# High dose magnesium supplementation effects on 400m sprint performance and metabolism

Chen, C, H., Smith, R.W., Jang, J. T.
*National Taiwan Sport University, Taoyuan*
Taiwan

## Abstract

The **purpose** of this study was to investigate the effects of high doses of magnesium intake before training on 400m sprint performances and metabolism. Six 400m track male specialists (age: 17±1.17 years old, height: 173.50±5.43 cm, weight: 61.83±5.04 kg) participated in this study.

**Method**: Two tests were investigated in this study. The first was specific test (pretest and posttest which consisted of 400m), the second was a training test( high intermittent training on the 1st and 3rd day). The training program consisted of a high intermittent mode on the 1st and 3rd day and a continuous run on the 2nd day. The intermittent workload was set at 90% of the individuals best performance time (3x3x20s), the continuous workload was set at 50 % (15min); each athlete took 400 mgs magnesium (+100mg Vitamin C ) with water and warmed up for 30mins before each of the three days of training sessions.

**Results**: In training test (Tr-1 and Tr-3), blood lactate concentration and $NH_3$ decreased after Tr-3 ($p>0.05$). In the 400m test, three subjects improved their range of speed performance by 0.01-1.80 s posttest; two subjects improved their range of speed performance by (0.21 and 0.54 s). Only one subject had no increase in range of speed performance but still maintained pretest results. Between pretest and posttest a decrease in maximum lactate decreased by 1.06mmol/L ($p>0.05$). An increase in NH3 was observed 23.63 $\mu$l ($p>0.05$).

**Conclusion**: From the findings of this study the best time to incorporate this type of training model would be one month prior to a major competition, while the athletes are in their best physical condition and metabolism is able to adapt to the three days of intense training. In final thought the high magnesium intake was able influence the contraction of the muscle fibers reducing muscle fatigue, resulting in improved 400 m individual times.

**Keywords:** intermittent training, lactate, $NH_3$

## Introduction

Matwejews (1972) proposed the sports training "period" he divided it into preparation periods ( I , II), specific training periods ( I , II), and a competition period. This type of process allow athlete to reach their best physical condition in specific period II and maintain it through the competition period. For this reason, coaches of sports adjust the training protocols before the competition period. It is still unclear weather other training methods can push the athlete to breakthrough through to new levels of peak performance using short periods of training. The physiological consequences of these biochemical activities include Mg's central roles in the control of neuronal activity, cardiac excitability, neuromuscular transmission, muscular contraction, vasomotor tone, and blood pressure(Altura, 1994; Shirey, 1995). Hutzelmann et al.(1993) study showed that magnesium supplementation over a period of time can reduce blood lactate concentration during and after exercise. Therefore, the purpose of this study was to investigate the effects of a short term high intensity interval training protocol for 400 m runners and high-doses of magnesium with 200 ml water before training on sprint performance and metabolism.

## Methods

### Subjects

Six 400m track specialists, without injuries and without taking any supplementary nutritional supplements were selected as subjects for this study. Prior to the study all procedures of the research design were explained in detail. All subjects agreed to the study and filled out a standard form which included health information.

Table 1 Subjects characteristics

| | Age (years) | Height (cm) | Weight (kg) |
|---|---|---|---|
| Mean ± SD | 17.00±1.10 | 173.50±5.43 | 61.83±5.04 |

### Experimental method

Training was performed 3 days a week (Figure. 1). The training design and intensity of the 1st day (Tr-1) and 3rd day (Tr-3) were similar. It consisted of intermittent training at 90% intensity of the individual's best performance in the 400m run. Training consisted of 3 sets with an active (1.7 m/s) resting period of 3 minutes between each set. Each set was composed of three 20 second intervals with an active (2.5 m/s) resting period of 30 seconds between each interval ($3 \times 3 \times 20s$). On the 2nd day (Tr-2) subjects were required to perform a continuous training session at 50 % intensity of their best performance in the 400m run for 15min.

