

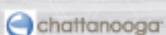
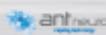


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วิทยาศาสตร์การได้ชัย (Sports Coaching Science)

การเปลี่ยนแปลงของความแข็งแรงของกล้ามเนื้อและสมรรถภาพแบบไม่ใช้ออกซิเจนจากการฝึกด้วยยางยืดในนักกีฬามวยปล้ำเยาวชน

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บทคัดย่อ

วัตถุประสงค์ของการศึกษานี้เพื่อศึกษาผลของการฝึกด้วยยางยืดต่อสมรรถภาพร่างกาย ประกอบด้วยความแข็งแรงของกล้ามเนื้อ, สมรรถภาพร่างกายแบบไม่ใช้ออกซิเจนและปริมาณแลกเทที่ในนักกีฬามวยปล้ำเยาวชน อาสาสมัครจำนวน 20 คน ถูกสุ่มแบ่งออกเป็น 2 กลุ่มๆละ 10 คน คือกลุ่มที่ฝึกปกติควบคู่กับการฝึกด้วยยางยืด (Routine training with additional elastic band training; RET) และ กลุ่มที่ได้รับการฝึกปกติที่ไม่ควบคู่กับการฝึกด้วยยางยืด (Routine training without elastic band; RT) อายุเฉลี่ย 15.1 ± 0.45 และ 15.2 ± 0.42 ปีตามลำดับ อาสาสมัครทั้งสองกลุ่ม ได้รับการฝึกตามปกติ 3 ครั้งต่อวัน 6 วันต่อสัปดาห์ ในขณะที่กลุ่ม RET ได้รับการฝึกด้วยยางยืดเพิ่มวันละ 1 ครั้ง หลังจากเสร็จสิ้นการฝึกปกติ โดยการฝึกอย่างต่อเนื่องเป็นเวลา 3 เดือน ในขณะที่แต่ละเดือนเก็บข้อมูลต่อเนื่อง 2 วัน ติดต่อกัน โดยวันที่ 1 ช่วงเช้าจะเก็บลักษณะของกลุ่มตัวอย่างและการทดสอบบินเกต ขณะและวันที่ 2 ช่วงเช้าจะเก็บกรดแคลคติกในเลือดก่อนและหลังการฝึกซ้อมในช่วงเช้าและทดสอบความแข็งแรงของกล้ามเนื้อในช่วงบ่าย

ผลจากการวิจัยพบว่าความแข็งแรงของกล้ามเนื้อ triceps brachii และ middle deltoid ในกลุ่ม RT และ RET ไม่มีการเปลี่ยนแปลงหลังจากได้รับการฝึกทั้งด้านขวาและซ้ายทั้งในกลุ่ม RT และ RET, ความแข็งแรงของกล้ามเนื้อบiceps brachii และ anterior deltoid ลดลงในกลุ่ม RET ในขณะที่ ความแข็งแรงของกล้ามเนื้อ wrist flexor และ wrist extensor เพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ ($p < 0.05$) ในกลุ่ม RT และ RET ทั้งขวาและซ้าย ความแข็งแรงที่ได้รับพบเฉพาะมัดกล้ามเนื้อ quadriceps ของขาด้านซ้ายในกลุ่ม RET เพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ ($p < 0.05$), ในขณะที่ความแข็งแรงของกล้ามเนื้อ hamstrings เพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ ($p < 0.05$) ทั้งขวาและซ้ายในกลุ่ม RT, PP และ AP ที่เพิ่มขึ้นเฉพาะกลุ่ม RET นอกจ้านี้แลกเทที่ในเลือดหลังฝึกมีความคล้ายคลึงกันในทั้งสองกลุ่ม ผลจากการวิจัยสรุปได้ว่าการฝึกความแข็งแรงด้วยยางยืด เมื่อเพิ่มเข้าไปในการฝึกปกติช่วยเพิ่มความแข็งแรงของมัดกล้ามเนื้อ quadriceps เช่นเดียวกับสมรรถภาพทางกายแบบไม่ใช้ออกซิเจนของขา แต่ความแข็งแรงของกล้ามเนื้อรอบข้อเม็ดขี้นไม่เว้าจะได้รับการฝึกด้วยยางยืดหรือไม่ก็ตาม การตอบสนองทางชีวเคมีไม่ได้รับผลกระทบจากการฝึกด้วยยางยืด เครื่องมือของการฝึกนี้อาจเป็นตัวกำหนดปริมาณของการฝึกสำหรับกล้ามเนื้อด้วยเฉพาะในนักกีฬามวยปล้ำเยาวชน

