Applying the Sports Medicine Australia Pre-Exercise Screening Procedures: Who will be Excluded?

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Recently Sports Medicine Australia (SMA) and the Australian Association for Exercise and Sport Science (AAESS) developed guidelines for pre-exercise screening and supervision of fitness testing, based on the American College of Sports Medicine (ACSM) system. The procedure involves classifying individuals into one of three risk groups (apparently healthy, at higher risk, with known disease). Using data collected in a 1992 survey of 2298 Australian adults aged 18-78 years conducted by the Department of the Arts, Sport, the Environment and Territories (DASET), we calculated the percentage of the general population falling within each risk group and therefore exclusion rates (ie the proportion of subjects who, it is recommended, would require medical clearance prior to exercise or exercise testing). The analysis of data found that between 43-73% of males and 44-61% of females would require clearance. A cost analysis suggests that a rigorous application of the SMA-AAESS guidelines would cost between $250 million and $1.2 billion each year. On the basis of the results, suggestions for reviewing the guidelines have been proposed.

Introduction

In Australia, 13.8% of the population express an intention to take up an exercise program, and a further 30.6% say they intend to increase the amount of exercise they are currently doing (Department of the Arts, Sport, the Environment and Territories, 1992). Starting an exercise program or increasing one's level of exercise entails a transient increased risk of negative health outcomes, ranging from joint problems to sudden cardiac death (Siscovich, 1990). For that reason, a number of professional organisations [eg American College of Sports Medicine (ACSM), Sports Medicine Australia (SMA), Australian Association for Exercise and Sports Science (AAESS), National Heart Foundation (NHF)] recommend pre-exercise screening procedures to identify those at particular risk from functional exercise testing and/or from subsequent exercise prescription. These procedures usually involve a risk stratification procedure which categorises individuals into various classes (known disease; at higher risk; apparently healthy). On the basis of this stratification, decisions are made as to whether the individual needs to undergo a medical screening by a physician (medical doctor), including a stress electrocardiogram (ECG) and blood tests, and whether a physician needs to be
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present during maximal and/or submaximal testing. Anecdotal evidence among health and fitness centres, gymnasias, universities and sports institutes suggest current procedures vary from no screening at all, limiting the age of subjects/clients (to reduce injury risk), to the use of any of a number of local or professional screening guidelines.

Pre-exercise screening is an important issue for a number of reasons. Firstly, it defines delicate zones of overlap in the functions of medical and paramedical personnel (physicians, exercise scientists, physiotherapists and nurses, for example), and may influence curriculum development in their training, as well as other areas of professional practice. It is possible that this will shape legislation governing professions involved in fitness testing and exercise prescription. Secondly, it has ramifications for professional responsibilities and may serve as a basis for litigation, which in turn may impact upon insurance premiums. Thirdly, it has the potential to influence the health budget. If screening procedures are too conservative, unnecessary expense is incurred in demanding medical examinations for individuals at low risk, who may also then be discouraged from exercising.

In 1994, SMA produced guidelines for pre-exercise screening procedures based largely on the 1991 ACSM model. To our knowledge, only one study has applied pre-exercise guidelines to a large sample of potential exercisers (Kohl, Gibbons, Gordon & Blair, 1990). In that study, 24,332 subjects visiting a preventive medicine clinic were analysed. Of these only 30% of males and 37% of females were classified as "apparently healthy" using slightly modified 1986 ACSM guidelines. As a result of this study, the 1991 ACSM guidelines were modified. Had the 1991 guidelines been applied to the same sample, about 64% of males and 67% of females would have been classified as "apparently healthy". These figures represent the maximum percentage of subjects who would have avoided "exclusion" (that is, who would have required a medical examination before exercise), since pre-exercise examinations are recommended for some "apparently healthy" subjects on the grounds of age and exercise intentions.

In the study of Kohl et al. (1990), however, the sample was not randomly chosen, and no other study has applied the guidelines to a large random sample. This is doubtless because over forty physiological, behavioural and medical variables (including blood lipid profiles and blood pressure readings) are required to systematically apply these guidelines. Complete data on large random samples drawn from relevant populations are lacking. However, without a knowledge of what percentage of potential exercisers will fall into each of the risk stratification classes, it is impossible to conduct a cost-benefit analysis of these screening procedures. In 1990-91, DASET commissioned a quasi-random sample of almost 2300 Adelaide residents. Data from this study contain values for a large proportion of the variables required to apply the SMA screening system.

