

Effects of acute taurine consumption on single bout of muscular endurance resistance exercise performance and recovery in resistance trained young male adults

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Abstract

Study aim: This study investigated the effect of taurine supplementation on exercise performance and recovery from resistance exercise. The study was conducted with a cross-over design in a double-blind manner.

Material and methods: Ten resistance trained males (age 21.4 ± 2.01 years; BMI: 23.6 ± 2.5 kg/m²) ingested either a taurine (0.1g/kg) supplement or placebo (18 mg aspartame) prior to resistance exercise. Vertical jump, flexibility, balance, systolic blood pressure, diastolic blood pressure, heart rate (HR), maximal voluntary muscle contraction, speed, lactate, glucose and perceived soreness and strain were assessed. The subjects performed two exercise trials with 1 week wash out interval. Blood samples were collected at baseline and before each exercise (chest press, abdominal crunch and leg extension) to analyse plasma levels of lactate and glucose.

Results: Paired-T test results showed statistically significant increment ($p < 0.05$) in total volume (kg \times #repetitions), chest press volume and leg extension volume. Repeated measure ANOVA results demonstrated statistically significant differences ($p < 0.05$) in lactate and flexibility in trial and time, and in maximal voluntary isometric muscle contraction (MVIC) test in time, trial and trial \times time in favour taurine group. No statistically significant differences were found in cardiovascular parameters, glucose, and balance parameters ($p > 0.05$).

Conclusion: In conclusion, 0.1 g/kg of taurine consumption before resistance exercise could positively affect exercise performance by increasing exercise volume and reducing lactate levels.

Keywords: Strength training – Nutrition – Fitness – Muscle function – Exercise performance

Introduction

Recently, with the spread of sports and exercise culture, the popularity of pre-training nutritional supplement products with complex content, that can increase performance and can facilitate training adaptations is gradually increasing [13]. Although there are different ingredients in pre-workout nutritional supplements, many contain a large proportion of taurine [16]. However, performance and recovery enhance effects of taurine is not well understood [17].

Taurine is both used as a single product and is included in complex-containing products to increase athletic performance and taurine seems to cause similar effects

to those of creatine [8]. It is predicted that taurine can increase muscle strength and endurance and cause a decrease in recovery times after exercise, as well as supports muscle hypertrophy by absorbing water into the muscle cell [8]. Moreover, taurine may affect the resistance performance by effecting the muscle contraction mechanism and may affect recovery by regulating reactive oxygen species (ROS) and exercise-related inflammation [35, 36]. Taurine increases the calcium secretion from sarcoplasmic reticulum and increases sensitivity to calcium of contractile proteins of muscle cell [35]. Although, aforementioned mechanism may facilitate the muscle contraction, diminished calcium balance can activate proteolytic system and calpain mechanism that responsible from catabolic process in muscle cells [31]. However, taurine

may prevent calpain activation by reducing NADPHoxi-dase activation and reducing ROS [31]. Thus, additional taurine supplementation may increase resistance exercise performance and reduce recovery time in following days of exercise session [20]. There are few studies on exercise in which taurine is consumed alone. Consuming daily 6 grams of taurine for 1 week has increased the maximal oxygen consumption (maxVO₂) values, total work volume, and exercise duration of the individuals [42]. In addition, 1.66 grams of taurine consumption before exercise has increased fat oxidation in 90 minutes of sub-maximal cycling exercise [28]. In studies conducted with taurine-containing supplement, the findings demonstrated that the number of repetitions and exercise parameters of exercises applied with the upper extremity of the body did not change, while the number of repetitions and exercise parameters in exercises with the lower extremities increased [34]. In a meta-analysis study, taurine and caffeine consumption were examined and it was emphasized that the increase in exercise performance was dependent on the amount of taurine [32]. Moreover, taurine intake may regulate increased cardiovascular demands that caused by high repetition resistance exercise. With the continuous muscle contraction increased intramuscular compression reduces blood flow into muscle thus it may lead an increment in the cardiovascular demands [22]. Research demonstrated high dose taurine increases vasodilation, therefore taurine intake may lower the cardiovascular demands during the exercise [25]. Resistance exercise also decreases blood glucose levels that may impair performance [21]. Taurine may prevent this effect by regulating glucose homeostasis via effecting insulin signalling pathways [6]. In addition to exercise performance, taurine affects also recovery [20]. The exercise related neuromuscular fatigue may affect the performance components such as flexibility, power, speed and balance [9]. Especially, neuromuscular fatigue can cause impairment in postural control, thus balance tests may measure indirectly neuromuscular fatigue [2]. These measurable components also used for measuring recovery and neuromuscular fatigue indirectly [26]. However to the best of our knowledge there is no study evaluated the effects of taurine on the recovery of aforementioned performance components after a single bout of resistance exercise.