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คำสำคัญ: ยางยืด, มวยปล้ำ, ความแข็งแรง

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นิพนธ์ต้นฉบับ (Original articles)

วิทยาศาสตร์การโค้ช (Sports Coaching Science)

CHANGES IN MUSCLE STRENGTH AND ANAEROBIC PERFORMANCE FOLLOWING ELASTIC BAND TRAINING IN YOUTH WRESTLERS

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ABSTRACT

To investigate the effects of elastic band training on physical performance including muscle strength, anaerobic performance (peak power, PP and average power, AP) and blood lactate concentration in youth wrestlers. Twenty Thai male wrestlers participated and were randomly divided into 2 groups: routine training with additional elastic band training (RET, n=10) and routine training without additional elastic band training (RT, n=10) with mean ages of 15.1 ± 0.45 and 15.2 ± 0.42 years, respectively. Both RT and RET groups routinely trained for their wrestling program 3 times per day for 6 days per week whereas RET group additionally worked out with progressive elastic band training for 1 hour once a day after daily routine training. Data were collected continuously for 3 months on a monthly basis, for 2 consecutive days. Day one, anthropometry were collected in the morning. Then, all participants performed Wingate testing. In the morning and afternoon on day two, blood lactate concentration and muscle strength were collected. Results showed that muscle strength of upper extremities including triceps brachii and middle deltoid for both RT and RET for both right and left sides did not change from training. Muscle strength of biceps brachii and anterior deltoid showed decline in RET, whereas the strength of both wrist flexor and extensor significantly increased for both RT and RET for right and left sides ($p < 0.05$). For lower limbs, muscle strength improvement was found only in left quadriceps in RET ($p < 0.05$) whereas hamstring muscle strength significantly increased for both right and left sides in RT group ($p < 0.05$). Higher PP and AP showed only in RET. Blood lactate levels were similar in both groups after training. In conclusion, elastic band training, when added into a routine training program, improved muscle strength of quadriceps and hamstring as well as anaerobic performance of lower limbs. Strength of muscles around the wrist improves regardless of whether elastic band training was involved or not. Biochemical responses were not affected by elastic band training. This training tool may be selectively prescribed for particular muscles in youth wrestlers.

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Keywords: Band/ Wrestling/ Strength

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INTRODUCTION

Wrestling is a popular combat sports since the ancient Olympics. International wrestling competitions include two styles: 1) Greco Roman where player is not allowed to attack below the opponent's waist line and 2) Freestyle where player can attack the whole parts of the body including upper and lower extremities. Physiologically, nature of wrestling match consists of intermittent vigorous physical exertions at variable intensities². Key performance components are characterized by sudden, explosive attacks and counterattacks¹, in which energy supply is derived mainly from anaerobic and partly from aerobic energy systems³. The anaerobic system provides the short quick bursts of maximal power for explosive attacks and is reported to be the primary energy system but this energy system can supply for less than 30 sec activity⁵. Aerobic energy system, on the other hands, affords the wrestler's ability to sustain effort for long duration of the match⁴. Whilst upper and lower body strength and power are important, agility and flexibility are also key physical fitness components¹. Well-trained wrestlers usually achieve an excellent level of physical fitness and conditioning because of training⁵.

Recently, training with elastic bands has become widely used and popular mode of resistance training because it is easily handled, less expensive, and offer variable resistance throughout a full range of motion⁶ with both concentric and eccentric muscle contractions⁹. Elastic band training has been introduced with unclear benefit. Using combined elastic band with weight resistance training induced gaining maximum upper limb including trunk muscles strength¹⁰, increased muscle peak force⁷, and neuromuscular activation especially in fast motor units⁸. Presently, there is a few scientific application of elastic bands training to improve performance in athletes. Therefore, the aim of this study is primarily to study the effectiveness of long-term elastic band training on physical performance in youth wrestlers.