Thirty minutes before training, 400 mg magnesium (+100 mg Vitamin C) were dissolved in water (200ml) and ingested. Followed by a 30 min warm-up and stretching period. Next two training tests were conducted. The first was conducted after the first 400m test (T-1). Two days of rest were then allowed before the following training session period Tr-1. The second test (T-2) was then conducted on the second day after Tr-3.

Biological parameters (Figure. 2) were measured at rest before exercise, during Tr-1, Tr-3, at the end of each set and in the $3^{rd}$,$5^{th}$,$7^{th}$ and $10^{th}$ min after exercise (recovery period). Biological parameters were also taken before the 400m T2 test (Figure 2) and after the T2 test in the $1^{st}$,$3^{rd}$,$5^{th}$,$7^{th}$,$10^{th}$ and $15^{th}$ minute of recovery period.

The biological parameters that were measured were lactate and ammonia (NH3). 10μl blood was drawn and used to analyze lactate with a German lactic acid analyzer (EKF) and 20μl of blood was drawn and used to analyze ammonia (NH3) with a Japanese ammonia analyzer.

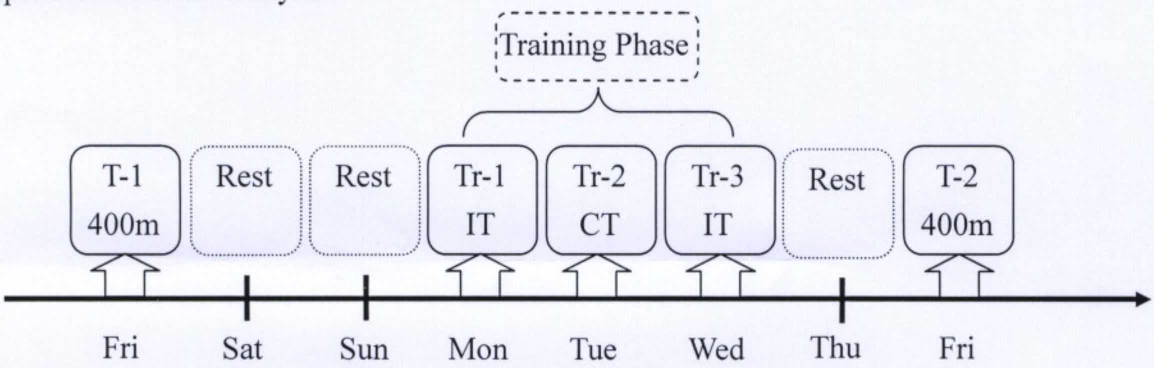


Fig. 1 Experimental flow chart

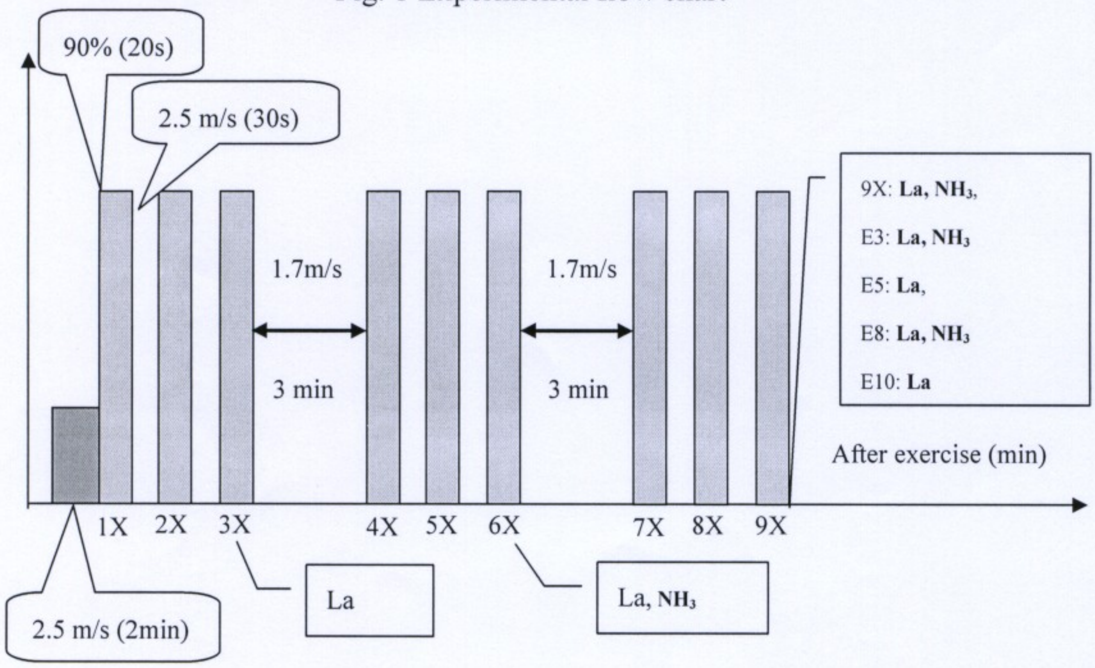


Fig. 2. Training test Tr-1 and Tr-3's training methods, content and