The different findings in the literature related to acute taurine consumption effects on exercise point to the need for new studies in this area. According to our knowledge, there is no study that evaluated acute taurine consumption alone on strength endurance exercise volume. Therefore, the main aim of this study is to examine taurine effects on exercise volume, plasma lactate and glucose concentration and on cardiovascular parameters. The second aim of this study is to examine taurine effects on recovery, based on performance components.

Material and methods

Participants

Ten physically active, resistance-trained (RT) males (age 21.4 ± 2.01 year; body mass index: 23.6 ± 2.5 kg/m², height 178.70 ± 6.49 cm and body mass 75.78 ± 10.80 kg) were recruited for the study from Bursa province. Participants were made aware of all procedures' risks and benefits, gave written consent and completed health history, diet history and physical activity questionnaires. All participants had several years (5.3 ± 2.5 year) of resistance exercise training experience, with an average self-reported training time of 7.3 ± 2.1 hours per week. Individuals were recruited only if they met the following criteria: were non-smokers, were not consuming creatine, taurine and protein supplements within the past six months, were not consuming certain medications (non-steroidal anti-inflammatory or steroidal drugs), were not consuming alcohol more than 1–2 drinks per week and had no known history of cardiovascular disease. The characteristics of the subjects at baseline are shown in Table 1. Measurement of body composition (Body Mass, fat percentage,) conducted with Tanita electronic scale (Tanita BC 418, Japan). As baseline measurements sit and reach flexibility test, flamingo balance test, vertical jump, Maximal Voluntary Isometric Muscle Contraction (MVIC) test with using TKK 5402 brand back leg dynamometer (TKK 5402, Takei, Japan), and 30 meters sprint test were performed.

Approach to the research question

In order to evaluate the effects of acute taurine ingestion on a single bout of exercise, we selected a single set protocol and exercises performed till exhaustion. Three major muscle groups were targeted, pectoralis, abdominals and quadriceps respectively. Total volume of exercise, blood markers (plasma lactate and glucose concentration) and cardiovascular parameters were measured. In addition, we evaluated recovery based on performance components (balance, sprint, Maximal Voluntary Isometric Contraction (MVIC), vertical jump and flexibility) and subjective scales.

Experimental design

Using a double-blind, crossover study design, subjects acted as their own controls and were assigned to the two experimental conditions (taurine consumption and placebo consumption), 1 week apart, in a counter-balanced order. Total exercise volume, flexibility, balance, vertical jump, maximal voluntary isometric contraction, 30 meters sprint, plasma lactate and glucose levels, heart rate (HR), systolic blood pressure, diastolic blood pressure, ratings of subjective feelings of pain and strain, in response to taurine and placebo trials were evaluated.

Table 1. Descriptive characteristics of subjects at baseline

	Minimum values	Maximum values	Mean \pm SD
Age [years]	19	24	21.4 \pm 2.0
Body Mass [kg]	60.4	98.2	75.8 \pm 10.8
Height [cm]	165.0	185.0	178.7 \pm 6.5
BMI [kg/ m ²]	20.0	28.7	23.7 \pm 2.6
Percentage of Fat [%]	3.64	21.35	12.23 \pm 5.92
Flexibility [cm]	7.0	27.0	17.6 \pm 5.7
Balance (#failure)	0	10	4 \pm 3
Vertical Jump [cm]	42.0	57.0	50.6 \pm 5.4
Maximal Voluntary Isometric Muscle Contraction [N]	1084	2158	1539 \pm 323
30 Meters Sprint [seconds]	4.22	4.70	4.47 \pm 0.15

All participants were thoroughly familiarized with the study design; specially with one repetition maximum (1RM) protocol, resistance exercise protocol, timing and procedures of blood collection, supplementation regimen and performance measures. During the familiarization session participants were informed to how to record their diet in terms of quantity and ingredients their meals. Figure 1 depicts the overall study design.