METHODS

Participants

Healthy twenty Thai-male wrestlers, physical education students from Sisaket Sport School, age between 14-18 years. They were currently trained for wrestling with the same protocol by the same coach voluntarily participated in this study and who have recent injury and have known limitations on Cardiorespiratory, Neuromuscular, and Musculoskeletal system will be excluded. They were randomly divided into two groups; Control Group (Routine wrestling training, RT, n=10) and Experimental Group (Routine training with additional elastic band training, RET, n=10). All subjects were interviewed, physically screened and explained for testing procedure, benefits and possible risks. Informed consent form was signed before starting the experiment. The protocol was approved by the Human Research Ethics Committee of Mahidol University.

PROCEDURE

Training protocol

Subjects in RT group were assigned to perform two routine training programs, about 1 hour and 30 minutes/session, 3 sessions per day, 6 days per weeks for three months. Following this protocol, subjects in RET group were trained for about 1 hour, with progressive elastic band training once a day. Each month, data were collected continuously on 2 consecutive days. Day one, anthropometry was collected in the morning. Then, all participants performed Wingate testing. In the morning and afternoon on day two, blood lactate concentration and muscle strength were collected respectively. Three months progressive training program was designed by investigator and controlled by wrestling coach.

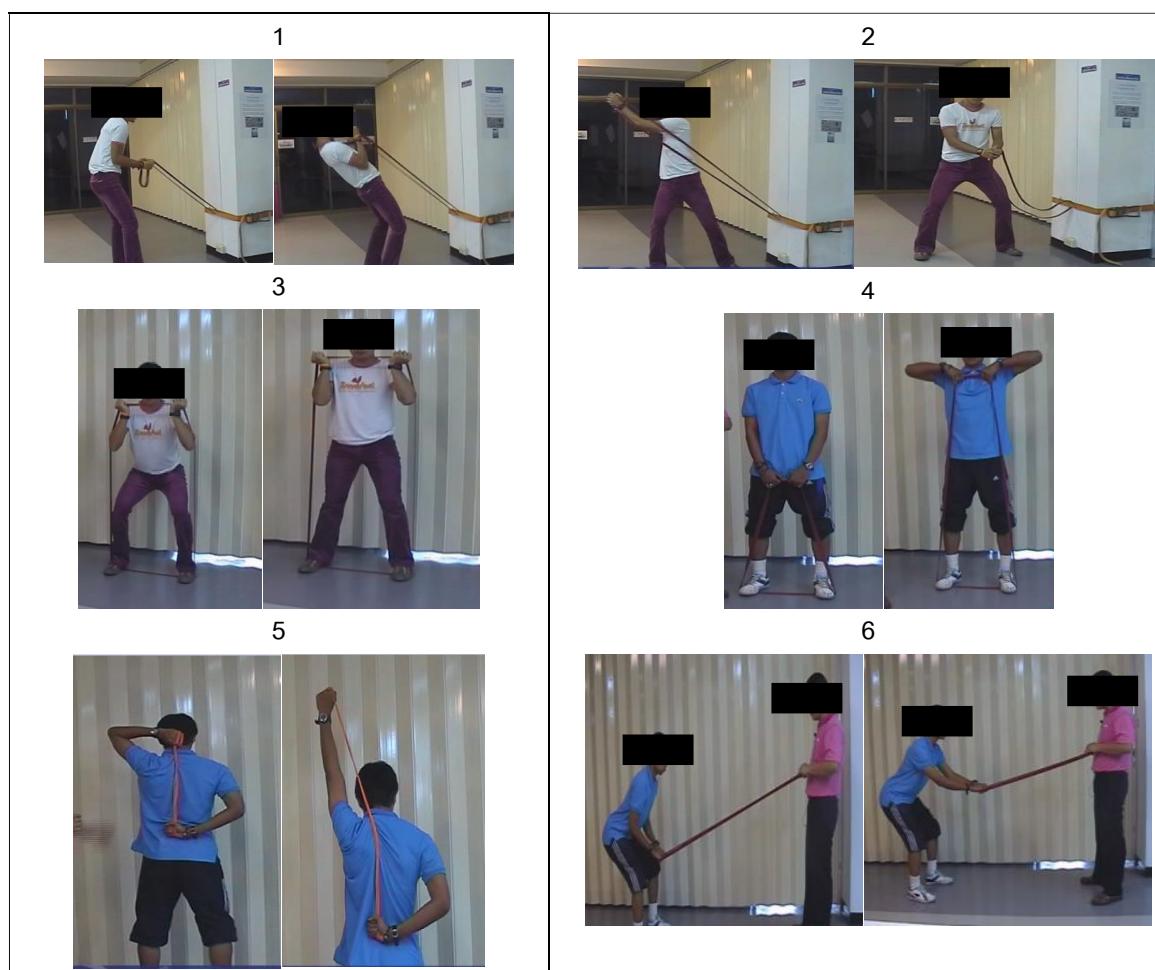


Figure 1. Illustration of elastic band training for wrestlers (focused on main muscles used in wrestling)

