Effects of $\alpha$-tocopherol acetate on the swimming endurance of trained swimmers\textsuperscript{1, 2, 3}

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ABSTRACT Well-trained, competitive swimmers were divided into two groups. Group A was given 900 IU $\alpha$-tocopherol acetate daily for 6 months while group B was given placebos. A swimming endurance test was given before the start of supplementation and after 1, 2, 5 and 6 months. No difference in swimmers' endurance was observed between the two groups during the 6-month period. There was also no difference in postexercise serum lactic acid levels.

Younger, less well-trained, competitive swimmers were also divided into two groups. Group A received 900 IU $\alpha$-tocopherol acetate daily while group B received placebos. Swimming times for these swimmers were erratic, reflecting a lack of training. $\alpha$-Tocopherol did not appear to have any effect on their swimming endurance.

Coaches, athletes and trainers have long contemplated the possibility that some nutrients could supercharge the body and thereby increase athletic performance. Vitamin E has attracted special interest in this regard because: $\text{1)}$ vitamin E deficiency in some animals causes muscles to become dystrophic (1); $\text{2)}$ there is evidence that the resistance to hypoxia and hyperoxia in some animals is affected by vitamin E status (2, 3); and $\text{3)}$ there has been value attributed to the use of vitamin E in the treatment of coronary and circulatory problems (4, 5). Attempts to show a direct relationship between vitamin E status and human athletic performance have yielded equivocal results (6–9). Sharman et al. (9) reported that vitamin E supplementations had no observable effect on the physiological function and athletic performance of untrained adolescent swimmers. They noted that the effects of the training regime were so great that if the supplementation had any effect, it was completely masked. In the present study the effects of vitamin E supplementation on the swimming endurance of well-trained competitive swimmers and partially-trained swimmers were investigated.

Materials and methods

The subjects for this study were 48 members of the Greenwave Swim Club under the direction of the Tulane University swimming coach. The team consists of two divisions, A and B, based on swimming ability. Each division was divided into two groups matched for age, sex, and swimming ability by the coach. Supplementation with either $\alpha$-tocopherol acetate or a placebo was assigned by lot in a double blind design. The vitamin supplements were prepared for each individual by a research assistant who had no direct contact with either measuring the swimming performance or the biochemical evaluation.

In a prestudy interview, each participant was asked what vitamins or other food supplements were being taken routinely prior to the beginning of the study. One month before the study began, the swimmers were instructed to stop taking their own vitamins and supplements. All swimmers were asked to take one One-A-Day multiple vitamin\textsuperscript{7} daily. These vitamins did not contain vitamin E.

Supplements

Twenty-one chewable butterscotch-flavored tablets\textsuperscript{8} containing either 300 IU of $\alpha$-tocopherol acetate.

\textsuperscript{1}From Tulane University, New Orleans, Louisiana 70112.
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\textsuperscript{3}Preliminary results of this study were presented to the 52nd Annual Meeting of the American College Health Association, April 4, 1974, Dallas, Texas.
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\textsuperscript{7}Miles Laboratories, Inc., Elkhart, Indiana.
\textsuperscript{8}Hoffmann-La Roche, Inc., Nutley, New Jersey.
or a placebo without α-tocopherol acetate were packed in similar plastic vials. Vials labeled with the date, name, and I.D. number of each swimmer were handed out every week. The old vials containing any unused tablets were collected to estimate consumption. The participants remained on a treatment schedule for six months.

**Serum tocopherol determinations**

Nonfasting blood was collected from each subject prior to the start of the study and then after months 1, 2, 5, and 6. Total serum tocopherol was determined by the following semimicro method adapted from the methods of Quaife et al. (10), and Hashim (11). To precipitate the protein, 0.5 ml of serum was vortexed for 10 sec with an equal amount of absolute alcohol in a 10-ml round bottom screw top tube. One milliliter of analytical grade xylene was then added to each sample. The tubes were shaken for 5 min on a mechanical shaker and centrifuged at 1,000 rpm for 10 min. Half a milliliter of the supernatant was transferred to a 12 × 75 mm cuvette, α-Tocopherol standards containing 1 and 2 mg of α-tocopherol acetate in 100 ml of xylene and carotene standards containing 0.1 and 0.2 mg of β-carotene in 100 ml of xylene were prepared.

Six hundred microliters of bathophenanthroline solution (200 mg in 100 ml of n-propional) were added to each tube. The tubes were vortexed for 10 sec. The carotene concentration in each sample was determined from the optical density read at 455 μm on a Coleman Jr. spectrometer. All samples were read against the reagent blank containing 0.5 ml of xylene in place of the serum extract. The α-tocopherol concentration of the samples was determined as follows. While mixing on a vortex, 0.25 ml of 0.120% FeCl₃ solution (120 mg of FeCl₃·6H₂O in 100 ml of xylene, prepared immediately before use) was added to each tube. After mixing for 20 sec, 0.2 ml of 6.23% H₃PO₄ (made up in xylene) was added and mixed for an additional 5 sec. After 5 min, the optical density at 535 μm was determined.