The experimental protocol was approved by the Bursa Uludağ University Faculty of Medicine Clinical Research Ethics Committee and was performed in accordance with the principles of the Declaration of Helsinki.

Interventions and blinding

Two trials were conducted as taurine and placebo trials. The wash-out interval between trials was determined

as 1 week. One hour after consumption of placebo (18 mg aspartame) or taurine (0.1 gram/Body weight) mixed waters, 5 minutes of light tempo aerobic running followed by dynamic stretching exercises were performed as a warm-up [23] and the same exercise protocols applied in both trials.

The experiment was conducted with a randomized double-blind design. One of researchers prepared portions of taurine or placebo (aspartame) and wrote the body weight of the subjects. Before preparations of portions this researcher chose randomly five name from the name list of participants and prepared taurine drinks for chosen names for first week to randomize the consumptions. The researcher A who prepared taurine and placebo drinks did not contact any of subjects and did not indicate which bottle had taurine to the researcher who run experiment during the experimental period.

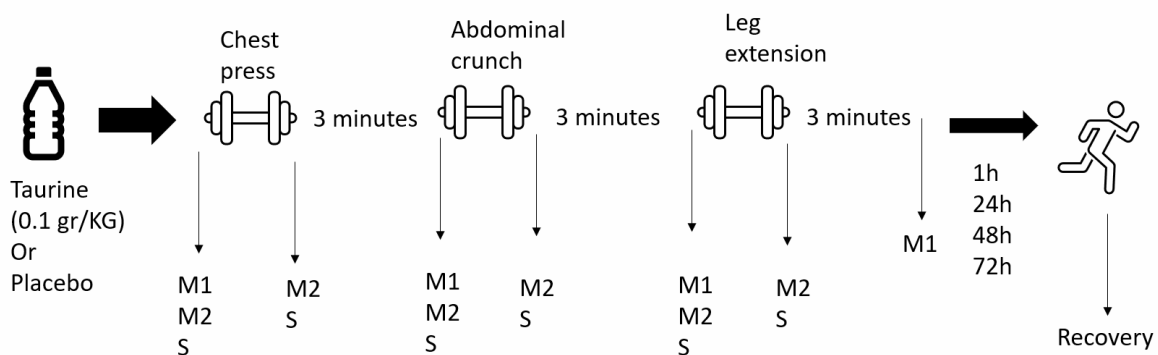


Figure 1. Trial Design (CP = Chest Press; AB = Abdominal Crunch; LE = Leg extension; M1 = Plasma Lactate and glucose concentration measurements; M2 = Systolic, diastolic blood pressure and heart rate measurements; S = Subjective scale measurements; Recovery = Sit and reach flexibility test, Flamingo balance test, Vertical Jump Test, Maximal Voluntary Isometric Contraction Test, 30 Meters Sprint; 1h = 1 hour; 24h = 24 hours; 48h = 48 hours; 72h = 72 hours)

Following the warm-up, just before the first exercise, lactate (Lactate Scout +, EKF diagnostics, United Kindom) and glucose (Life Check Smart TD-4360, Life Check, Turkey) were measured from the capillary blood of the participants. Systolic blood pressure (Life Check BPM15, Life Check, Turkey), diastolic blood pressure (Life Check BPM15, Life Check, Turkey), and heart rate (Life Check BPM15, Life Check, Turkey) were measured from the radial arteries while participants were in seated position they raised their left hand and hold it in heart level till results show up on the screen. Subjective pain and strain values were obtained using visual analog scales. A recovery time of 3 minutes was given between exercises [7]. Blood parameters were taken just before each exercise and 3 minutes after the last exercise for lactate 0,5 μL and for glucose 0,5 μL from finger tips. Cardiovascular values (Systolic blood pressure, diastolic blood pressure, and heart rate) were measured just before and just after each exercise. Subjective values (perceived pain and exhaustion) were measured with 10 point Likert scale just before each exercise.