Testing protocol

Wingate anaerobic test was used to determine the arms performance. All participants were test after the anthropometry collection. Arm cranking test was performed in the standing position using a modified Monark cycle ergometer (Ergomedic 894 E Peak Bike, Sweden). Testing was started with 3-5 minutes

pedaling warm-up at zero resistance and then cycled at subject's maximum speed under verbal encouragement for 30 seconds. Resistance was set at $0.05 \text{ kp}\cdot\text{kg bodyweight}^{-1}$ ¹⁶¹. Peak power (PP), and average power (AP) were collected.

Strength test

Strength tests were performed on the next day, 24 hours after Wingate test, using a Digital Hand-Held dynamometer (Lafayette, U.S.A) to obtain maximum voluntary isometric contraction (MVIC). With different sizes of adjustable resistive pad, this dynamometer allows investigator to apply and read strength from various muscles of the body. Before the test, subject was asked to warm up. Starting position and placement of resistive pad were selectively adjusted for the pre-determined muscle group including quadriceps, hamstring, biceps and triceps surae, anterior and middle deltoid, wrist flexor and wrist extensor. Isolated muscle strength was collected both on dominant and non-dominant sides. Maximum strength was achieved from the highest value of two repeated tests with one minute rest. After 10-15 min rest, another muscle strength test was performed. During testing, each muscle group, subjects pushing against the dynamometer to maintain steady maximum effort for 5 seconds. The score was recorded to the nearest kilogram⁵⁸. Before blood sample collection, all subjects did not intake food. Blood samples were collected from tip of finger, under anti-septic procedure, at early morning before training and immediately after training for blood lactate analysis. (Lactate Scout Assistant, Germany).

Statistical analysis

All data were presented as mean \pm SEM. Shapiro-Wilk test was used to determine the normal distribution of the data. Pair t-test and independent t-test were used to evaluate for significant differences within and between groups. Wilcoxon and Mann-Whitney U test were performed for non-normal distributions for Pair and independent t-test. The level of significance was set at $p < 0.05$. The statistical analysis was undertaken using SPSS 17.0 for Windows.

RESULTS

Subjects characteristics

The anthropometric data (Table 1) were not significantly different between two groups. With wrestling experience in RT and RET (3.4 ± 0.64 and 2.7 ± 0.47 years, respectively) showed no significant difference between groups.

Table 1.General physical characteristics at rest

Parameters	RT(n=10)	RET(n=10)
Age (yr)	15.2 ±0.42	15.1 ±0.45
Height (cm)	165.4 ±1.41	168.4 ±0.86
Weight (kg)	56.4 ±1.01	57.5 ±1.67
Body fat (%)	9.8 ±0.63	11.9 ±0.89
BMI (kg.m ⁻²)	20.5 ±0.15	20.1 ±0.49

Muscle strength

The most remarkable increase in muscle strength are found in wrist flexor and extensor groups in both right and left arms of both RT and RET. Muscle strength of upper extremity including triceps surae and middle deltoid muscles in both RT and RET did not show any change from training (Table 2). After the training, biceps brachii and anterior deltoid muscles in RET group showed decline from initial phase.

For muscle strength of lower extremity, the right quadriceps muscle strength at initial phase of both RT and RET were not significantly different. Furthermore, the right quadriceps strength had not changed during follow-up phase. Comparison from initial to follow-up phase did not show any significant difference in right quadriceps strength of either RT or RET. The left quadriceps strength had significant increase in RET only. In addition, the left hamstring muscle strength of RET at initial phase was significantly higher than that of RT and from initial phase to follow-up phase, there was significantly increased in left hamstring muscle strength in RT.

Table 2.Changes in strength of eight muscles (kg) between initial and follow-up phases. Values are means (\pm SEM).