The aim of the current study was to strictly apply the SMA guidelines to the DASET dataset to determine what percentage of people in the general Australian population would be classified into the various risk categories. This information was then used as a basis for a cost analysis of applying the SMA screening procedures. At this stage, it was not an intention of this paper to analyse the possible benefits of the screening associated with application of the SMA guidelines.
Methods

The DASET dataset

The sample selection and data-gathering methods for the DASET data have been described elsewhere (Department of the Arts, Sport, the Environment and Territories, 1992; Gore, Owen, Bauman & Booth, 1993). Briefly, it is based on a three-stage (districts; dwellings; individuals) randomised sampling procedure generated by the Australian Bureau of Statistics, covering adult (ages 18-78 yr) Adelaide residents between 1990 and 1991. Participation was on a voluntary basis. Of the 2289 respondents in the DASET survey, 1246 underwent health assessment.

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>SMA</th>
<th>DASET</th>
</tr>
</thead>
<tbody>
<tr>
<td>diabetes mellitus</td>
<td>• IDDM and (age &gt; 30 years or had IDDM for &gt; 15 years or NIDDM and age &gt; 35 years</td>
<td>• using insulin and age &gt; 30 or using oral hypoglycaemics and age &gt; 35</td>
</tr>
<tr>
<td>cardiovascular disease</td>
<td>diagnosed cardiovascular disease</td>
<td>• answered “Yes” to the question: “Has your doctor ever said you have heart trouble?” or • answered “Yes” to the question: “Have you ever suffered from a stroke?” or • taking cardiovascular medication (eg beta-blockers, diuretics, anti-hypertensives)</td>
</tr>
<tr>
<td>asthma</td>
<td>not defined</td>
<td>• currently using asthma medication and • answered “Yes” to the question: “My breathing is never quite right.” or • answered “Yes” to the question: “I get regular trouble with my breathing, but it always gets completely better.”</td>
</tr>
<tr>
<td>pregnancy</td>
<td>not available</td>
<td>responses to the question: “Is there a good physical reason not mentioned here why you should not undertake a physical health assessment even if you wanted to?” were judged on an individual basis*</td>
</tr>
<tr>
<td>other diseases</td>
<td>not defined</td>
<td></td>
</tr>
</tbody>
</table>

IDDM = insulin-dependent diabetes mellitus; NIDDM = non-insulin-dependent diabetes mellitus.
* Examples of conditions which were judged as sufficient to exclude subjects: peritonitis, neck injury, knee reconstruction. Examples of conditions which were not judged sufficiently serious to exclude subjects: psoriasis, bruised ribs, backache.

Table 1: Definition of exclusion criteria at Stage 1 for the SMA guidelines and the DASET dataset.
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and blood lipid analysis. Of these, 1203 records (603 males and 600 females) contained complete information on physical characteristics, self-reported lifestyle habits, symptoms, medication, blood pressure, and blood chemical characteristics which allowed us to apply the SMA screening guidelines.

**Deriving SMA exclusion criteria from the DASET dataset**

The definitions of the exclusion criteria from the SMA guidelines and the DASET survey which were used in this analysis are shown in Tables 1, 2 and 3. The SMA criteria have been derived from the guidelines published by Sports Medicine Australia and from references therein (Sports Medicine Australia, 1994; American College of Sports Medicine, 1985, 1991). The DASET survey did not contain information on the following factors which are also used in the SMA screening system: pregnancy; ankle edema; palpitations; claudication; heart murmur and family history of cardiovascular disease. There was also no information in the DASET survey regarding the intensity at which respondents would like to exercise - that is, whether subjects, if they were to undertake an exercise program, would like to undertake moderate or vigorous exercise. Therefore our analysis includes simulations for a range of assumed exercise intentions.

