The Distribution Range of Total Thiamin Concentration in Whole Blood of University Student Athletes

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Summary

A considerable problem of insufficient vitamin intake exists among athletes. The objective of this study is to reveal the total thiamin concentration in whole blood of university student athletes and general students of the same age group, and to investigate the possibility of a lack of thiamin due to a difference in the amount of exercise. The results showed that the distribution of thiamin concentration for both male and female general students was within the standard value, and that there was an almost normal distribution. In contrast, for the distribution of thiamin concentration in athletes, there was a lower frequency marking higher values compared with that in general students. In addition, as the average thiamin concentration in both male and female student athletes was significantly lower than that in general students, we hypothesized the possibility of a latent thiamin deficiency among student athletes. To clarify this issue, other blood examination items should be further reviewed.

Keywords: thiamin (vitamin B1); blood examination; nutritional state; athlete; university student

Introduction

In recent years, the interest in avitaminosis has been low, owing to the current belief that the national nutritional status has improved and that vitamin deficiency is now a problem of the past. However, studies have shown that nutritional imbalances and latent avitaminosis do exist1,2).

In a previous study with university students, we investigated the total thiamin concentration in whole blood, and reported that the thiamin concentration of the participants was mostly within the standard value. Furthermore, although the results indicated the possibility of a latent deficiency3), no marked deficiency conditions were observed among the participants4,4).

However, in the young population, a lack of thiamin exists because of special factors such as diet habit and transition to independent living5). Therefore, the possibility of an avitaminosis condition, which is dependent on certain circumstances, cannot be denied. Above all, a notable issue concerning vitamin intake exists among exercising persons.

In a previous report, increased energy consumption was found to enhance the metabolism of thiamin, which leads to an increase in the body’s thiamin requirement6). Also, in a study on rats, a decrease in thiamin content in the body due to increased energy consumption was observed7). Currently, the standard thiamin requirement is set per 1000 kcal of energy8,9). Exercising persons are often required to take thiamin in accordance with the recommended increased amount of energy intake7); however, there are few actual data demonstrating this need. Also, there is no report showing that athletes who perform highly intensive exercise develop thiamin deficiency.

In this study, we focused on university students who are members of clubs composed of top athletes. We can assume that these athletes engage in strict training activities daily. We compared their total thiamin concentration in whole blood with that of general students from the same age group. Through this, we examined the influence of exercise and the possibility of nutritional deficiency conditions.

Materials and Methods

Participants

We asked for the cooperation of student athletes (here-
Statistics

We used the software IBM SPSS Statistics 21 for statistical analysis. To examine the difference in average values, we used the nonparametric Mann-Whitney U test and assigned p < 0.05 as the significant difference.

Agreement

We explained the research content in written form, and the participants signed certificates of informed consent. This investigation was approved by the Nagoya University of Arts and Sciences Ethics Committees and meets the standards of the Declaration of Helsinki.

Results

Fig. 1 shows the distribution of thiamin concentration in both athletes and general male students. Fig. 2 shows the same data for the female participants.

The results in Fig. 1 show that the range of thiamin concentration in 68 male athletes was from a minimum deviation of 24 ng/mL to a maximum deviation of 50 ng/mL, and that the concentration value fell in the range of 31–40 ng/mL in approximately 71% (48 students) of all male athlete participants. In contrast, the range of thiamin concentration in the 54 male general students was from a minimum deviation of 22 ng/mL to a maximum deviation of 84 ng/mL; approximately 39% (21 students) of the general student participants showed a concentration in the range of 41–50 ng/mL. In addition, the average ± standard deviation for male athletes was 34.5 ± 5.3 ng/
Discussion

Thiamin mainly functions as a co-enzyme of carbohydrate metabolic enzymes, and thiamin deficiency causes subjective symptoms such as feelings of malaise in the whole body, fatigue, palpitations, and shortness of breath. Thiamin is an important nutrient for maintaining normal bodily functions \(^1,13,14\). It has been reported that with exercise, the energetic metabolism increases, which, in turn, increases the required quantity of thiamin. If the thiamin level is inadequate for the consumption of glucose, the metabolism from pyruvic acid to acetyl-CoA is hindered \(^15,16\). The increased production of lactic acid from pyruvic acid leads to an accumulation of lactic acid, which causes fatigue \(^17\). Currently, the standard thiamin requirement is set per 1000 kcal of energy. In exercising persons, it is often recommended to increase the amount of energy intake by consuming well-balanced meals \(^9,18\).

In this investigation, we compared the distribution and average values of thiamin concentration between athletes and general students. The results showed that for both male and female athletes, the distribution of thiamin concentration showed a lower frequency marked high values than that in general students. In addition, for both male and females, because the average value of thiamin concentration was significantly low, the possibility of a latent thiamin deficiency in student athletes was considered.