The sit-and-reach flexibility test, flamingo balance test, vertical jump test, MVIC, and 30 m sprint test performed for indirect measurement of recovery and tests were performed 1 hour (1H), 24 hours (24H), 48 hours (48H), and 72 hours (72H) after the trials. In order to reduce the effect of circadian rhythm, trials and measurement of exercise parameters were applied at the same hours throughout the study period.

Supplementation and diet control protocol

In the trials, volunteers consumed 0.1 g of taurine powder (Big Joy) per kilogram of their body weight, mixed with 0.25 ml of water or 18 mg aspartame mixed with 0.25 ml of water 1 hour before exercise. Participants were asked to detailed record one week's diet before experiment and were asked to follow same diet throughout the experimental period[20].

Exercise protocol

All the exercises used in the study were performed within a single set protocol with a 50% of maximum one repetition, and exercises continued until volunteers were exhausted. The rest period between exercises was set as 3 minutes [7, 23]. Exercises were performed on the chest press machine (CP) for the pectoralis muscle group, on the abdominal crunch machine (AB) for the abdominal muscle group, and on the leg extension machine (LE) for the quadriceps muscle group respectively. The CP machine is a machine that targeted chest muscles and exercise was performed with pushing the handles forward in seated and facing forward position. The AB crunch machine is the machine that targeted abdominal muscles. Exercise was performed with curling torso down against resistance in

upright seated position. The leg extension machine is targeted quadriceps muscles. Exercise was performed with raising the padded bar with extending the leg against resistance in upright seated position.

Statistical analysis

Data analysis was performed using dependent T-test between group means and two-way analysis of variance (ANOVA) for repeated measures. In cases where sphericity could not be achieved in comparisons between groups, Greenhouse-Geisser outputs were used for analysis. When differences were detected between groups, Bonferroni post-hoc test was used in multiple comparisons. The results were reported as mean and standard deviations. All statistical analysis was performed using SPSS 22 program, and significance values were tested with 0.05.

In order to evaluate the trial orders effect, we performed independent T test for total volume, and mixed model ANOVA for lactate and recovery outcomes, between placebo to taurine and taurine to placebo groups as suggested in literature [41]. According to results obtained from statistically analysis, we couldn't obtain any significant value.

Results

Total and regional exercise volume

We measured total exercise volume with multiplying repetitions that performed and weight that lifted during the repetitions. According to results of the dependent T-test data, there was a statistically significant difference between the taurine and placebo groups in terms of means ($\pm\text{SD}$) of total exercise volume (Taurine Groups: 4699 ± 821 kg; Placebo Group: 4270 ± 781 kg; $P = 0.018$), chest press volume (Taurine Group: 1279 ± 278 kg; Placebo Group: 1141 ± 323 kg; $P = 0.011$), and leg extension volume (Taurine Group: 1325 ± 358 kg; Placebo Group: 1195 ± 340 kg; $P < 0.001$). According to statistical analysis data, no statistically significant difference in terms of mean ($\pm\text{SD}$) (Taurine Group: 2096 ± 376 kg; Placebo Group: 1984 ± 477 kg; $P > 0.05$) was found in the scope of the abdominal crunch volume (Figure 2). The results demonstrated that taurine intake leads to an increment in total exercise volume, chest press volume, and leg extension volume that are lifted by participants. However, taurine intake did not affect the abdominal crunch volume.

Blood parameters

As a result of the two-way analysis of variance, a significant difference in terms of mean ($\pm\text{SD}$) (Taurine Group: 6.7 ± 3.1 mmol/L; Placebo Group: 7.1 ± 3.4 mmol/L; $P = 0.03$) was detected in the lactate data obtained from repeated measurements, while there was no significant

