times \text{intensity} + \text{restHR} \\
= (\text{maxHR}(220-\text{age}) - \text{restHR}) \times \text{intensity} + \text{restHR}
\]

\(^1\) 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.
So, a 60 year old exercising with a 60% rate of heart rate reserve (intensity) and with a resting heart rate of 70 b.p.m\(^2\) 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 max\(\text{VO}_2\). 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 max\(\text{VO}_2\). With well-trained or elite athletes the intensity could be as high as 90% of max\(\text{VO}_2\) for an effect to be seen (Foss M.L. & Keteyian S.J., 1998).

Although it is more accurate to measure max\(\text{VO}_2\) 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 maxVO₂ is more appropriate. For the elite athlete working to improve their performance at the margins means that accurate information of maxVO₂ 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 maxVO₂ 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 maxVO₂, using the heart rate measures, will lead to false test parameters. Therefore, the physiotherapist has to judge whether submaximal testing for baseline measurement of maxVO₂ is appropriate for the patient and may wish to refer the patient for a direct test to measure maxVO₂. Once accurate maxVO₂ is known submaximal testing can always be used to follow-up with intermittent and end measurements, if considered safe.

The Harvard Step Test is a simple 6 minute test that does not require the techniques outlined above for calculating maxVO₂, namely heart rate measurement, blood lactate threshold and rating of perceived exertion. Instead, the submaximal aspect of the test is inherent to the step apparatus itself; for example, it is not necessary to calculate target heart rates in order for the subject to exercise at a certain intensity because the height of the steps (40 cm males, 33 cm females) and the step frequency (22.5 steps/minute) have been designed so that the subject exercises submaximally. Calculating the level of intensity that the subject worked at,

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3 This level of information is hard to reference. The authors have been taught this on the ESP Programme at the HvA.
can be calculated using the Karvonen heart rate formula, but this will be discussed later (see the interpreting the results” section).

6. The Harvard Step Test (Åstrand-Ryhming method) – a manual

The Harvard Step Test was first developed by Brouha, Graybriel and Heath in 1943 (Brouha, Graybiel & Heath, 1943, found in Maud & Foster, 1995). In its original form, the recovery heart rate is used when estimating aerobic power. In this version the test makes use of the Åstrand-Ryhming Nomogram. It is a simple 6 minute step test that uses a step bench that is 40cm high for males and 33cm high for females. Subjects exercise with a step frequency of 22.5 steps per minute. It can be used for both men and women of various ages and relies on the linear relationship between heart rate and VO$_2$ to predict maxVO$_2$. The test has been used as part of exercise testing for more than 50 years.

There are limitations in the Harvard Step Test. The workload cannot be adjusted and depending on the subject the test can be easier or harder (intensity too low or too high). For example, a very unfit subject may be exercising closer to their maximum aerobic capacity whilst a very fit subject or elite athlete will probably be exercising at a level that is below the intensity that a submaximal test requires.

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. In appendix 2 you will find one example of a health history questionnaire.

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 in appendix 3. Where a subject has a condition that is considered a relative contraindication, 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 the test

As with contraindications, indications to stop a test can be split between absolute and relative indications. You will find a comprehensive list of indications 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 of a feeling of a lack of air;
- Fainting;
- Orthosympathetic responses (sweating or pallor);
- Leg cramps or claudication;
- Failure of the testing 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 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. The resting pulse can be used when interpreting the results of the test, in particular calculating the level of intensity that the subject exercised at.

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 follow 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 their 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 & Dean, 2000).
6.6 Tools you will need to perform the test

1. Step bench

Female 33cm  Male 40cm

2. Heart Rate Monitor

3. Tape recorder/CD Player

4. Step Frequency cassette/CD Rom

22.5 steps/minute

5. Weight scale

6. Pen and paper

7. Nomogram (appendix 1)
6.7  The test

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

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

Step 3: Take the weight of the subject. This is necessary later when calculating ml per kg;

Step 4: 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 placed on the skin, in the video it is placed over clothing 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);

Step 5: Make sure that the tape recorder and cassette both work!

Step 6: Make sure that you have chosen the correct bench depending on whether the subject is male or female;
Step 7: Have ready a piece of paper and pen to take note of the subject’s heart rate during the test;

Step 8: Start the cassette on the tape recorder. Demonstrate, together with the subject, the stepping cycle in rhythm with the step frequency heard on the cassette. On count 1 the subject places one foot on the bench followed by the other foot; on count 2 the first foot is brought back down to the floor followed by the other foot. Right leg, left leg leading preference is left to the subject to choose.

Step 9: Once the subject is comfortable with the stepping cycle the test can begin. Use the stop watch or your own watch to start the test.

Step 10: At the end of each minute take note of the subject’s heart rate. You will have to ask the subject to give you the pulse reading from their heart rate monitor watch.

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;

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 (with the same subject) that your verbal encouragement is the same; otherwise the two tests cannot be honestly compared;
Step 13: When the test has ended you can ask the subject to walk around the gym/room for a minute cool-down;

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>145</td>
</tr>
<tr>
<td>2</td>
<td>150</td>
</tr>
<tr>
<td>3</td>
<td>153</td>
</tr>
<tr>
<td>4</td>
<td>154</td>
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<tr>
<td>5</td>
<td>156</td>
</tr>
<tr>
<td>6</td>
<td>156</td>
</tr>
</tbody>
</table>

Now take the average of the last two minutes. Using the above sample the average is:

\[156 + 156/2 = \text{avg} 156\]

Step 15: Using the Nomogram, mark the average heart rate and mark the weight of the subject. Draw a line between the two marks and where this line dissect the VO2 line in the middle, take the reading. If the subject is below 17 years old or above 35 years old, you will have to apply a correction factor, which is written in the bottom left hand corner of the Nomogram.

