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Effect of supplementary consumption vitamin B1 (thiamine) on blood glucose changes during and after maximal aerobic exercise

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Abstract

The purpose of the present study was to determine the effect of vitamin B1 (Thiamine pyrophosphate) (TPP) on blood glucose changes. We observed that when the subjects received 300 mg thiamin /day, there was a lowering of blood glucose level during and after physical activity. Like the other B vitamins, thiamin is used to treat fatigue. High-dose thiamin supplementation may be helpful in preventing fatigue or accelerating recovery from exercise-induced fatigue. In this research 36 non-athlete university students male were selected with average 22.8, 179 and 77.16 for age, height and weight respectively,(12 persons in each group).The subjects placed in three groups: Experimental Group A(EGA),Experimental Group B(EGB) and Control Group(CG).They have to exercise on treadmill before and after the thiamin consumption. First of all, blood glucose measured in three groups before exercise and then performed exercise on treadmill until exhaustion. Blood glucose changes in subjects measured by (GOD-PAP method) after 5 minutes and in the end of the exercise (pre-test).The subject's consumed thiamin during 10 days (EGA 30 mg /day, EGB 300 mg/day and CG just placebo) Blood glucose changes measured in three groups like as pre-test, during and the end of the exercise on treadmill after 10 days (post-test). Our results indicates, that there is no changes in blood glucose in EGA (30 mg thiamin/day) and CG(placebo) but showed that blood glucose reduced in EGB (300 mg thiamin/day)(P>0.05). In fact, degree of exhaustion increased in EGB that they consumed 300 mg thiamin per day, and they could to do exercise for a long time. Like the other B vitamins, thiamin is used to treat fatigue. High-dose thiamin supplementation may be helpful in preventing fat.igue or accelerating recovery from exercise-induced fatigue.

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Introduction

Vitamin B1 (Thiamine pyrophosphate)(TPP) is an essential vitamin for glucose metabolism (Marcus *et al.,*2001; Nelson *et al.,* 2000). After being absorbed (from) the intestine, it is phosphorylated into thiamine pyrophosphate (TPP). TPP is the co-factor of three important enzymes: pyruvate dehydrogenase, alpha-ketoglutarate dehydrogenase and transketolase. Pyruvate dehydrogenase is a multi-enzymatic complex which, under aerobic conditions, allows pyruvate to be decarboxylated into Acetyl-CoA. TPP is also necessary for the decarboxylation of alpha-ketoglutarate into succinyl-CoA within the citric acid cycle, thus favoring aerobic glucose oxidation to obtain ATP, while transketolase acts in the pentose phosphate pathway (Romanski, 2000). It has been shown that lactic acidosis is favored in situations where there is thiamine and pyruvate dehydrogenase deficiency (Ozawa *et al.,* 2001; Arici *et al.,* 2001).

On the other hand, the regular practice of exercise increases oxygen availability to the skeletal muscle due to myoglobin formation, increased muscle capillarization, increase in the size and number of mitochondria, increase in aerobic enzyme levels and activity, etc. These adaptations increase an individual's physical capacity increases, which are often detected by decreases in muscle and blood lactate concentrations (Wasserman *et al.,* 1986; Holloszy *et al.,* 1984; MacRae *et al.,* 1992). There is evidence that thiamine administration (100 mg/day during 3 days) improves exercise performance, reduces blood lactate and decrease exercise-induced fatigue (Suzuki *et al.,* 1996; Strumilo *et al.,* 1999; Larrieu *et al.,* 1987; Chobitko *et al.,* 1993). Although McNeill and his colleague (McNeill et al., 1983) showed the efficacy of thiamine administration as an ergogenic aid, Webster (Webster, 1998) and Webster and co worker (Webster *et al.,* 1997) showed no effect of thiamin on exercise performance, including blood lactate levels. Taking this into account, it is possible that TPP could have an effect on lactate levels, tentatively, upon improving carbohydrate oxidation through aerobic metabolism. Therefore, the objective of the present work is to study the effect of TPP supplementation in young, sedentary adults during moderate physical activity.