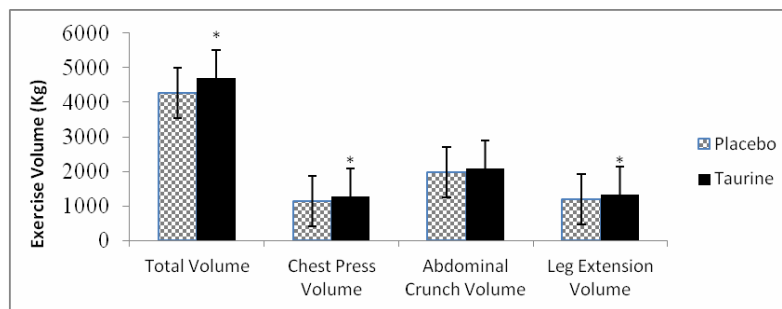


Figure 2. Taurine versus placebo effects on total and regional exercise volume according to dependent T-test results (* = $P < 0.05$)

difference in terms of trial \times time. These, results indicate that taurine intake before the exercise reduced plasma lactate level of participants.

As a result of the two-way analysis of variance, no statistically significant difference in terms of mean (\pm SD) (Taurine Group: 92.1 ± 4.9 mg/dl; Placebo Group: 91.9 ± 6.5 mg/dl; $P = 0.92$) was found in the glucose data obtained from repeated measurements in the trial, time and trial \times time. These results show that there is no effect of taurine consumption before exercise on plasma glucose levels of participants.

Cardiovascular parameters

As a result of the two-way analysis of variance, no statistically significant differences were found in terms of mean (\pm SD) in systolic (Taurine Group: 112 ± 14 mmHg; Placebo Group: 115 ± 15 mmHg; $P = 0.309$) and diastolic blood pressure (Taurine Group: 79 ± 15 mmHg; Placebo Group: 79 ± 15 mmHg; $P = 0.858$) data obtained from repeated measurements in the trial, time, and trial* \times time while a statistically significant difference ($P < 0.05$) was found in heart rate in the time. No statistically significant difference was found in heart rate data in terms of mean (\pm SD) in trial (Taurine Group: 105 ± 21 BPM; Placebo Group: 104 ± 20 BPM; $P = 0.541$) and trial \times time. The results indicates that taurine consumption before exercise did not effect the cardiovascular parameters of participants.

Pain and perceived exhaustion

According to the results of the two-way variance analysis, there was no statistically significant difference ($p > 0.05$) in the pain and perceived exhaustion values felt during exercise, which was obtained from the repeated measurements data, in the trial and the trial \times time, while a statistically significant difference was found in the time ($p < 0.05$).

Recovery parameters

According to the two-way variance analysis results, a statistically significant difference was found in flexibility

data obtained from repeated measurements in the trail in terms of mean (\pm SD) (Taurine Group: 15.9 ± 5.4 cm; Placebo Group: 14.7 ± 5.1 cm; $P = 0.09$) and time ($p < 0.05$) while there is no statistically significant difference in trail \times time ($p > 0.05$). According to recent results taurine consumption ,before resistance exercise, increased recovery of flexibility of participants.

No statistically significant difference was found in balance data obtained from repeated measurements in terms of mean (\pm SD)(Taurine Group: 4 ± 3 failure; Placebo Group: 4 ± 3 failure; $P = 0.35$). These result indicates that taurine consumption before resistance exercise did not affect of recovery of balance of participants.

Statistically significant difference observed in vertical jump data obtained from repeated measurements in the time ($p < 0.05$) while there is no statistically significant difference in the trail in terms of mean (\pm SD) (Taurine Group: 47.2 ± 5.2 cm; Placebo Group: 46.7 ± 5.2 cm; $P = 0.33$) and trail \times time ($p > 0.05$). These results indicates that, recovery from resistance exercise changed by the time, however those changes was not affected by taurine consumption. Thus, taurine consumption did not affect the vertical jump recovery from resistance exercise of participants.

However, according to results from the two-way variance analysis, a statistically significant difference was found in MVIC data obtained from repeated measurements in terms of mean (\pm SD) in the time, trail (Taurine Group: 1439.9 ± 288.8 N; Placebo Group: 1388.9 ± 285.5 N; $P = 0.006$) and trail \times time ($p < 0.05$). These results demonstrate that, taurine consumption before resistance exercise increased recovery of MVIC of participants.