biological parameters

**Statistics analysis**

All data are presented as means ± SD. A paired *t* test was used to analyze lactic acid and ammonia levels between pre and post training 400m performances (T-1, T-2) as well as the intermittent training sets(Tr-1, Tr-3). Statistical analysis level significance was set at $p< 0.05$.

## Results

After each subject's best T-1 (400m) performance, the training speed for the study was determined and set at 90% (m/s) for Tr-1and Tr-3 and 50% (m/s) for Tr-2 of their maximal speed in the 400m (Table 2). Figure 4 and 5 present lactate and $NH_3$ on the 1st Tr-1 and 3rd day Tr-3 of training. R represents lactate and $NH_3$ before the magnesium supplement was ingested and R2 represents the lactate and $NH_3$ 30min after the supplement was ingested. Furthermore, biological parameters are shown at the end of each set (3X, 6X, 9X) and during the recovery period ($E_3$ -$E_{10}$).

Table 2: pre-test max speed in 400m, 90% max speed and 50% max speed.

| | 400m (T-1) | 90% | 50% |
|---|---|---|---|
| m/s | 7.41±0.19 | 6.67±0.16 | 3.70±0.09 |

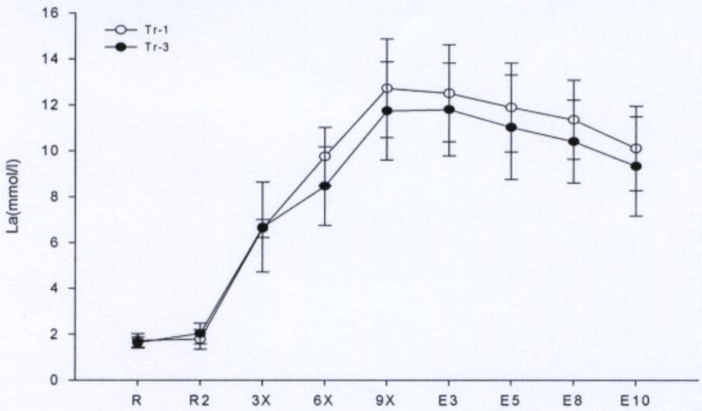


Figure 4: Lactate during the 1st (Tr-1) and 3rd day (Tr-3) of training including recovery time (E).