It is pertinent to study in this population as a physiologic al condition, because previous reports were done on individuals with disease. Additionally, to the best of our knowledge, this is the first study that has administered TPP intravenously in young sedentary adults. Thiamin is also known to act as a cofactor in numerous reactions of carbohydrate metabolism including activation of pyruvate dehydrogenase (PDH) (Lonsdale, 2006; Strumilo *et al.,* 1999). PDH is a mitochondrial enzyme that catalyzes the conversion of pyruvate to acetyl-CoA and the entry of carbohydrate derived substrates into the citric acid cycle for oxidation (Paquet *et al.,* 1972). It has been reported that in thiamin deficiency, production of lactate is increased because of decreased oxidation of carbohydrate due to reduced activity of PDH. Therefore administration of thiamin in the deficient state can affect carbohydrate metabolism (Veech RL *et al.,* 1973; Park *et al.,* 1996). However, it is not clear whether ingestion of thiamin under non-deficient conditions affects arbohydrate metabolism at rest or during exercise. Lactate had been regarded as an end-product of carbohydrates and as the main cause of muscle fatigue. However, recent studies have shown that lactate is not a waste product but an oxidizable fuel and that muscle fatigue is not necessarily caused by the accumulation of lactate (Allen *et al.,* 2008; Gladden, 2001). Thiamin is often used to prevent fatigue; not only muscle fatigue but also feelings of fatigue (Kitamori *et al.,* 1993; Suzuki *et al.,* 1996). The rationale for the use of thiamin as an anti-fatigue reagent has been that it can inhibit production of lactate because of increased PDH activity by thiamin, and the decreased production of lactate seen after ingestion of thiamin in a thiamin deficient state has been seen as evidence of this (Park *et al.,* 19966). However, it is not established that thiamin actually decreases production of lactate under normal dietary conditions.

Therefore, the mechanism of the effect of thiamin on fatigue has not been determined. In this study we are trying to consider one of supplements, vitaminB1 (Thiamin), in relation with body activities and blood glucose. Most of the body's cells use glucose as energy sources when Oxygen help glucose to change into energy, the aerobic energy production is called. This process is not possible unless there would be enough Vitamins. Vitamin B_1 is a part of enzyme system (pyruvate dehydrogenate) which helps to moving glucose with oxygen. When B_1 act as an co-factor to produce energy, it appears as Thiamin diphosphate (TDP). For analyzing carbohydrates the body needs this vitamin. The released energy from this metabolism is used for respiratory and movement. Thiamine is essential for the final metabolism of carbohydrates and absorbs the glucides and digestion depends on it (Allen *et al.,* 2008).

Materials and methods

A randomized, double blind crossover trial was carried out at the Islamic Azad University's Faculty of physical education and sport sciences. The subjects that they were non- athletes male students with 19-26 years old (22.8± 2.4) participates Volunteer then selected 36 that they were divided in to 3 groups each group 12 persons; experimental B experimental A and control. First the students completed the questionnaire which estimated the rate of calorie and energy that used daily. Subjects having any physical or mental alteration, significant emotional anguish, psychiatric incapacity, arrhythmias, or electrolyte abnormality did not participate in the study. The influence of other factors such as physical state and type and length of exercise has been described and they were controlled in our study. Subjects were sedentary, but we controlled for the amount of physical activity that each subject performed before trials, asking them to refrain from exercising for 48 hours before the trials. Then their blood glucose was measured (GOD-PAP method) For pre-test subject's rans on treadmill based on the Balke treadmill protocol but before run them doing warm up for 5 minutes which included some stretching and light movements. Then they started to run to exhaustion and they had their blood tested and the glucose changes were considered during after 5 minutes and immediately after activities covered the level of blood glucose was recorded. Two groups were asked to use B_1 EGA 30 mg, EGB 300m.g and CG only use placebo (control group were not aware of the ingredients of placebo). They were also asked to don't change their activities and calorie. In the end of the Thiamin consumption again they had their blood glucose measured and compare with the level of pre-test and post-test the blood glucose considered. Averages, standard deviations and variance were used to obtain descriptive statistics. Paired Student t-test and 95% confidence intervals were used for the inferential statistics. Differences were considered significant when $p<0.05$.

Results

The blood glucose of the groups before test (before using supplement) there were no any changes in the blood glucose including before and after aerobic exercise which reveal that the groups were congenial.

After using Thiamin by the groups and considering blood sugar changes in different stages of aerobic exercise, the conclusion of variance and standard of deviation there were no changing in blood glucose before and during activity. But after activity there were some changes in the blood sugar.

Discussion

The objective of the present study was to determine the effect of supplementary consumption vitamin B1 (thiamine) on blood glucose changes during and after maximal aerobic exercise. It has been noted in the literature that active individuals with poor nutritional status for a B-vitamin may have decreased ability to perform exercise at high intensities (Woolf *et al.,* 2006). Administration of thiamine (100 mg/day for 3 days) has proven to reduce serum lactate and improve resistance to fatigue (Suzuki *et al.,* 1996; Strumilo *et al.,* 1999; Strumilo *et al.,* 1993). It has also been shown that thiamine supplementation has ergogenic properties.(McNeill *et al.,* 1983). On the other hand, two studies suggest that thiamine supplementation does not influence physical activity or the levels of serum lactate (Webster *et al.,* 1997; Webster *et al.,* 1998).

Table 1. The level of blood glucose among groups before Thiamin consumption.

