PHYSICAL PERFORMANCE CAPACITY OF FEMALE STUDENTS UNDER SUPPLEMENTATION OF B VITAMINS (THIAMINE, RIBOFLAVIN AND PYRIDOXINE)

SUMITA GHATAK, SOUMITRA MUKHERJEE AND PRATIMA CHATTERJEE

Department of Physiology,
Exercise and Sports Physiology Laboratory,
92, Acharya Prafulla Chandra Road,
Calcutta-700 009

Effects of supplementation of the B group vitamins on physical performance and endurance were studied on 48 undergraduate and postgraduate female students (aged 21—24 years). The subjects were divided into four groups—Thiamine Group, Riboflavin Group, Pyridoxine Group and Placebo Group—each group comprising 12 subjects.

Study of physical fitness by modified step test and of endurance time by magnetic brake bicycle ergometer was carried out on each group before and after supplementation of the vitamins on two different days. Endurance time and physical fitness showed significant increase in all groups after supplementation of the respective vitamins. Riboflavin was found more effective in terms of endurance time, showing a 24.55% increase compared to 21.18% increase for thiamine and 10.77% increase for pyridoxine. Riboflavin was also found more effective in regard to physical fitness, registering a 23.48% increase compared to 18.67% increase for thiamine and 18.72% increase for pyridoxine.

It is true that the B complex vitamins play an important role in many of the reactions that make energy available for muscular work. This vitamin B complex forms part of the reaction chains concerned carbohydrate and fat metabolism.

The role of the B complex vitamins in physical performance of humans of either sex and of different age groups has been investigated by a number of workers (1—19, 21, 22).
B VITAMINS AND PHYSICAL PERFORMANCE

But not much investigation has been carried out to study the effects of B vitamins supplementation on physical performance at the nutritional level and social set up under the Indian conditions. Sohal et al. (19) have conducted some investigations on the effect of vitamin B1 supplementation on same categories of male Indian athletes. Very little is known about the role of vitamins (particularly of B vitamins) on the physical performance of females, both sedentary and athletes, in the varying physical and social conditions in different regions of India.

The present study was therefore undertaken to determine whether or not supplementation of B vitamins (thiamine, riboflavin and pyridoxine) (i) has any significant effects on physical fitness score, and (ii) leads to significant improvement of endurance time of Bengali girl students in age group 21 to 24 years.

MATERIALS AND METHODS

Forty eight girl students (21—24 years in age) from both undergraduate and postgraduate sections of the Calcutta University were included in the study. The total number of subjects was divided into three experimental groups—Thiamine Group, Riboflavin Group, Pyridoxine Group and a Placebo Group, each group comprising 12 subjects.

The subjects were given respectively 50 mg of thiamine, 10 mg of riboflavin and 20 mg of pyridoxine tablets. Their heights, weights and pre-exercise heart rates were measured. The physical fitness index (PFI) of the subjects was determined by using modified step test (20) both before and after supplementation of vitamin B1, B2 and B6. The same was done also for the Placebo Group. The subjects were asked to step up and down on a 16” stool as long as they could do at a rate of 30 complete steps per minute. The rates of the steps were matched with a metronome.

To express endurance capacity, endurance time (in minutes) for doing a fixed work load till exhaustion was measured by the following procedure. The subjects in all Vitamin groups and also Placebo Group were asked to do work at 600 kgm/min of magnetic brake bicycle ergometer, maintaining a rate 60 revolutions/min, as long as they could both before and after supplementation of the vitamin. The endurance time was noted with a stopwatch and expressed in minutes. On the following day the subjects of the Placebo Group were given placebos which were identical in appearance to vitamin tablets and after one hour the same experiment was performed on them to find out any changes in endurance time and physical fitness. In the case of experimental groups the same experiment was performed before and after supplementation.
B VITAMINS AND PHYSICAL PERFORMANCE

RESULTS

Table 1 shows the physical characteristics of the sedentary subjects of both the Vitamin Groups and the Placebo Groups.