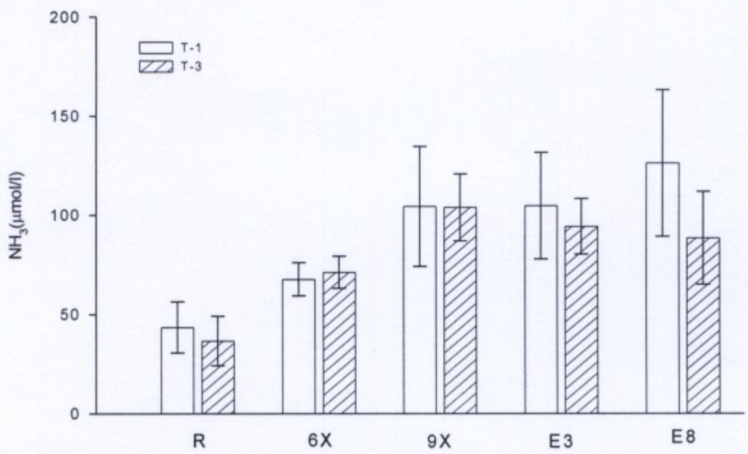


Figure 5: $NH_3$ during the1st (Tr-1) and 3rd day (Tr-3) of training including recovery time (E)

The highest lactate concentrations were measured and recorded at the end of set 3 (9X) in Tr-1 as well as in Tr-3. In contrast to Tr-1 the biological parameters in Tr-3 decreased during the training and recovery period except for the first set (3X) and at the preparation phase (R, R2) but it needs to be noted that this decrease was not significant ($p> .05$). Furthermore, before training (R), $NH_3$ in Tr-3 was significantly ($p <.05$) lower than $NH_3$ in Tr-1 but by the end of the second set (6X) $NH_3$ in Tr-3 was not significantly higher than in Tr-1 ($p> .05$). In addition by the end of the third (9X) set $NH_3$ was slightly lower in Tr-3 than Tr-1.This tendency could also be observed during the recovery period (E3 and E8). These differences were not significant ($p> .05$) but still need to be noted.

As we take a look at Table 3 we can see the results of the 400m tests T-1 and T-2(s) and their differences. The average speed was 54.02 s ± 1.36 in T-1 and 53.66 s ± 0.72 in T-2. The average improvement of 0.36 s between T-1 and T-2 was not significant ($p> .05$). Looking at lactate before and after the post-test T-2 it indicates a slight increase over T-1 with the exception of E8 and E10, which indicated no difference (Fig. 6). Even though there is an increase in lactate it is not significant($p > .05$).

Table 3: Individual results of 400m pre-test (T-1) post-test (T-2)

| No. | T-1 | T-2 | Diff |
|---|---|---|---|
| 1 | 55.30 | 53.50 | -1.80 |
| 2 | 54.00 | 54.00 | 0.00 |
| 3 | 54.20 | 54.19 | -0.01 |
| 4 | 53.00 | 53.21 | 0.21 |
| 5 | 55.60 | 54.49 | -1.11 |
| 6 | 52.00 | 52.54 | 0.54 |
| M±SD | 54.02±1.36 | 53.66±0.72 | - |

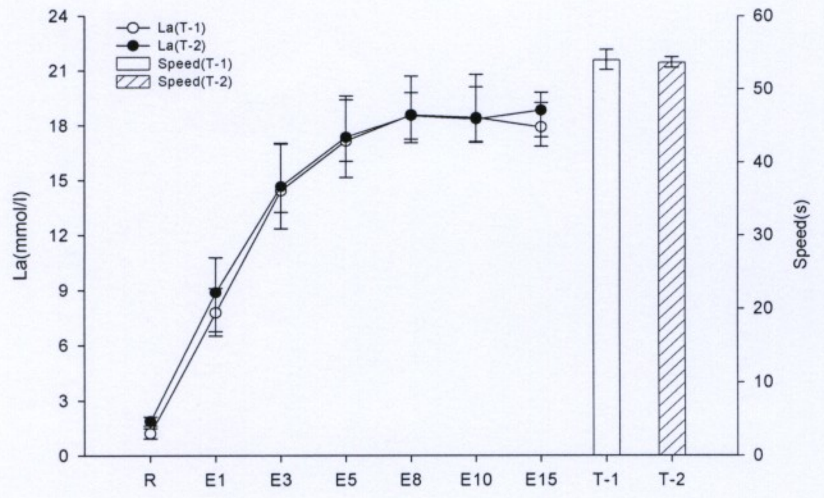


Figure 6: Comparison of lactate (mmol/l) during 400m pre-test and post-test.