Group	BG before activity (pre-test)	BG during activity (pre-test)	BG after activity (pre-test)
Experimental A	97.57±7.9	96.41±7.7	87.08±7.6
Experimental B	95.66±7.73	94.75±7.33	89.75±7.46
Control	97.83±4.56	96.91±5.85	91.91±5.33

Table 2. The level of blood glucose among groups after Thiamin consumption

Group	BG before activity (pre-test)	BG during activity (pre-test)	BG after activity (pre-test)
Experimental A	97.57±7.09	96.16±7.18	93.83±6.86
Experimental B	97.66±5.21	95.50±5.63	85.08±5.17
Control	97.58±3.62	96.75±3.93	92.91±4.1

In a more recent study Bautista and colleagues (Bautista *et al.,* 2008) suspected that based on the available literature thiamine pyrophosphate (TPP) might affect the concentration of serum lactate by improving oxidation of carbohydrates during aerobic metabolism. They recruited 27 male athletes with the objective to determine the effect of TTP on the serum lactate concentration, VO_{2max} and heart rate. Athletes that received TPP had significantly lower heart rate and lactate serum levels, and VO_{2max} was significantly higher than that of the placebo group after exercise. Thiamin is known to activate Pyruvate Dehydrogenase (PDH) (Lonsdale, 2006; Strumilo *et al.,* 1999). PDH can play a pivotal role in the oxidation of carbohydrates because it is one of the rate limiting steps in this process (Parolin et al., 1999). It has been shown through administration of dichloroacetate, which is an activator of PDH that activation of PDH can increase oxidation of carbohydrates and lactate at rest and during exercise (Hatta *et al.,* 1991). However, it is not known whether supplemental administration of thiamin has effects on carbohydrate metabolism in the absence of thiamin deficiency. Mechanism of many of the mineral is unknown for even biochemistry expects and nutritionists have different opinion about the amount & time of the using supplementary foods.

Some believe that on equilibrant diet covers all of the needs. But the fact is that these days' people have turned to fast food and less often care of the value of them. Two athletes in the same weight, size, major and food may need to different supplementary food. As in the chart were shown before and after test in control group and group A there was no difference and the only difference before and after test was in group B that the level of blood glucose is very lower than before test. These achievements are same with the Suzuki M. and co worker (Suzuki *et al.,* 1996) research achievement. Actually it was stated that using 100 mg Thiamin every day increase the blood glucose. Knippel,M. and his colleagues (Knippel *et al.,* 1986) reported the reduction of blood glucose in the bike riders who used 900 mg Thiamin every day which are same with the present research. In the present research in one group 30m.g and another 300 mg were supposed so with the research of Tabatabaie (Tabatabai *et al.,* 2003) is different.

In other word using 450 mg Thiamin has no effect but in the present research 300mg reduced effectively the level of blood glucose. The important point is that using 300 mg during 10 days in non – athlete persons reduce the blood sugar after a tiring exercise. We can consider if from many different angles. First, do non-athlete people need using Thiamin every day or no? If there would be any needs. How much should be the amount? Due to the reduction of blood glucose in the participants, maybe it can be delicately mentioned that by reduction of blood sugar we can be hopeful that using Vitamins can be very useful especially among people who practice aerobic exercise. Actually Thiamin consumption and its relation to carbohydrates can be considered in long term activities. Thiamin has an important role in metabolism, according biochemistry, and it moves the Picric Acid into krebs cycle. In those who affected by lack of Thiamin hyperglycemia and Hyper Lactose are apparent. So Thiamin controls the level of blood glucose and help liver save glycogen.

In the whole we can say using Thiamin is essential for metabolism functions and using vitamin B1 300 mg every day during 10 days improved the quality and quantity of the body activities. It appears that thiamin status was more likely to be affected by intensive training than is riboflavin status in athlete. Given that dietary intakes of thiamin did not differ, it is likely that increased training may have elevated the thiamin need somewhat. It is important to note, however, that estimation of nutrient intakes via food records can be difficult (Akiko *et al.,* 2001).Interestingly, thiamine supplementation can improve the performance and significantly reduces fatigue after exercise (Suzuki *et al.,* 1996). These thiamine effects can be explained as thiamine is converted to thiamine pyrophosphate to exert its cellular action (Marcus *et al.,* 2001). It is important to underline the fact that none of the subjects reported secondary effects following the placebo and thiamine administration. We do not yet have an explanation for that phenomenon that the physical well-being ("without fatigue, still physically strong, can do more exercise") described by the subjects at the time of taking the treadmill test after having received the thiamine is noteworthy. Our data indicate that thiamine can lead to reduced fatigue in young people and longer they can continue to physical activity.

Through further studies these results could be extended to include high-impact (elite) athletes and so invaluably contribute to the scientific control of athletic training and the improvement of physical capacity. There are different compensating mechanisms that increase the organic capacity to aerobically metabolize carbohydrates, thus reducing the quantity of lactate produced during physical activity. Even though pyrophosphate levels of the subjects were not measured, we consider that a substantial amount of the thiamine pyrophosphate dose administered was still present during exercise period, because in adults, the minimal daily requirement is 1 mg, when intake exceeds the requirement, tissue stores are first saturated, as the intake of thiamine pyrophosphate is increased, the excess is excreted in urine several days after (Marcus *et al.,* 2001).

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