Below you can see the results, using the Nomogram (following page), for the above example of our 49 year old female weighing 61 kg:
Age = 49
Weight = 61 kg
Average heart rate = 156 b.p.m.
MaxVO₂ = 2.4 l/min
Age correction = 2.4 x 0.78 = 1.87 l/min
MaxVO₂ per kg = 1.87 x 1000 = 1870 ml

\[
\frac{1870 \text{ ml}}{61 \text{ kg}} = 30.66 \text{ ml/kg/min}
\]
Nomogram – Harvard Step Test

<table>
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<th>age (yrs)</th>
<th>factor (x)</th>
</tr>
</thead>
<tbody>
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<tr>
<td>16</td>
<td>1.1</td>
</tr>
<tr>
<td>17-35</td>
<td>1.0</td>
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<td>35</td>
<td>0.87</td>
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<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\textsubscript{2}. A general overview of norms can be found in Maud & Foster (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, 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 an impact on the result 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 the subject during test
• The personality, knowledge and skill of the tester are the same for each test that the subject undertakes.

**Intensity**

With the Harvard Step Test it is not known at which level of intensity the subject exercised at. However, this can be calculated using the Karvonen heart rate formula. The Karvonen formula (also known as the heart rate reserve method) is a heart rate method that calculates a target heart rate for submaximal exercise testing and is, for example, used in the Åstrand Bike Test. The formula is as follows:

\[
\text{Target Heart Rate (THR)} = \text{(heart rate reserve)} \times \text{intensity} + \text{rest HR};
\]

\[
= \text{(maxHR}(220-\text{age}) - \text{restHR)} \times \text{intensity} + \text{restHR}
\]

So, for example, the 49 year old female exercising with a 60% rate of heart rate reserve (intensity) and with a resting heart rate of 70 b.p.m\(^4\) would have a THR of 131 b.p.m:

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

With the Harvard test that was carried out in the video we know that the average heart rate of minute 5 & 6 of the test was actually 156 b.p.m; we know that the resting heart rate was 70 b.p.m, so in order to calculate intensity we have to use the Karvonen formula by working backwards:

---

\(^4\) It is best to take resting heart rate first thing in the morning, just after waking-up. Otherwise, take it after a 30 minute sleep or rest.
(171 – 70) X ? + 70 = 156 b.p.m;
(171 – 70) x ? = 156 – 70
X = 156 – 70
171 – 70
= 0.91 x 100 = 91%

Therefore, we can now say that the subject worked at 91% of maximum. This is closer to a maximum test than submaximal. This highlights one of the criticisms of the Harvard Step Test that was discussed earlier, that it is a test that can be too difficult for persons that are unfit, older and short in height.

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 Harvard Step 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

<table>
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<th>factor(x)</th>
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</tr>
<tr>
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<td>40</td>
<td>0.83</td>
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<td>45</td>
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<td>50</td>
<td>0.75</td>
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<tr>
<td>55</td>
<td>0.71</td>
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</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:

Back SLA  Heart MC  Kidney SLA  Eyes SLA  Joint SLA  Neck SLA
Ears SLA  Hernia SLA  Lung SLA  Other

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

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

14. Circle all medicine taken in last 6 months:

Blood thinner MC  Epilepsy medication SEP  Nitroglycerin MC
Diabetic SEP  Heart rhythm medication MC  Other
Digitalis MC  High blood pressure medication MC
Diuretic MC  Insulin MC
15. Any of these health symptoms that occurs 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


Part 4. Health-related attitudes

24. These are traits that 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 maxVO₂ 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 V₁ 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 test

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Below Average</th>
<th>Average</th>
<th>High</th>
<th>Very High</th>
</tr>
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<tbody>
<tr>
<td><strong>Astrand Bicycle Ergometer Test VO&lt;sub&gt;2&lt;/sub&gt; max Normative Data – Females</strong></td>
<td></td>
<td></td>
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<tr>
<td>20 - 29 years</td>
<td>&lt;1.69</td>
<td>1.70-1.99</td>
<td>2.00-2.49</td>
<td>2.60-2.79</td>
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<tr>
<td>(l/min)</td>
<td>&lt;28</td>
<td>29-34</td>
<td>35-43</td>
<td>44-48</td>
<td>&gt;49</td>
</tr>
<tr>
<td>(ml.kg/min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></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>(l/min)</td>
<td>&lt;27</td>
<td>26-33</td>
<td>34-41</td>
<td>42-47</td>
<td>&gt;48</td>
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<tr>
<td>(ml.kg/min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></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>(l/min)</td>
<td>&lt;25</td>
<td>26-31</td>
<td>32-40</td>
<td>41-45</td>
<td>&gt;46</td>
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<tr>
<td>(ml.kg/min)</td>
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<td></td>
<td></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>
</tr>
<tr>
<td>(l/min)</td>
<td>&lt;21</td>
<td>22-23</td>
<td>29-36</td>
<td>37-41</td>
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<td>3.10-3.69</td>
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<td>44-51</td>
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Government of Western Australia
Department of Industry and Resources