In figure 7 maximum pre-test post-test lactate and $NH_3$ are not compared so this will not be discussed. As we look at maximum lactate though, it indicates a decrease from 20.23±1.64 mmol/l in T-1 to 19.17±1.31 mmol/l in T-2. Furthermore, maximum $NH_3$ increased from 227.33± 33.28μmol/l in T-1 to 251.00±33.55 μmol/l in T-2. In conclusion, no significant differences ($p > .05$) were found in the two biological parameters pre-test vs. post-test.

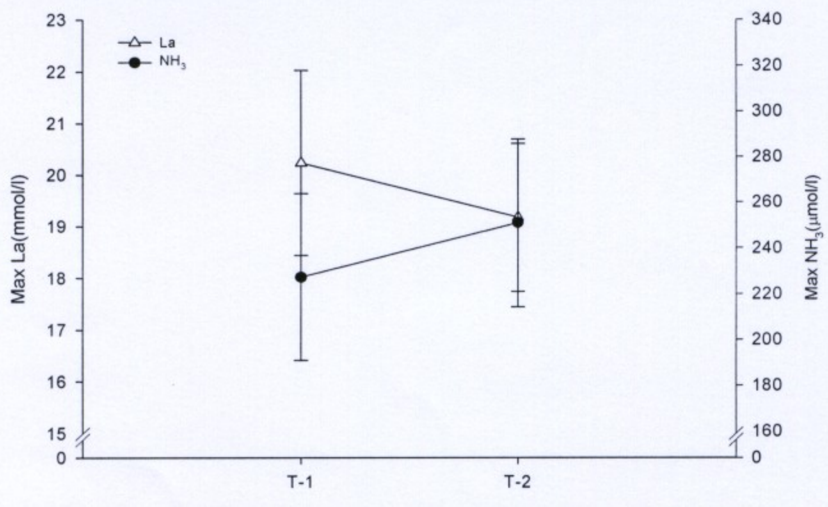


Figure 7: Comparison of maximum lactate and ammonia ($NH_3$) during 400m pre-test and post-test

## Discussion

During the training test (Tr-1 and Tr-3), blood lactate concentration decreased after Tr-3, under high-intensity exercise with high dose magnesium, the decrease in blood lactate concentrations were discussed by Hutzelmann et al.(1993). The study indicated that when ingesting magnesium there was a significant reduction in the load in sports with the end effect being a decrease in lactic acid accumulation. Lukaski (1983) explained this theoretical mechanism by saying that magnesium stimulates the two-phosphoglycerate (2, 3-diphosphoglycerate, 2, 3-DPG) enzymes, while increasing red blood cells to release oxygen to work the application of muscle tissue. Furthermore, $NH_3$ indicated a downward trend during (Tr-1 and Tr-3). Bertschat et.al.(1986) study when looking at marathoners who supplemented with magnesium showed a significant reduction in competition protein degradation. Hypothetically speaking, this may be due to the reduction of neonatal sugar resulting in a reduction in amino acid degradation to generate energy, but reduces its metabolites $NH_3$, in addition to magnesium and is also involved in cell ammonia (ammonia) to eliminate an important enzyme.

In conclusion Golf et.al. (1998) pointed out that triathlon competitors after four weeks of added magnesium reduced their race times. In comparison to this study only three subjects improved their 400m times, this may be due to the supplement ingestion time being only 3 days.

## Conclusion

From the findings of this study the best time to incorporate this type of training model would be one month prior to a major competition, while the athletes are in their best physical condition and metabolism is able to adapt to the three days of intense training. In final thought the high magnesium intake was able influence the contraction of the muscle fibers reducing muscle fatigue, resulting in improved 400 m individual times.

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