Heart rate responses of women aged 23–67 years during competitive orienteering

S Bird, M George, J Balmer, R C R Davison

Objectives: To compare the heart rate responses of women orienteers of different standards and to assess any relation between heart rate responses and age.

Methods: Eighteen competitive women orienteers completed the study. They were divided into two groups: eight national standard orienteers (ages 23–67 years); 10 club standard orienteers (ages 24–67 years). Each participant had their heart rate monitored during a race recognised by the British Orienteering Federation. Peak heart rate (HR\(_{\text{peak}}\)), mean heart rate (HR\(_{\text{mean}}\)), standard deviation of her heart rate during each orienteering race (HR\(_{\text{SD}}\)), and mean change in heart rate at each control point (ΔHR\(_{\text{CONTROL}}\)) were identified. The data were analysed using analysis of covariance with age as a co-variate.

Results: National standard orienteers displayed a lower within orienteering race standard deviation in heart rate (6 (2) v 12 (2) beats/min, p<0.001) and a lower ΔHR\(_{\text{CONTROL}}\) (5 (1) v 17 (4) beats/min, p<0.001). The mean heart rate during competition was higher in the national standard group [170 (11) v 158 (11) beats/min, p = 0.025]. The HR\(_{\text{mean}}\) for the national and club standard groups were 99 (8)% and 88 (9)% of their age predicted maximum heart rate (220–age) respectively. All orienteers aged >55 years (n = 4) recorded HR\(_{\text{MEAN}}\) greater than their age predicted maximum.

Conclusions: The heart rate responses indicate that national and club standard women orienteers of all ages participate in the sport at a vigorous intensity. The higher ΔHR\(_{\text{CONTROL}}\) of club standard orienteers is probably due to failing to plan ahead before arriving at the controls and this, coupled with slowing down to navigate or relocate when lost, produced a higher HR\(_{\text{MEAN}}\).

METHODS

The University College ethics committee approved the study.

Subjects and recruitment

Subjects were recruited through advertisements in local orienteering club newsletters, a national orienteering magazine, and leaflets distributed at British Orienteering Federation orienteering races. All subjects were regularly involved in competitive orienteering and had a minimum of four years experience, which ensured that they were familiar with the procedures and techniques of orienteering, and consequently were capable of providing valid data.

All subjects were informed that they were able to withdraw from the study at any time without any obligation. Before collection of the heart rate data, all subjects completed the following:

- general health questionnaire;
- consent form;
- questionnaire on current activity levels and general history of participation in physical activities;
- personal orienteering information sheet providing details of their orienteering history, standard of participation, and any specific achievements.

To assess the effects of standard on the subsequent heart rate data, the subjects were divided into two groups according to their standard at the time of data collection:

1. National standard orienteers with more than 3500 national ranking points (pre-2001 British Orienteering Federation ranking system) and who had been ranked nationally.

Previous research into the physiological demands of women’s orienteering has primarily focused on elite level orienteers aged 21–35 years. The high level of fitness required at an elite level is reflected in the maximum aerobic power of women from the Danish (59.1 ml/kg/min) and Norwegian (66.4 ml/kg/min) national teams, and research into the physiological demands of the sport has recorded mean blood lactate levels of 3.4 mmol/l for women of the Norwegian national team during simulated orienteering races. Heart rate monitoring during competitive orienteering races has indicated mean heart rates of 172 beats/min for elite British Women and 179 beats/min for members of the Norwegian women’s national team. According to Creagh and Reilly, these values are similar to those observed during marathon running, but the variability in heart rate is much greater. For example, the standard deviation in heart rate for elite women within an orienteering race are generally reported to be in the region of 10 beats/min. Masters age categories for orienteering increase in five year increments from the age of 35 years, thereby providing an age related competitive structure at local, regional, national, and international orienteering races up to and including 90+ years. According to the International Orienteering Federation, over one million people regularly participate in orienteering across 58 countries. At the 2001 British Orienteering Championships, there were over 600 women competitors. Of these, 59% were aged over 35 years, with one of the most popular age classes being 50–54 years, in which there were 77 participants. However, despite the fact that orienteering is a popular competitive sport and recreational activity for women over 35 years of age in numerous countries throughout the world, relatively little is known about the demands of the sport and the physiology of those competing in the older age groups. Indeed there has been a relative paucity of research on older women athletes per se.

Therefore the aims of this study were to compare the heart rate responses of competitive women orienteers of different standards across a broad spectrum of ages and to assess whether the heart rate responses were related to age.
in the top six for their age group within the previous year. All subjects in this group had also represented England or Scotland at Senior and/or Masters level and/or had finished in the top three for their age group at the British Orienteering Championships.