### Table 2: Definition of exclusion criteria at Stage 2 for the SMA guidelines and the DASET dataset.

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>SMA</th>
<th>DASET</th>
</tr>
</thead>
<tbody>
<tr>
<td>chest pain</td>
<td>pain or discomfort in the chest or surrounding areas that appears to be ischemic in nature</td>
<td>answered “Yes” to the question: “Do you frequently have pains in your heart and chest?”</td>
</tr>
<tr>
<td>shortness of breath</td>
<td>unaccustomed shortness of breath, or shortness of breath on mild exertion</td>
<td>answered “Yes” to the question: “Have you, at any time in the last 12 months, had an attack of shortness of breath which came on during the day, when you were not doing anything strenuous?”</td>
</tr>
<tr>
<td>dizziness</td>
<td>dizziness or syncope</td>
<td>answered “Yes” to the question: “Do you often feel faint or have spells of severe dizziness?”</td>
</tr>
<tr>
<td>dyspnea</td>
<td>orthopnea/paroxysmal nocturnal dyspnea</td>
<td>answered “Yes” to the question: “Have you, at any time in the last 12 months, been woken at night by an attack of shortness of breath?”</td>
</tr>
<tr>
<td>ankle edema</td>
<td>not available</td>
<td></td>
</tr>
<tr>
<td>palpitation/ tachycardia</td>
<td>not available</td>
<td></td>
</tr>
<tr>
<td>claudication</td>
<td>not available</td>
<td></td>
</tr>
<tr>
<td>heart murmur</td>
<td>not available</td>
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</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Stage 3: cardiac risk factors - any two of the following</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONDITION</strong></td>
</tr>
<tr>
<td><strong>SMA</strong></td>
</tr>
<tr>
<td>smoking</td>
</tr>
<tr>
<td>high blood pressure</td>
</tr>
<tr>
<td>high cholesterol</td>
</tr>
<tr>
<td>high triglyceride</td>
</tr>
<tr>
<td>family history of cardiovascular disease</td>
</tr>
<tr>
<td>diabetes</td>
</tr>
</tbody>
</table>

IDDM = insulin-dependent diabetes mellitus; NIDDM = non-insulin-dependent diabetes mellitus.

* Individuals who indicated that they smoked, but not on a daily basis, did not incur a risk factor.

Table 3: Definition of exclusion criteria at Stage 3 for the SMA guidelines and the DASET dataset.

Because the DASET survey questions and data did not always correspond precisely to the SMA screening guidelines, and because those guidelines are occasionally imprecise, we were obliged at times to exercise our judgment in deciding whether exclusion criteria were met. In such cases, we endeavoured to minimise exclusion rates where doubt existed. For example, even though up to 49% of the sample reported having bone and joint problems, this would not necessarily contra-indicate exercise and therefore was not included as exclusion criterion. Judgment as to whether to exclude on the grounds of “other diseases” was made on a case-by-case basis. Table 1 gives examples of some of the judgments made.

**Applying the SMA exclusion criteria**

A custom computer program was written to apply the SMA exclusion criteria. These criteria were construed as a series of filters organised into four stages (see Figure 1). Stage 1 represented known disease, Stage 2 symptoms and signs suggestive of cardiopulmonary or metabolic disease, Stage 3 cardiac risk factors, and Stage 4 age and exercise intentions. There were a number of subroutines...
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Figure 1. The SMA screening system construed as a series of filters. The filters are organised into four stages: known disease; signs and symptoms; risk factors; and age and exercise intentions. No data were available from the DASET dataset on the items in italics. ESP = exercise science professional. The figures in bold type indicate the adjusted exclusion rates shown in Table 5. The screening decisions (in circles) are recommendations based on the following three questions: (1) Does the subject need a medical check-up and stress ECG prior to any exercise testing outside of the clinical setting, or before commencing an exercise program?, (2) Does a medical doctor (physician) need to be present during a maximal exercise test?, and (3) Does a medical doctor need to be present during a submaximal exercise test?
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<table>
<thead>
<tr>
<th>age group</th>
<th>DASET males</th>
<th>DASET females</th>
<th>ABS males</th>
<th>ABS females</th>
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<td>7.7</td>
<td>7.1</td>
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<tr>
<td>30-39</td>
<td>10.0</td>
<td>10.9</td>
<td>11.0</td>
<td>11.1</td>
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<tr>
<td>40-49</td>
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<td>50-59</td>
<td>9.2</td>
<td>10.4</td>
<td>7.2</td>
<td>6.5</td>
</tr>
<tr>
<td>60-69</td>
<td>9.0</td>
<td>7.5</td>
<td>5.5</td>
<td>5.8</td>
</tr>
<tr>
<td>70-79</td>
<td>2.7</td>
<td>2.2</td>
<td>3.1</td>
<td>4.1</td>
</tr>
<tr>
<td>total</td>
<td>50.1</td>
<td>49.9</td>
<td>49.7</td>
<td>50.3</td>
</tr>
</tbody>
</table>