Statistically significant data was found in 30 m sprint data obtained from repeated measurements in time ($p < 0.05$) while there is no statistically significant difference in terms of mean (\pm SD) in trail (Taurine Group: 4.6 ± 0.2 seconds; Placebo Group: 4.6 ± 0.2 seconds; $P = 0.47$) , trial \times time ($p > 0.05$). These results, indicates that recovery of sprint performance changed by the time, however these changes are not related with taurine

consumption. Thus, taurine consumption did not effect recovery of sprint of participants

According to results of two-way variance analysis, statistically significant differences were found in both leg and abdominal muscles DOMS data obtained from repeated measurements in time ($p < 0.05$) while there were no statistically significant differences in the trail, trail*time ($p > 0.05$). A statistically significant difference was found in chest muscles DOMS data obtained from repeated measurements in the time, trail and trail \times time ($p < 0.05$)

Discussion

According to the findings obtained from the study results, consumption of 0.1 g of taurine 1 hour before acute exercise delays exhaustion, increases exercise volume and decreases lactate concentration during exercise. In addition, post-exercise flexibility and MVIC were significantly better in the taurine trial group than in the placebo group. However, no differences were observed within the cardiovascular parameters; heart rate, systolic and diastolic blood pressure. In addition, there was no difference in glucose concentration and subjective pain levels during and after exercise. However, the only reduction in DOMS after exercises, was observed in the taurine group after 24 hour of exercise.

The 0.1 g of taurine consumed per kilogram of body mass by volunteers in the study is the highest amount consumed before training within our knowledge. This amount was used by McLeay et al in 2017. In addition, there is no observed side effects of taurine consumption up to 10 grams per day [20]. The weight of the volunteers participating in our study was less than 100 kg and average taurine consumption was 7.5 grams. In addition taurine reaches maximum concentration in plasma between 60 minutes and 150 minutes after consumption [11]. In this context, the consumption time we used was 1 hour before exercise.

Considering the training total volume, the training volume increased in the group that supplemented with taurine. A meta-analysis pointed out that caffeine and taurine-containing energy drinks' acute contribution to exercise performance, depends on the amount of taurine and is independent to amount of caffeine [32]. The findings obtained from our study are similar to the findings of Souza et al. This similarity is supported by studies [3, 12, 14] showing that taurine increases intramuscular calcium regulation and has a suppressive effect on the calpain mechanism, which activated by calcium overload in muscle cells and plays a role in muscle breakdown. In addition, the sarcoplasmic calcium deposition rate in type 1 and type 2 muscle fibres could facilitate muscle stimulation and muscle contraction [32]. At the same time, the lactate level was found to be

lower in the taurine group in our study. This might explain the increase in training volume. The increase in the total amount of volume in the study is statistically significant in chest press and leg extension exercises. The data obtained in the study indicate that taurine consumption may increase the volume of exercises performed with the lower extremity and upper extremity. To the best of our knowledge, there is no study in which taurine only is consumed and training volumes are compared regionally, but there are such studies on pre-training products containing taurine [3, 34]. However, contradictory results were found in studies that consumed pre-training products. More studies should be conducted on the effect of taurine on the volume of training in this context.

Our findings show that taurine keeps the lactate concentration lower than in the placebo group. This has been shown as an indicator of metabolic stress required for muscle hypertrophy [30]. However, when the increased metabolic stress exceeds the threshold level in individuals, it makes the continuity of exercise difficult and can stop muscle contraction by disrupting various enzyme activities [33]. High amounts of taurine intake can increase ATP production from oxidative metabolism [29]. This improvement in mitochondria may also reduce lactate accumulation [5]. Data to support the findings of the recent study were observed in the study of Imagawa et al. on mice. In the study, taurine consumption for 2 weeks lead to a significant decrease in lactate levels [15]. In the context of human subjects, taurine consumption also decreased the lactate levels of athletes [18]. Our exercise protocol was designed to generate high amounts of lactate [38] and showed findings similar to those of the aforementioned studies.

The findings in our study indicate that taurine consumption does not cause a significant difference on glucose values. Ribeiro et al. (2018) indicate that consumption of taurine affects various amino acids in the blood and can reduce the negative effects of type 2 diabetes caused by insulin resistance and indirectly affect islets in the pancreas and play a role in insulin and lipid metabolism [27]. In our opinion, the exercises that volunteers performed, were not intense enough and with long duration to affect blood glucose levels.