The total tocopherol concentration in the serum is calculated by the following formula:

\[
\text{Total tocopherol/dl} = \frac{\text{OD sample at 535 μm} - (F \times \text{OD sample at 455 μm}) \times [E] \times D}{\text{OD tocopherol standard at 535 μm}}
\]

\[
F = \frac{\text{OD of carotene at 455 μm}}{\text{OD of carotene at 535 μm}}
\]

\[E = \text{concentration of α-tocopherol standard}
\]

\[D = \text{dilution factor (2)}
\]

**Lactic acid determination**

A venipuncture was performed, without the use of a tourniquet, on swimmers immediately after they completed a continuous 15-min swim. One milliliter of blood was immediately mixed with 2 ml of cold 8% perchloric acid and shaken vigorously for 30 sec. The samples were transported to the laboratory on ice and centrifuged for 10 min at about 3,000 rpm. The concentration of lactic acid in the clear supernatant was determined by the method of Marbach and Weil (12).

### Table 1

<table>
<thead>
<tr>
<th>Number of participants taking various vitamins and other supplements up to 1 month before baseline date</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>23</td>
</tr>
<tr>
<td>Multivitamins</td>
<td>16</td>
</tr>
<tr>
<td>High potency multivitamins</td>
<td>7</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>11</td>
</tr>
<tr>
<td>Wheat germ</td>
<td>2</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>17</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>2</td>
</tr>
<tr>
<td>Cod liver oil</td>
<td>1</td>
</tr>
<tr>
<td>Vitamin B complex</td>
<td>4</td>
</tr>
<tr>
<td>Protein tablets</td>
<td>1</td>
</tr>
<tr>
<td>Yeast</td>
<td>1</td>
</tr>
<tr>
<td>Ca</td>
<td>1</td>
</tr>
<tr>
<td>Mg</td>
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</tbody>
</table>
TABLE 2
Mean serum α-tocopherol levels (mg/100 ml) of all swimmers (A and B) before and after taking either 900 IU of α-tocopherol or placebos for 6 months

<table>
<thead>
<tr>
<th>Treatment group</th>
<th>Pretreatment</th>
<th>1 month</th>
<th>6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>α-Tocopherol</td>
<td>1.30 SD 0.18</td>
<td>3.40</td>
<td>2.84 SD 1.49</td>
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<tr>
<td>(n = 25)</td>
<td></td>
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</tr>
<tr>
<td>Placebo</td>
<td>1.23 SD 0.20</td>
<td>1.35</td>
<td>1.31 SD 0.27</td>
</tr>
<tr>
<td>(n = 19)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

returned each week. Table 2 shows the effects of supplementation with 900 IU of α-tocopherol acetate daily for 1 month and 6 months on serum vitamin E levels. Baseline vitamin E data show that all swimmers have vitamin E levels within normal ranges previously published. The mean serum E levels increased 2.6 times after 1 month in the group receiving vitamin E and after 6 months their vitamin E level remained 2.2 times above their pretreatment levels. The placebo group remained at approximately their presudy levels.

Table 3 shows the mean swimming times for the broken 1,000 yards for the group A swimmers. It can be seen that there was little difference between the two treatment groups. After 1 month of supplementation, the two groups decreased their swimming time by an average of 0.43 min (3%). This was presumably due to training effect, i.e., the swimmers learned to pace themselves for the 1,000 yards. After 6 months of treatment, the swimmers taking vitamin E reduced their times by an average of 0.90 min (6.8%) and the placebo group 0.81 min (6.2%). The differences in the percentage of improvement are not significant.

In the same 6-month period, a third group consisting of division A swimmers who did not participate in the study decreased their swimming time by approximately the same amount.

Table 4 shows the mean swimming times for the broken 500 yards for the swimmers in group B. Unlike group A, who were relatively well-trained swimmers, members of group B were younger and less experienced. Their times throughout the study were erratic. The differences were almost certainly due to the inability to learn to pace themselves in a consistent manner. At the end of the 6-month period, those taking vitamin E had decreased their swimming time by 0.64 min (8.6%) while those taking the placebos reduced their swimming time by 1.18 min (15.8%).

It has been shown that there is a relationship between serum lactic acid levels and oxygen debt in strenuous exercise (13). Prokop (8) suggests that vitamin E may decrease oxygen debt. We attempted to look at this relationship by examining the serum lactic acid levels of swimmers immediately after 15 min of strenuous swimming. The data show no significant difference between the postexercise serum lactic acid levels of the vitamin E group (5.66 ± 2.17 mg/dl) or the placebo group (5.66 ± 1.68 mg/dl).

Discussion
Under the conditions set up for this study, it appears that vitamin E had no effect on increasing swimming endurance. The improvement of the well-trained swimmers in group A appears to reflect training rather than any vitamin supplement being used. In the younger, less well-trained swimmers in group B, the differences in time are not consistent with taking either supplement but rather appear to be a reflection of training and ability to learn to...
pace themselves. Vitamin E does not affect postexercise lactic acid levels which suggests that vitamin E may not have a beneficial effect on the anaerobic capacity and performance as has been suggested (8).

In their paper, Sharman et al. (9) recommended that any further trial test should be carried out with well-trained swimmers because they found that improvement due to training masked any possible benefits that vitamin supplementation may have. In the present investigation, we used highly trained as well as partially trained swimmers and as Sharman et al. observed, vitamin E does not appear to have any effect of the athletic performance on either the untrained or the well-trained swimmers. There seems to be no reason to use vitamin E in an attempt to increase endurance.

References