(2) Club standard orienteers with 2500–3500 national ranking points.

Collection of heart rate data

All the orienteering races used for data analysis in the study were recognised by the British Orienteering Federation and had a winning time in excess of 40 minutes. Orienteering races were therefore of a “classic” nature and did not include short or sprint orienteering races. Each participant was provided with a heart rate monitor (PE3000 or Sports Tester, Polar Electro Oy, Kempele, Finland) with which the participants were encouraged to familiarise themselves during training runs before using it during the orienteering race. Monitors were preset to record heart rate at 15 second intervals. During the orienteering races the subjects were requested to record their split times on arrival at each control after leaving the control. A mean change in heart rate at controls was calculated for each competitor’s race data.

To assist with the analysis of heart rate data, each subject was requested to provide the following information after each orienteering race:

- copy of the race map with identified route and controls clearly marked;
- analysis sheet highlighting any important information about the race, such as any difficulties in locating particular controls or obstructive vegetation;
- time taken to complete the race (which was also available from published results lists).

This information was then used to identify any specific incidents that may have influenced the recorded heart rate data.

Analysis of the heart rate data

From the heart rate recordings, each of the following were identified and calculated. Using the criteria of Creagh et al., data were omitted for the first four minutes of each race to allow the initial increase in heart rate to reach “normal” race intensity.

- Heart rate peak (HRPEAK): the highest heart rate recorded during the orienteering race.
- Heart rate mean (HRMEAN): the mean heart rate during the orienteering race (excluding the aforementioned first four minutes).
- Heart rate standard deviation (HRSD): the standard deviation in heart rate within the orienteering race (excluding the aforementioned first four minutes).
- The mean change in heart rate at each control (ΔHRCONTROL): the change in heart rate occurring at a control was calculated as the difference between the highest heart rate recorded 15–30 seconds before reaching the control (as indicated from the split time recorded on the heart rate monitor) and the lowest heart rate recorded 45–60 seconds after leaving the control. A mean change in heart rate at controls was calculated for each competitor’s race data.

To investigate any trend in heart rate within a race, regression analyses were used (time v heart rate recorded at 15 second intervals, excluding the aforementioned first four minutes) and assessed for positive or negative trends.7

Heart rate data for an orienteering race were to be rejected if they displayed uncharacteristic spikes or flat plateaus suggesting that the receiver had failed to record a true heart rate profile during the orienteering race. A participant’s ΔHRCONTROL was not calculated if they failed to record a split time for more than three of their controls.

Statistical analysis

Data were analysed using the Statistical Package for Social Sciences (SPSS version 10.0). Analysis of covariance was used to assess any differences in the responses of the groups (national standard v club standard), with age being the covariate. Regression analyses were used to determine any relations between each heart rate factor (HRPEAK, HRSD and HRMEAN) and the age of the participants. The data were checked for normality using Kolmogorov-Smirnov tests, and none violated normality. Values for HRPEAK and HRMEAN were compared with predicted maximal heart rate derived from the algorithm 220–age.7

To investigate any trend in heart rate within a race, regression analyses were used (time v heart rate recorded at 15 second intervals). Regression lines were classified as either positive or negative if p<0.05, and neutral if p>0.05. The frequency of positive, negative, and neutral regression lines were analysed using log-linear and χ² analyses (SPSS 10).

RESULTS

Eighteen women orienteers (eight national standard and 10 club standard) completed the study (table 1). Analysis of covariance with age as a covariate showed that HRMEAN was
Table 3  Regression analysis between heart rate responses (beats/min) and age (years) for national and club standard orienteers, and combined groups