Table 4: Percentage of Australians between the ages of 18 and 79 falling into different age groups for the DASET sample, and according to the Australian Bureau of Statistics 1991 census (ABS).

within each stage. Each of the 1203 DASET records was then fed through this series of filters. Subjects who did not meet the exclusion criteria at each stage passed onto the next until either they had been excluded or had passed through without exclusion. For each record, the program determined

(a) at what stage (if at all) the subject was excluded, and thus required a medically supervised examination and ECG prior to exercise testing;

(b) whether a medical doctor should be present during maximal and/or submaximal tests;

(c) the reasons for exclusion.

**Correcting for demographic factors**

The age and gender distribution of the 1203 DASET records does not match that of the Australian population as shown in Table 4 (Australian Bureau of Statistics, 1993). The DASET sample is somewhat older, and we felt that this might tend to inflate exclusion rates. The numbers in each 10-year age by gender slice were therefore adjusted to reflect the distribution in the Australian population, and overall exclusion rates were adjusted accordingly. For example, the DASET sample included 125 50-59 year old females (10.4% of the sample). However, this group represents only 6.5% of the Australian population aged between 18 and 80. Therefore, the n for this subgroup was adjusted downwards (adjusted n = 125 X 6.5/10.4 = 78). These adjustments tended to reduce exclusion rates (see Table 5).

**Cost analysis**

The cost of performing medical screenings (including stress ECGs and the required pathology tests) per adult member of the community was calculated in the following way. The cost of medical screenings (Cost) was calculated as

\[
\text{Cost} = \$\text{(exam)} \times p(\text{exam})
\]

where \$\text{(exam)} is the Medicare rebate for a medical examination including stress ECG and lipid profiles ($282 as of October 1995), and \( p(\text{exam}) \) is the probability that any adult member of the community would be required to undergo a medical screening if the SMA guidelines were strictly adhered to. Then, \( p(\text{exam}) \) was calculated as:

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<table>
<thead>
<tr>
<th>gender</th>
<th>age</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>no exam</th>
<th>n</th>
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<tr>
<td>male</td>
<td>18-29</td>
<td>7.5</td>
<td>8.6</td>
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<td>74.2</td>
<td>93</td>
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<td>30-39</td>
<td>5.0</td>
<td>3.3</td>
<td>23.3</td>
<td>38.3</td>
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<tr>
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<td>40-49</td>
<td>8.6</td>
<td>10.8</td>
<td>27.3</td>
<td>53.2</td>
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<td>139</td>
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<td>111</td>
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<tr>
<td></td>
<td>70-79</td>
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<td>25.0</td>
<td>21.9</td>
<td>0</td>
<td>32</td>
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<td>36.2</td>
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<td>141</td>
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<td></td>
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<td>25.9</td>
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<td>males and females</td>
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<td>28.1</td>
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<tr>
<td></td>
<td>adj. data</td>
<td>total</td>
<td>15.8</td>
<td>11.5</td>
<td>15.7</td>
<td>24.0</td>
<td>32.9</td>
</tr>
</tbody>
</table>

Raw data refers to the age distribution in the actual DASET dataset. Adjusted data refers to the DASET dataset corrected to reflect the age and gender distribution in the Australian population.

Table 5: Percentage of sample excluded (i.e. requiring medical screening) at Stages 1, 2, 3 and 4 (assuming vigorous exercise is to be undertaken) of the Sports Medicine Australia system for each gender and age group.

\[ p(\text{exam}) = p(\text{new exercise}) \times p(\text{exclusion}) \]

where \( p(\text{new exercise}) \) is the probability that an adult will be starting an exercise program, and \( p(\text{exclusion}) \) is the probability that individual would be excluded using the SMA guidelines. The first variable, \( p(\text{new exercise}) \), was estimated using DASET questionnaire data, where subjects were asked if they intended to start exercising or to increase their current level of exercise. Since it is unclear from the guidelines whether increasing one's level of exercise would require a screening procedure, the costs have been modelled using two different assumptions:

(a) that only those who intend to start new programs should be required to undergo screening; and

(b) that both those who intend to start new programs and those who intend to increase their level of exercise should be screened.