Table 1

Physical characteristics of sedentary subjects of both Vitamin B and Placebo groups

<table>
<thead>
<tr>
<th>Parameters</th>
<th>B₁ Thiamine Gr N=12</th>
<th>B₂ Riboflavin Gr N=12</th>
<th>B₃ Pyridoxine Gr N=12</th>
<th>Placebo Gr N=12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>23 ± 0.7</td>
<td>23 ± 0.5</td>
<td>23 ± 0.9</td>
<td>23 ± 0.8</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>152 ± 2.6</td>
<td>153 ± 4.3</td>
<td>154 ± 4.9</td>
<td>153 ± 4.6</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>49 ± 3.1</td>
<td>50 ± 3.1</td>
<td>51 ± 3.3</td>
<td>47 ± 5.0</td>
</tr>
</tbody>
</table>

Fig 1 shows that after supplementation of B vitamins (B₁, B₂ and B₃) physical fitness index scores have increased by 18.6%, 23.4% and 18.7% for Thiamine Group, Riboflavin Group and Pyridoxine Group respectively.
B VITAMINS AND PHYSICAL PERFORMANCE

In respect of endurance time Fig 2 shows the increase to be 21.8%, 24.5% and 10.7% respectively for the same groups. In case of both PFI and endurance time the increase is significantly higher for vitamin B2. All the increases are found to be at significant level.

DISCUSSION

As noted above, the present study shows that physical fitness index (PFI) scores increased significantly (P < 0.001 in case of thiamine and pyridoxine, and P < 0.01 in case of riboflavin) in the experimental groups, indicating that B vitamin supplementation one hour prior to the step test exercise, had a beneficial role in cardiovascular system during exercise performance.

Chatterjee et al. (6) observed that when athletes were given supplementation of vitamin B1 (100 mg) one hour before exercise it improved their working capacity and endurance time in terms of VO2 max. Physical fitness index has been considered a good predictor value of cardiovascular efficiency. Higher values of PFI have been obtained after supplementation of thiamine.
B VITAMINS AND PHYSICAL PERFORMANCE

Enhancement of physical performance after supplementation of vitamin B1 has been observed by several other workers. Gounelle (9) and McCormick (16) observed this effect respectively in cyclists and swimmers. The imperative need for adequate daily intake of thiamine, and probably of the whole of B complex, to maintain fitness by men doing hard physical labour and during severe exercise was noted by Johnson et al (15) and Bicknell (2). Belko et al (4) noted similar requirements for riboflavin.

Resistance to fatigue and improvement of muscular and mental ability for work through application of B Group vitamins have been observed by Egana et al (7), Frankau (8), Hörwitt et al (13), VanDam (22), Buskrik and Hayness (3), Manore et al (17), and Bhatia (5). Ushakov and co-workers (21) at the Institute of Biomedical Problems, Moscow, similarly observed significant improvement of physical work capacity. The present study shows that endurance time has significantly increased after supplementation of vitamin B1, B2 and B6.

So, B vitamins play a significant role in improvement of physical fitness and endurance time possibly through many metabolic reactions that make energy available for muscular work.

All these results seem to lead to the conclusion that Vitamin B (thiamine, riboflavin and pyridoxine) permits greater physical endurance for longer periods of time and improves performance.

ACKNOWLEDGEMENT

The authors are indebted to R D Birla Smarak Kosh for financial support to the project under scheme Fel 88-89/(13)

REFERENCES

1 Aldashev, A A, Mikhail Zhanov, E K, Apsatarva, R A, M I Ionina and Smyavskii Yu A (1979) Vopr Pitan, 0(4), 30

VOL XXXXIV, NO 3 114
B VITAMINS AND PHYSICAL PERFORMANCE

5 Bhatia, B (1989) Health and Personality Vol V, No 1 p 31
8 Frankau, I M (1942) Brit Med J, 11, 601
9 Gounelle, H (1940) Bull Soc Med Hap Pals, 56, 225
16 McCormuck, W J (1940) Med Record, 152, 439
18 Podorozhny, P G, And A I Kononenko (1979) Vopr Pitan, 0 (4), 27
21 Ushakov, P (1978) Space Environ Med, 49,
22 Vai3>am, B (1978) Brit J Sports Med, 12, 74

IND J PHYSIOL & ALLIED SCI, 1990
EFFECT OF THIAMINE (Vitamin B₁) SUPPLEMENTATION ON BLOOD LACTATE AND BLOOD PYRUVATE CONCENTRATION IN FEMALE SWIMMERS IN RESPONSE TO EXERCISE

Sumita Ghatak, Nimai Masanta and Pratima Chatterjee
Department of Physiology, Sports and Exercise Physiology Laboratory
92, Acharya Prafulla Chandra Road, Calcutta 700 009

Abstract
Effect of supplementation of thiamine on blood lactate and blood pyruvate concentration has been studied on 10 female competitive swimmers of mean age 16±1.25 years, height 152.7±2.49 cm and weight 45.5±2.29 kg. The subjects were submitted to the maximal upright exercise test on bicycle ergometer. Blood samples were taken before exercise, at 3rd minute and 20th minute after exercise for determination of blood lactate and blood pyruvate conc. and the same procedure was followed after 15 days of supplementation of thiamine.