<table>
<thead>
<tr>
<th>Factor</th>
<th>Group</th>
<th>Heart rate correlation with age</th>
<th>r² Value</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak heart rate (HR&lt;sub&gt;PEAK&lt;/sub&gt;)</td>
<td>Combined</td>
<td>HR&lt;sub&gt;PEAK&lt;/sub&gt; = 0.256 age + 191</td>
<td>0.131</td>
<td>0.140</td>
</tr>
<tr>
<td></td>
<td>National</td>
<td>HR&lt;sub&gt;PEAK&lt;/sub&gt; = 0.333 age + 197</td>
<td>0.193</td>
<td>0.276</td>
</tr>
<tr>
<td></td>
<td>Club</td>
<td>HR&lt;sub&gt;PEAK&lt;/sub&gt; = 0.281 age + 190</td>
<td>0.166</td>
<td>0.243</td>
</tr>
<tr>
<td>Mean heart rate (HR&lt;sub&gt;MEAN&lt;/sub&gt;)</td>
<td>Combined</td>
<td>HR&lt;sub&gt;MEAN&lt;/sub&gt; = 0.079 age + 166</td>
<td>0.008</td>
<td>0.732</td>
</tr>
<tr>
<td></td>
<td>National</td>
<td>HR&lt;sub&gt;MEAN&lt;/sub&gt; = 0.412 age + 190</td>
<td>0.274</td>
<td>0.183</td>
</tr>
<tr>
<td></td>
<td>Club</td>
<td>HR&lt;sub&gt;MEAN&lt;/sub&gt; = 0.020 age + 159</td>
<td>&lt;0.001</td>
<td>0.950</td>
</tr>
<tr>
<td>Within race heart rate SD (HR&lt;sub&gt;SD&lt;/sub&gt;)</td>
<td>Combined</td>
<td>HR&lt;sub&gt;SD&lt;/sub&gt; = 0.091 age + 13</td>
<td>0.137</td>
<td>0.131</td>
</tr>
<tr>
<td></td>
<td>National</td>
<td>HR&lt;sub&gt;SD&lt;/sub&gt; = 0.015 age + 7</td>
<td>0.014</td>
<td>0.777</td>
</tr>
<tr>
<td></td>
<td>Club</td>
<td>HR&lt;sub&gt;SD&lt;/sub&gt; = 0.059 age + 14</td>
<td>0.212</td>
<td>0.180</td>
</tr>
</tbody>
</table>

HR<sub>PEAK</sub> as % of 220-age: Combined % predicted HR<sub>PEAK</sub> = 0.468 age + 82 0.593 0.001
HR<sub>MEAN</sub> as % of 220-age: Combined % predicted HR<sub>MEAN</sub> = 0.517 age + 71 0.492 0.002

Figure 1  Heart rate profiles of a national standard (aged 41 years) and club standard (aged 37 years) orienteer.
standard orienteers was partly due to navigational errors that caused them to slow down and/or stop to relocate their position. A further factor contributing to the higher HRc was larger ΔHRc of the club standard orienteers. Observations made at controls that were visible to the investigators suggested that the national standard orienteers had checked that the code of the control matched that on the list they carried while approaching the control and had planned their direction of exit from the control before reaching it. Consequently they minimised the amount of time spent at the control and resumed running immediately. Conversely, club standard orienteers were often observed to pause and check their control code after they had arrived at the control. They then exited from the control reading their map at a walking pace before starting to run again. This appeared to be due to their failure to plan their route to the next control, including their immediate exit from the one that they were at, before arriving at it. They may therefore be deemed to have wasted time at the control. The difference between the two groups is perhaps exemplified by paraphrasing a quote from a British Champion who said that “top orienteers pass through the controls which are on their route around the course, whereas club standard orienteers use the controls as beginning and end points to a navigational leg”.

For the club standard group, fluctuations in running intensity caused by navigational difficulties (which were reported on the analysis forms) and the greater mean decrease in heart rate at controls is likely to have contributed to their lower HRMEAN. Such fluctuations and variations may also explain why the regression of HRMEAN with age was not significant.

The findings of this study indicate orienteering to be a physically demanding activity for both club and national standard women across the age range 23–67 years. Competitors displayed relatively high heart rate responses (HRmax and HRmean) during orienteering races. In older women orienteers of both national and club standard, heart rate algorithms such as 220-age appear to underestimate the heart rate responses of these “athletic” women and would therefore appear to be inappropriate for these groups. This is despite the fact that they were not specifically trying to attain an HRmax and therefore their true maximum heart rate may be even greater.

The finding of HRmax values greater than that predicted from the algorithm 220-age agrees with the results of Bird et al., who suggested that women orienteers aged >45 years spend a considerable proportion of a competitive orienteering race with a heart rate higher than would be predicted from commonly applied algorithms such as 220-age for maximum heart rate.7

Likewise, the mixture of neutral, positive, and negative heart rate profiles also agrees with the work of Creagh et al., who indicated that, unlike cross country running races in which a consistent rise in heart rate was observed within a race, heart rate responses during orienteering races were less consistent and were likely to reflect the technical difficulty of the course as well as its topography.

Take home message

Although many aspects of this paper are descriptive, they provide an original insight into the heart rate responses of older women athletes who are an under-researched group. During competitive orienteering, many of the women sustained heart rates that were above what may have been expected if age related heart rate algorithms were applied. The intensity of the exercise could be described as strenuous, with differences between national and club standard competitors being evident in the form of greater fluctuations in heart rate in the club standard group, probably caused by less competent navigation and failing to plan ahead.

REFERENCES