The probability of being excluded was calculated as:

\[ p(\text{exclusion}) = p(1) + p(2) + p(3) + p(\text{over age}) \times p(\text{vigorous}) \times [1 - p(1) - p(2) - p(3)] \]
where \( p(1) \), \( p(2) \) and \( p(3) \) designate the probabilities of being excluded at stages 1, 2 and 3 of the SMA screening procedure respectively, \( p_{\text{over age}} \) is the probability of being over 35 (for men) or over 45 (women), and \( p_{\text{vigorous}} \) is the probability of wishing to undertake vigorous exercise (which the SMA guidelines define as being >60% \( \text{VO}_{2\text{max}} \)). The first four variables were derived from the exclusion analysis. The DASET survey reported on the incidence of self-reported vigorous activity over the last six months in the various age by gender slices. These proportions were calculated for each age by gender slice, and were used as operational equivalents of \( p_{\text{vigorous}} \). In addition, costs were modelled for a range of assumed \( p_{\text{vigorous}} \) values from 0 to 1.

Since the variable \( p_{\text{new exercise}} \) is age by gender-specific, the cost analysis was performed for each ten-year age and gender slice. The calculated costs were then multiplied by the fraction of the adult Australian population represented by that slice \([\text{population}]\), based on the ABS Census, 1991] and an overall cost was arrived at. The overall cost was therefore

\[
\text{Cost} = \sum_{i=1}^{n} \left( \text{\$}(\text{exam}) \ p(\text{exam}) \ i(\text{population}) \right)
\]

where the subscript \( i \) designates one of the \( n \) age by gender slices.

**Results**

**Incidence of reported conditions**

Table 6 shows the incidence of conditions constituting exclusion criteria reported in the DASET dataset.

**Reasons for exclusion**

The reasons for exclusion are shown in Table 7.

**Cost analysis**

The results of the cost analysis are shown in Table 8.

**Discussion**

**Reasons for exclusion**

Exclusion rates are surprisingly high across age by gender slices (see Table 5). Using data adjusted to the general population, between 43-73% of males and 44-61% of females would require medical screening. In some age groups, this rises to between 70 and 100%. Even in the youngest age group, 26% of all respondents would require screening. This would mean that one in every four young people should be required to have a medical check-up before being allowed to start exercising. Above the age of 35 for males and 45 for females, every individual must have a check-up before undertaking a “vigorous” (>60% \( \text{VO}_{2\text{max}} \)) exercise program. Using the estimated \( \text{VO}_{2\text{max}} \) values from the DASET (1992) survey, most 45 year-old subjects could not even jog at 8 km.h\(^{-1}\) at 60% \( \text{VO}_{2\text{max}} \). In strict terms, then, the guidelines are suggesting that before undertaking even a program of brisk walking, most individuals over 45 years of age would require a medical check-up.

