Muscle Glycogen Consumption during Cross-Country Skiing (the Vasa Ski Race)

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Abstract. The glycogen content in muscle tissue of the quadriceps femoris and the deltoid muscles was examined in four healthy subjects, performing a ski race of 85 km. Muscle samples were obtained before, after 45 km, and at the end of the race. The glycogen content before was above the normal range in all the subjects due to a special training and diet program. The decrease of glycogen in the leg muscles was most pronounced during the first part of the race and also at the end there was a sufficient amount of glycogen in the leg muscles. In the arm muscles, on the other hand, practically complete exhaustion of the glycogen store was found at the end of the race. The subjects experienced a marked feeling of tiredness in the arm muscles during the last kilometers of the race.

The result can partly be explained by the topographical profile of the race.

Key words: Ski-Race — Exercise — Muscle Glycogen — Diet.

It has previously been shown that skiing of the kind performed in the Vasa ski race, i.e. 85 km in 6 to 10 h, means a strenuous physical exertion. Hedman (1957) investigated the energy metabolism during this kind of skiing measuring the oxygen uptake as well as the respiratory quotient. He found that large quantities of carbohydrate were used up. At one Vasa race (1954) a carbohydrate consumption of totally 710 to 770 g was estimated.

In recent years a method for determination of the glycogen content in muscle obtained by needle biopsy technique has been worked out at S:t Eriks sjukhus. Experiments have shown that the working capacity during hard and prolonged muscular work is well correlated to the glycogen store (Ahlborg, 1967; Bergström, 1967). Therefore it was considered interesting to determine to what extent the capacity to perform so long a ski race was dependent upon the glycogen store.

Material and Methods

Four subjects, entered for the Vasa race, volunteered to let themselves be examined with needle biopsy before, in the middle of, and after the race. They were all reasonably well trained. Anthropometric data are shown in Table 1.
Table 1. Anthropometrical data

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age yrs</th>
<th>Height cm</th>
<th>Weight kg</th>
<th>( V_{\text{O}_2 \text{ max}} ) l/min</th>
<th>Quantity consumed</th>
<th>Time during race</th>
</tr>
</thead>
<tbody>
<tr>
<td>S - n</td>
<td>27</td>
<td>183</td>
<td>64</td>
<td>3.8</td>
<td>350</td>
<td>8 h 48' 04&quot;</td>
</tr>
<tr>
<td>N - g</td>
<td>23</td>
<td>178</td>
<td>72</td>
<td>4.1</td>
<td>260</td>
<td>7 h 43' 57&quot;</td>
</tr>
<tr>
<td>N - s</td>
<td>23</td>
<td>172</td>
<td>66</td>
<td>4.3</td>
<td>340</td>
<td>7 h 08' 16&quot;</td>
</tr>
<tr>
<td>S - d</td>
<td>23</td>
<td>176</td>
<td>73</td>
<td>4.4</td>
<td>280</td>
<td>6 h 53' 00&quot;</td>
</tr>
</tbody>
</table>

The topographical profile of the Vasa race is shown in Fig. 1.

The biopsies were performed at the start, after 45 km, and at the end of the race. The biopsy technique has been described previously [Bergström, 1962; Hultman, 1967 (1)]. Needle biopsy samples were taken from both the lateral portions of the quadriceps femoris and from the deltoid muscle. The biopsy material was weighed and homogenized in water and precipitated with TCA, thereafter analyzed for glycogen content.

Biopsies were performed before as well as after the race in both m. quadriceps femoris and m. deltoideus, before the race on the left and after the race in the right side.

In the middle of the race, i.e. after 45 km, a biopsy was performed in the right leg.