Experimental results show significant decrease in blood lactate as well as blood pyruvate concentration in all cases due to thiamine supplementation.

It may be revealed that thiamine supplementation is an effective physiological support for the endurance performance of female swimmers by raising the anaerobic threshold and also the aerobic capacity.

Introduction
During physical exercise changes in energy metabolism occur in which vitamins may have some important role. Many investigations have been done with respect to these vitamins especially because of their role in so many of the biochemical reactions which make energy available for muscular work (Chatterjee et al., 1989; Foster et al., 1979). Thiamine (Vitamin B₁) plays an important role in the oxidative decarboxylation of pyruvate to acetyl CoA for entrance in the Kreb's cycle and subsequent oxidation to ATP (Brouns and Sans, 1989).

Vitamin B₁ is in its physiologically active form of the Co-carboxylase essential for the breakdown of dextrose and is thus of great significance for any endurance performance with caloric demands. According to Horwitt et al. (1948), besides the effect on heart rate and blood pressure, Vit. B₁ is related to physical and mental changes correlated with carbohydrate index.

It is now accepted that thiamine requirement of athletes is enhanced due to their increased energy metabolism and relative high carbohydrate portion in their daily food (Brouns and Sans, 1989).

The aim of the present study is to observe to what extent the changes of blood pyruvate and blood lactate level of female swimmers following a course
of thiamine supplementation have occurred before and after exercise.

**Materials and Methods**

10 female athletes (swimmers) of mean age \(16 \pm 1.25\) years, height \(152.7 \pm 2.49\) cm and weight \(45.5 \pm 2.29\) kg were selected for the study. The swimmers were collected from different swimming clubs in and around Calcutta. Their socio-economic background and nutritional status were similar and none had a history of chronic diseases. They were divided into a thiamine group and a placebo group (\(n = 10\) for each group).

Exercise tests were performed on a magnetic brake bicycle ergometer. On the first day, they were acquainted with the laboratory condition and experimental design. On the next day, each set of experiment each subject was advised to turn up in the laboratory at least one hour before experiment performed. They asked to take rest at first up to normal condition and then to perform exercise on the said instrument till exhaustion at fixed workload i.e. 1200 kgm/min. Blood samples were collected from antecubital vein before exercise at 3rd minute of recovery and then at 20th minute of recovery for estimation of lactic acid and pyruvic acid concentration. The athletes of the experimental group were next subjected to supplementation, each being given 50 mg thiamine tablets (Glaxo India) for 15 days. Thereafter, the same experimental procedure was followed.

For the placebo group, the same procedure was followed but using placebos which were identical in appearance to the thiamine tablets.

Blood lactic acid was measured by Barker-Summerson method (1941) modified by Strom (1949) and blood pyruvic acid was measured by DPN method (1943).

**Results**

The physical characters of the athletes e.g. age, height, and weight (mean values) of both thiamine and placebo groups are given in Table 1. Blood lactic acid concentration (mg%) of the subjects before and after exercise following prolonged supplementation (15 days) of thiamine is shown in Table 2. Table 3 gives similarly blood pyruvic acid concentration (mg%) of the subjects before and after exercise following 15 days of supplementation of thiamine.

**Discussion**

From the experimental results, it is noted that blood lactate concentration has diminished following prolonged (15 days) supplementation of thiamine. The blood lactate levels are significantly lowered after thiamine intake both in rest (\(P < 0.01\)) and in recovery periods (3rd minute of recovery \(P < 0.001\) and 20th minute of recovery \(P < 0.01\)).

Knippel *et al.* (1986) also observed significant reduction of blood lactate level in rest and recovery periods in a study conducted on competitive cyclists. The results obtained by them are in conformity with those of the present investigation.

During intense muscular exercise, lactate accumulates in the muscle and the ability of the muscle to perform work is diminished (Sahlin, 1986).