In Stage 1 of the screening procedure, established cardiovascular disease was the main reason for exclusion, affecting 12.3% of the total sample (Table 6). In Stage 2, a surprisingly large proportion of the sample indicated that they suffered subjective symptoms which could be indicative of cardiovascular disease: 9.2% of the sample noted shortness of breath, 5.5% chest pains, and 9.5% of all females
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<table>
<thead>
<tr>
<th>symptom</th>
<th>18-29</th>
<th>30-39</th>
<th>40-49</th>
<th>50-59</th>
<th>60-69</th>
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<th>all</th>
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<td>1.7</td>
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<td>16.1</td>
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<td>9.2</td>
<td>9.6</td>
<td>8.5</td>
<td>9.1</td>
<td>11.9</td>
<td>9.2</td>
</tr>
<tr>
<td>dizziness (M)</td>
<td>1.1</td>
<td>0.8</td>
<td>2.2</td>
<td>2.7</td>
<td>8.3</td>
<td>6.3</td>
<td>3.2</td>
</tr>
<tr>
<td>dizziness (F)</td>
<td>8.1</td>
<td>9.9</td>
<td>10.6</td>
<td>8.8</td>
<td>8.9</td>
<td>11.1</td>
<td>9.5</td>
</tr>
<tr>
<td>dyspnea</td>
<td>7.8</td>
<td>4</td>
<td>5.7</td>
<td>3.8</td>
<td>6.6</td>
<td>1.7</td>
<td>5.3</td>
</tr>
<tr>
<td>cigarette smoking</td>
<td>24.6</td>
<td>25.5</td>
<td>16.1</td>
<td>15.3</td>
<td>10.6</td>
<td>11.9</td>
<td>18.0</td>
</tr>
<tr>
<td>SBP &gt; 140 mm Hg (M)</td>
<td>7.5</td>
<td>4.2</td>
<td>7.9</td>
<td>20.7</td>
<td>37.0</td>
<td>53.1</td>
<td>17.1</td>
</tr>
<tr>
<td>SBP &gt; 140 mm Hg (F)</td>
<td>1.2</td>
<td>0.8</td>
<td>3.5</td>
<td>23.2</td>
<td>38.9</td>
<td>37.0</td>
<td>13.5</td>
</tr>
<tr>
<td>DBP &gt; 90 mm Hg (M)</td>
<td>0</td>
<td>5</td>
<td>10.1</td>
<td>15.3</td>
<td>11.1</td>
<td>12.5</td>
<td>8.8</td>
</tr>
<tr>
<td>DBP &gt; 90 mm Hg (F)</td>
<td>1.2</td>
<td>0.8</td>
<td>3.5</td>
<td>8.8</td>
<td>10.0</td>
<td>7.4</td>
<td>4.8</td>
</tr>
<tr>
<td>high cholesterol</td>
<td>23.5</td>
<td>34.3</td>
<td>50.7</td>
<td>64.8</td>
<td>67.2</td>
<td>66.1</td>
<td>49.5</td>
</tr>
<tr>
<td>high triglycerides (M)</td>
<td>6.5</td>
<td>20.0</td>
<td>28.8</td>
<td>27.0</td>
<td>20.4</td>
<td>28.1</td>
<td>21.7</td>
</tr>
<tr>
<td>high triglycerides (F)</td>
<td>3.5</td>
<td>2.3</td>
<td>10.6</td>
<td>20.8</td>
<td>25.6</td>
<td>18.5</td>
<td>12.5</td>
</tr>
</tbody>
</table>

M = males; F = females.

Table 6: Percentage of sample showing or reporting conditions for each age group and for the whole sample.

indicated that they suffered dizzy spells. It may not always be the case that these symptoms are indicative of cardiovascular or pulmonary disease. It has been suggested that, in the case of athletes, somatic complaints are common due to their preoccupation with physical well-being (Thompson, 1993). Shephard (1988) noted that interpretation of screening questions may be dubious, particularly in relation to blood pressure, joint problems, heart problems and medication and when analysing data found it necessary to discount for hypochondriacal subjects (Shephard, 1988). While medically- or paramedically-trained professionals may, through further questioning, distinguish between innocuous and suggestive symptoms, these guidelines will often be administered by essentially untrained personnel currently working in fitness centres, schools and other institutions. This suggests a need for greater clarity in questionnaire design so as to facilitate decision-making.

In Stage 3, almost half (49.5%) of the sample showed high cholesterol levels (Table 6). While cholesterol levels above 5.5 mmol.L⁻¹ may be a risk factor for the development of cardiovascular disease, it is questionable whether a condition affecting half the population should contribute towards exclusion. Other exclusion criteria which were reported by a large proportion of the sample were cigarette smoking (18%), high systolic blood pressure (17.1% of males and 13.5% of females), and high triglyceride levels (21.7% of males and 12.5% of females).

Factors which might bias estimated exclusion rates

The DASET survey did not contain information on some factors which are used in
Applying the Sports Medicine Australia pre-exercising screening procedures...