In a previous study, it was reported that thiamin deficiency rarely occurs as a result of exercise if the standard quantity of daily thiamin intake is satisfied \(^19\). We can

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**Fig. 2** Comparison of the distribution of total thiamin concentration in whole blood between student athletes and general students (females).
The average values of thiamin concentration were significantly lower in athletes than in general students. (p < 0.001  The nonparametric Mann-Whitney U test.)

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mL, whereas that for male general students was 46.9 ± 122 ng/mL.

Meanwhile, Fig. 2 shows the data for 104 female athletes. The range of thiamin concentration was from a minimum deviation of 19 ng/mL to a maximum of 50 ng/mL, and approximately 61% (63 students) of all female athlete participants showed a concentration value in the range of 21-30 ng/mL. In contrast, the range of thiamin concentration in 418 female general students was from a minimum of 11 ng/mL to a maximum of 77 ng/mL, with approximately 37% (155 students) of them showing a concentration value in the range of 31-40 ng/mL. In addition, the average ± standard deviation for female athletes was 28.7 ± 5.6 ng/mL, whereas that for female general students was 40.6 ± 10.4 ng/mL.

For both male and female general student participants, the distribution of thiamin concentration was mostly within the standard value, and the distribution was almost normal. For the distribution of thiamin concentration in female athletes, there was a lower frequency marking higher values compared with those in female general students.

From the above results, there was a similar trend for both male and females, and compared with general students, the average values of thiamin concentration were significantly lower in athletes (p < 0.001).
Therefore, we hypothesize that the athletes could not maintain sufficient thiamin intake through their diet. However, among the athlete participants of this study, a tendency to provide proper attention to nutritional intake was observed. Especially in A University, there is a club called Nutrition Support Team for Athletes that offers sufficient meals to members to ensure a fair nutrition supply. For instance, Table 1 shows that the energy intake for the athletes was 4500 kcal/day and protein intake was 170 g, which is two to three times higher than that recommended for males from the same age group. Especially, thiamin intake was provided at 2.7–3.6 mg, a level far higher than the recommended value (1.4 mg) to match the energy consumption in food intake standards. Nevertheless, in this study, some influence of thiamin concentration was observed, and we can consider that increased energetic metabolism might have other special effects besides increasing the thiamin requirement. For instance, the decreased vitamin absorption due to exercise and the increased excretion of vitamin in the urine and sweat can be considered as factors; however, there are extremely few data to demonstrate these assumptions at present.

Therefore, in the future, a review of causation should be undertaken through a longitudinal examination of the appropriate amount of nutritional intake, from meals or supplements, for both athletes and general students.

Also, as there is a report stating that there was no extensive lack of thiamin in participants who performed exercise at a level with low maximum oxygen intake, we can assume that the athletes we targeted in this study have a high exercise strength and a high maximum oxygen intake.

As this study is a cross-sectional investigation, it was difficult to examine the causality between exercise and the blood examination values. Therefore, for all of the parameters we considered, further longitudinal investigations should be performed. The sex, type of sports, practice duration, and body characteristics varied among the athletes in this study. Therefore, a detailed research needs to be carried out in consideration of the above-mentioned characteristics. Also, we cannot deny the possibility that the students we targeted in this study were receiving a specific nutrition supply from vitamin preparations and other sources. In recent years in Japan, the frequency of using vitamin premix formulations, which are likely to be combined with processed foods, has increased and there is a wide variety of thiamin-rich processed foods, beverages, and pharmaceuticals available. It is also necessary to examine the effects of those formulations.

University students are at an age when they transition from being reliant on their families to living an independent life. It is anticipated that their lifestyle (especially diet), which is closely related to health, changes during this time. Therefore, this population needs appropriate nutritional intake; however, athletes who exercise heavily every day generally have a low interest in nutrition and diet, and they especially tend to miss the importance of trace elements such as vitamins and minerals. On the other hand, it is difficult to generally set the requirement for the intake of energy and each nutritional item among athletes because of the variety of sports events, activity duration, as well as the athlete’s sex and body type. Therefore, the type of exercise should be considered and, at the same time, the appropriate amount of nutritional intake should be set, to be able to offer a recommendation for this population.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Dietary reference intakes for athletes and general students</th>
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</thead>
<tbody>
<tr>
<td>Athletes (example of A University)</td>
<td>Dietary reference intakes for Japanese</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>4500</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>170</td>
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<tr>
<td>Fat (%energy)</td>
<td>25</td>
</tr>
<tr>
<td>Carbohydrate (%energy)</td>
<td>60</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>1000–1500</td>
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<tr>
<td>Iron (mg)</td>
<td>15–20</td>
</tr>
<tr>
<td>Vitamin A (µg)</td>
<td>900–1500</td>
</tr>
<tr>
<td>Vitamin B1 (mg)</td>
<td>2.7–3.6</td>
</tr>
<tr>
<td>Vitamin B2 (mg)</td>
<td>2.2–2.7</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>200</td>
</tr>
<tr>
<td>Dietary fibers (g)</td>
<td>36–45</td>
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3) Computed from a Rugby player’s protein/fat/carbohydrate ratio (15:25:60).
References