The findings obtained in the study did not show a statistically significant difference in cardiovascular parameters such as systolic, diastolic pressure and pulse. A meta-analysis study, demonstrated that oral consumption of taurine can balance blood pressure by creating a decrease in blood pressure without any negative side effects [39]. In addition, taurine consumption reduced blood pressure in participants with heart disease [1]. Our findings are similar to the study conducted by Warnock et al. [40]. Our sample group is similar to the sample group of Warnock et al. In addition, there was an acute consumption of taurine in our

study. In studies with different findings to ours, chronic taurine consumption was applied and demographic differences existed in the sample group [1, 39].

The findings obtained in the recent study, did not demonstrate a statistically significant difference in the perceived difficulty levels during exercise. Page et al (2019) has demonstrated a reduction perceived difficulty during a cycling endurance exercise. However, our type of exercise was different, in addition our study had rest intervals. Those differences may cause contrast results with aforementioned study [24]. On the other hand, our findings are in parallel with the studies in which the measurement of perceived difficulty was included [10, 28].

The findings of this study show a significant difference in the level of DOMS in the chest area 24 hours after exercise. Considering the general volume of movements, the chest muscle group of the volunteers seem as the weakest muscle group among our participants. Therefore, usage of chest muscles extensively in single bout exercise may cause the DOMS for the first day after intervention. Therefore, taurine consumption may have caused a noticeable difference in delayed onset muscle soreness. However, the findings related with DOMS of our study is based of subjective assessment thus further studies should evaluate the taurine effects on DOMS with utilizing biochemical markers. More studies needed to identify this effect.

According to the findings we obtained from our study, better values were observed in the flexibility and MVIC in the taurine consuming group at recovery parameters after exercise. On the other hand, there was no statistically significant difference in balance, 30 meters speed and vertical jump test. Indirect measures based on exercise performance, which is a measure of recovery after exercise, were used in the study [37]. Similar results to our findings were obtained in a study examining the effect of taurine on muscle damage and recovery. In this study, muscle-damaging exercise was applied and blood parameters indicating both performance and muscle damage were examined. While no intergroup changes in blood parameters were observed, result was obtained in the favour of taurine group in performance improvement [20]. Although the data in the flexibility and MVIC in our study were in line with the work of McLeay et al.(2017), no significant difference was observed in 30-meter speed, balance and vertical jump performance. In addition, our study did not target muscle damage, besides we did not examine any blood parameters indicators of muscle damage. In our study, strength endurance exercise was performed for the chest, abdominal and leg muscles with 50 percent of 1RM until volunteers were exhausted. This type of exercise is not enough to significantly damage the muscle [30]. However, exercise might have affected sarcomeres length which is associated with flexibility and might affected the strength of the leg and abdominal muscles, which are used dominantly in MVIC.

We observed significant improvement in flexibility in taurine group. After a single bout of resistance exercise muscle stiffness may occur [4] and this effects flexibility [19]. The protective effects of taurine may prevent muscle stiffness [36]. Thus, flexibility might affected in taurine group [36]. On the other hand, in our opinion, exercises were not intense enough to affect the balance, 30 meters sprint and vertical jump performance at an advanced level. Therefore, the effect of taurine may not have been seen in the aforementioned performance parameters.

Our study has some limitations, most important one was the small sample size. Second limitation we used the performance parameters as a measurement of recovery. However the methods we used for assess recovery are valid and important for exercise science area [26]. Therefore we suggest that future studies should use larger sample size. The third limitation, we did not measure blood taurine levels of participants before study. Thus, further studies should evaluate the baseline taurine levels of participants.

Conclusion

Our study shows that 0.1 g/kg taurine consumption before acute strength endurance exercise can increase exercise performance, reduce lactate levels formed during exercise, and improve recovery after exercise. 0.1 g/kg of taurine can be beneficial in resistance exercise. We suggest that further studies should examine long term effects of high dose taurine on different type of resistance training with higher percentages of 1RM with larger sample size.

Conflict of interest: Authors state no conflict of interest.

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