<table>
<thead>
<tr>
<th>stage</th>
<th>reason for exclusion</th>
<th>n</th>
<th>% of exclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>this stage</td>
</tr>
<tr>
<td>1</td>
<td>diabetes</td>
<td>7</td>
<td>3.4</td>
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<tr>
<td></td>
<td>cardiovascular</td>
<td>146</td>
<td>70.2</td>
</tr>
<tr>
<td></td>
<td>asthma</td>
<td>22</td>
<td>10.6</td>
</tr>
<tr>
<td></td>
<td>other</td>
<td>33</td>
<td>15.9</td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>208</td>
<td>17.3</td>
</tr>
<tr>
<td>2</td>
<td>chest pains</td>
<td>41</td>
<td>28.9</td>
</tr>
<tr>
<td></td>
<td>shortness of breath</td>
<td>52</td>
<td>36.7</td>
</tr>
<tr>
<td></td>
<td>dizziness</td>
<td>35</td>
<td>24.6</td>
</tr>
<tr>
<td></td>
<td>dyspnea</td>
<td>14</td>
<td>9.9</td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>142</td>
<td>11.8</td>
</tr>
<tr>
<td>3</td>
<td>smoking</td>
<td>95</td>
<td>45.2</td>
</tr>
<tr>
<td></td>
<td>high blood pressure</td>
<td>82</td>
<td>39.1</td>
</tr>
<tr>
<td></td>
<td>high cholesterol</td>
<td>176</td>
<td>83.8</td>
</tr>
<tr>
<td></td>
<td>high triglycerides</td>
<td>67</td>
<td>31.9</td>
</tr>
<tr>
<td></td>
<td>diabetes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>420</td>
<td></td>
</tr>
</tbody>
</table>

For exclusion at Stage 3, two risk factors are required. The percentages given here for Stage 3 represent the proportion of the sample exhibiting that risk factor without consideration of other factors.

* Note: because two or more risk factors are required for exclusion at Stage 3, the total exclusions at this stage are not merely the sum of the percentages of individuals with each risk factor.

Table 7: Reasons for exclusion at Stages 1, 2 and 3 expressed as a percentage of all the exclusions at each stage, and as a percentage of the whole sample (i.e. n = 1203).

<table>
<thead>
<tr>
<th>Data set</th>
<th>% undertaking vigorous exercise</th>
<th>(a) Cost ($) if starting exercise only</th>
<th>(b) Cost ($) if both starting and increasing exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>15.77</td>
<td>49.94</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>20.52</td>
<td>64.52</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>25.27</td>
<td>79.10</td>
</tr>
<tr>
<td>4</td>
<td>DASET report</td>
<td>19.23</td>
<td>60.60</td>
</tr>
</tbody>
</table>

The table shows estimated costs assuming 0, 50 and 100% (data sets 1, 2 and 3, respectively) of those undertaking (a) new and (b) new or increased exercise programs wish to exercise vigorously (i.e. >60% VO2max). Also shown (data set 4) are the estimated costs based on the proportion of the adult population self-reporting vigorous exercise in the DASET survey.

Table 8: Cost ($) per member of the adult Australian community of a rigorous application of the SMA screening guidelines.
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the SMA screening system (e.g., pregnancy, ankle oedema, palpitations, claudication, heart murmur and family history of cardiovascular disease). Therefore the estimated exclusion rates will probably underestimate the true values, as some subjects may have been excluded on criteria for which information was not available. Furthermore, we have systematically chosen to interpret the guidelines so as to reduce exclusion rates where the guidelines are not specific. For example, cigarette smoking is considered a cardiac risk factor, although the SMA guidelines do not state a threshold level for smoking to be included. We used daily smoking as our criterion, and thus sporadic and occasional smokers did not incur a risk factor.

Of the 1203 subjects for whom complete records were available, 524 expressed a desire either to start an exercise program or to increase their current exercise level. It might be objected that we should have limited our analysis to this subset, on the grounds that the others are not candidates for screening. We did not do so because the reduction in numbers would have made the estimation of population parameters less reliable. However, it is possible that those who are candidates for screening may be quite different in terms of screening criteria from those who are not, and therefore the exclusion estimates would be biased. It is conceivable, for example, that those who are ill or at risk would not even consider starting an exercise program. Alternatively (and to counterbalance this consideration) those who are already exercising regularly (and who are therefore less likely to be excluded) are also not screening candidates. To control for these factors, we compared exclusions using the whole dataset (n = 1203, the full dataset) to exclusions using only candidates for screening (n = 524, the restricted dataset).

The percentage excluded at Stages 1, 2 and 3 for the whole dataset was 46.6% (Table 5). For the restricted dataset, it was 45.2%. The corresponding figures for males were 46.5% (whole dataset) and 41.2% (restricted dataset), and for females 46.7% (whole dataset) and 49.1% (restricted dataset). It seems likely then that limiting the dataset to only those who are candidates for screening does not make an appreciable difference to exclusion rates.