Karlson and Saltin (1970) pointed out that accumulation of lactate in the working...
### Table 1
**Physical Characters of Female Athletes of Thiamine and Placebo Groups (Mean ± S.D.)**

<table>
<thead>
<tr>
<th></th>
<th>N=10</th>
<th>Age (years)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamine Group</td>
<td></td>
<td>16±1.25</td>
<td>152.7±2.49</td>
<td>45.5±2.29</td>
</tr>
<tr>
<td>Placebo Group</td>
<td></td>
<td>16.20±1.85</td>
<td>151.47±1.50</td>
<td>47.7±3.31</td>
</tr>
</tbody>
</table>

### Table 2
**Blood Lactic Acid Concentration (mg%) of Female Athletes Before and After Exercise Following Prolonged Supplementation of Thiamine (Mean ± S.D.)**

<table>
<thead>
<tr>
<th></th>
<th>Pre-Exercise</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3rd Minute of Recovery</td>
<td>20th Minute of Recovery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Thiamine</td>
<td>9.24±1.84</td>
<td>8.24±2.11</td>
<td>52.23±3.59</td>
<td>48.59±5.72</td>
<td>15.52±3.53</td>
<td>13.45±2.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>P&lt;0.01</td>
<td></td>
<td>P&lt;0.001</td>
<td></td>
<td>P&lt;0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placebo</td>
<td>9.96±1.42</td>
<td>9.27±1.37</td>
<td>55.71±5.17</td>
<td>54.46±4.10</td>
<td>16.93±3.32</td>
<td>15.57±3.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>NS</td>
<td></td>
<td>NS</td>
<td></td>
<td>NS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 3
**Blood Pyruvic Acid Concentration (mg%) of Female Athletes Before and After Exercise Following Prolonged Supplementation of Thiamine (Mean ± S.D.)**

<table>
<thead>
<tr>
<th></th>
<th>Pre-Exercise</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3rd Minute of Recovery</td>
<td>20th Minute of Recovery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Thiamine</td>
<td>0.52±0.12</td>
<td>0.28±0.17</td>
<td>0.95±0.27</td>
<td>0.74±0.21</td>
<td>0.64±0.14</td>
<td>0.46±0.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of Significance</td>
<td>P&lt;0.001</td>
<td></td>
<td>P&lt;0.02</td>
<td></td>
<td>P&lt;0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placebo</td>
<td>0.80±0.07</td>
<td>0.62±0.08</td>
<td>0.98±0.25</td>
<td>0.94±0.16</td>
<td>0.72±0.11</td>
<td>0.70±0.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of Significance</td>
<td>N.S.</td>
<td></td>
<td>N.S.</td>
<td></td>
<td>N.S.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N.S. = Not significant
muscle groups acts as the limiting factor for maximal physical exercise of short duration. Administration of thiamine decreases the lactic acid concentration after exercise (Herwitt, 1948). Depocas et al. (1979) demonstrated that most of the lactate formed during exercise underwent direct oxidation via conversion into pyruvate and entry into the Krebs cycle. Our results support that supplementation of thiamine may influence the above pathway to reduce the blood lactate level in the athletes.

From Table 3, it may be seen that the blood pyruvate concentration also has decreased following supplementation of thiamine. Significant decreases of pyruvate levels are observed both in rest ($P < 0.001$) and recovery periods ($P < 0.02$ and $P < 0.05$ in the 3rd minute and 20th minute of recovery periods respectively).

Vitchikova (1958) also observed that supplementation of thiamine reduced the level of pyruvic acid in blood of manual workers before and after the training. On the other hand, muscular exercise in patients suffering from thiamine deficiency causes the level of blood pyruvate to rise still further (Bicknell and Prescott, 1953). Herwitt et al. (1948) observed that the conversion of pyruvic acid to acetyl CoA increased by thiamine administration by modifying the enzyme thiamine pyrophosphate.

From the above discussion, it may be concluded that thiamine is able to raise the anaerobic threshold and also influence the aerobic pathway to enhance the aerobic capacity of the athletes. Therefore, thiamine administration may be an effective physiological support for the endurance athlete.

Acknowledgement

Authors are grateful to Rameshwar dasji Birla Smarak Kosh, Bombay for financial assistance (Fei No 89-90/(13)) for conducting the research.

References