Finally, it is possible, since participation in the original DASET survey was voluntary, that there would be a tendency for healthier individuals, and for those more interested in their health and fitness, to volunteer. It is conceivable that a truly random sample of the population would reveal a generally less healthy profile, and therefore higher exclusion rates.

**Costs of screening**

The estimated cost per member of the adult Australian community ranges from $16 to $79 depending on the starting assumptions (Table 8). If rigorously applied, the SMA guidelines would cost a total of between 250 million and 1.2 billion dollars each year. Of course, the guidelines are not rigorously applied, so that the real cost is likely to be much less. Nonetheless, the guidelines are a policy document outlining recommended practice. Costs should be weighed against benefits, which are rather more difficult to quantify. A comprehensive analysis of potential benefits is therefore required to complete the picture. Certainly some lives would be saved by screening, some underlying illnesses would be detected earlier, and consciousness of health status would be heightened. To counterbalance this, many people would perhaps be dissuaded from exercise by the time and personal cost involved in the screening process.
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**Factors which might bias estimated costs**
The estimation of costs has also tended to underestimate actual costs. Firstly, medical screening was costed at current Medicare rebate rates. Many physicians will charge higher fees using the Australian Medical Association schedule. Secondly, the cost of having a physician present during maximal and submaximal tests has not been factored in. This is because no data are available on how many of those excluded will want to have maximal or submaximal tests. Certainly a number of mature athletes (excluded at Stage 4) would be likely to want such tests. Finally, the cost of administering the screening procedure (performed by a health professional) has not been included.

"Fuzziness" in the guidelines
One of the major problems we encountered with the SMA guidelines was their imprecision. For example, exercise science professionals are referred (p. 20) to a "General Health and Lifestyle Questionnaire" (p. 19) for screening purposes. However, this questionnaire contains items (eg Item 10, regarding Body Mass Index and Waist to Hip Ratio; Item 11, exercise habits) which are not exclusion criteria. Furthermore, some of the exclusion criteria are "fuzzy". In Item 1 (p. 21), for example, the guidelines state that exclusion may occur at Stage 3 even if only one cardiac risk factor is present, if that risk factor is "grossly abnormal". However, no clear definition of "grossly abnormal" is offered, except for blood pressure limits (180/120 mm Hg). Similarly, there is not a clear indication of what constitutes a 'cigarette smoker'. There is a need for information on the frequency, quantity and type (pipes, cigars etc) of tobacco habit, together with time since quitting smoking (eg 2 years) which would indicate a risk factor for CVD.

Importantly, no indication is given of what procedure to adopt if information on some of the risk factors is missing. If we do not know a subject's cholesterol or triglyceride levels, are we to assume that they are above or below the exclusion threshold? Or should we use population mean values? More rigid definitions and clearer flow charts are required for consistent application of these guidelines. This would also make it possible to construct a computer-programmable system accessible to health professionals.

**Recommendations**
On the basis of this analysis, we would make the following recommendations regarding the SMA pre-exercise screening guidelines:

1. A rigorous cost-benefit analysis of the screening guidelines should be conducted, assessing the benefits in terms of lives potentially saved, early detection of disease, and heightened awareness of health status, as well as the costs as described above.

2. The guidelines should be formalised into a precise and unambiguous computer-programmable flow-chart or decision-tree structure (see Figure 1), so that they can be applied as a preliminary screening by non-medically trained personnel.

3. In such a restructure, the order in which filters are applied should be considered, so that exclusion criteria depending on costly requirements (such as blood tests) should come after criteria relying on simple questionnaire responses.

4. Some of the more "draconian" filters (such as age cut-off levels) should be

(5) Questions where respondents are asked to report subjective symptoms such as dizziness and chest pains should be reworded so as to elicit more information as to whether these symptoms are innocuous or suggestive of underlying disease.

(6) Often simple changes to the screening structure can make the guidelines much easier to follow and to remember. One improvement would be to use either “greater than” or “greater than or equal to” exclusively and systematically throughout.

(7) Physicians should be made aware of the guidelines and their role in the screening process. A recent study showed that in the United States only 23% of physicians were familiar with the ACSM guidelines regarding exercise prescription (Williford, Barfield, Lozenby & Olson, 1992). No figures are available in the Australian context, but anecdotal evidence suggests a very low level of awareness of the guidelines.

Acknowledgments

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References