Muscle group	Initial				Follow-up			
	RT		RET		RT		RET	
	Right	Left	Right	Left	Right	Left	Right	Left
<i>Upper Extremity</i>								
Biceps brachii	23.1 \pm 1.4	21.8 \pm 1.5	23 \pm 1*	21.7 \pm 0.6*	22.3 \pm 1.4	22.2 \pm 1.2	21.5 \pm 0.9	20.4 \pm 0.7
Triceps surae	18.2 \pm 1.1	18 \pm 1.1	17.5 \pm 1.2	17.1 \pm 1.2	18 \pm 1.4	18.5 \pm 1.2	17.2 \pm 1	17.9 \pm 0.9
Anterior deltoid	22.5 \pm 2	23.3 \pm 1.8	20.8 \pm 1.2	21.2 \pm 1.4*	20 \pm 1.1	19.6 \pm 0.8	19.4 \pm 0.8	18.9 \pm 0.6
Middle deltoid	19.6 \pm 1.6	18.8 \pm 1.4	19.8 \pm 1.2	18 \pm 0.8	18.1 \pm 0.6	18.1 \pm 1.1	16.8 \pm 0.6	17.2 \pm 0.4
Wrist flexor	11.6 \pm 0.8*	11.8 \pm 0.8*	11.2 \pm 0.7*	11.2 \pm 0.6*	18.2 \pm 1.2	18.2 \pm 1.6	19.3 \pm 0.8	18.3 \pm 0.4
Wrist extensor	11.8 \pm 0.8*	10.8 \pm 1	12.9 \pm 1*	12.2 \pm 0.8*	17.2 \pm 1.5	16.2 \pm 1.4	17.9 \pm 0.4	18.4 \pm 0.7
<i>Lower Extremity</i>								
Quadriceps	42.6 \pm 3.6	37.6 \pm 3.1	36.2 \pm 2.4	36.7 \pm 2.6*	44.7 \pm 2.3	44.1 \pm 2.8	45.7 \pm 2.8	46.7 \pm 2.4
Hamstring	19 \pm 1.9*	18.9 \pm 1.7 ^{a,*}	25.1 \pm 2.3	25.3 \pm 2.1	28.1 \pm 1.2	27.4 \pm 1.6	26.8 \pm 1.1	28.3 \pm 1.3

*Significantly different between initial and follow-up phase ($p<0.05$), ^aSignificantly different between RT and

RET groups at initial phase ($p<0.05$).

Anaerobic performance

Results of peak anaerobic power (PP) (Table 3) in RT and RET groups at pre- test/initial phase showed that there was significant difference between groups where anaerobic peak power in pre-test in RT was higher than that of RET ($p<0.05$). But significant increase from initial to follow-up in RET group only. For anaerobic average power (AP), there was significant increase within RET group ($p<0.05$). In contrast, there were no significant different for between groups.

Table 3.Changes in Peak anaerobic power (PP, Watts) and Average anaerobic power (AP, Watts).

Group	PP		AP	
	Initial	Follow-up	Initial	Follow-up
RT	320.1 ± 30.39 ^a	319.3 ± 19.74	221.4 ± 12.13	222.6 ± 12.68
RET	231.4 ± 23.00	273.9 ± 24.01 [*]	180.3 ± 14.54	210.7 ± 15.61 [*]

Value are mean ± SE.

*Significant difference between initial and follow-up phase ($p<0.05$), ^aSignificantly difference between RT and RET groups at initial phase, $p<0.05$)

Blood lactate

Results of blood lactate (Table 4) showed that there were significant difference between pre- and post-training at initial and follow-up phase in both of RT and RET groups at $p<0.05$.

Table 4: Blood lactate concentration (mmol/L) in RT and RET groups

Group	Initial		Follow-up	
	Pre training	Post training	Pre training	Post training
RT	2.32 ±0.42	5.14 ±0.71 [*]	1.24 ±0.14	5.84 ±0.93 [*]
RET	1.62 ±0.25	7.14 ±0.74 [*]	1.55 ±0.31	5.52 ±0.65 [*]

Value are mean ± SE.

*Significant difference between pre and post training within group, ($p<0.05$).

DISCUSSION

This study aimed to investigate effect of elastic band training on physical performance including muscle strength, anaerobic performance and blood lactate in youth wrestler and compare the physical performance with those wrestlers who trained with routine protocol.

Muscle strength of upper extremity

Biceps brachii and anterior deltoid muscles in RET group showed decline from initial phase. The most remarkable increases in muscle strength are found in wrist flexor and extensor for both RT and RET for both right and left sides.

Wrist flexor and extensor groups are known as key success for wrestling. Grip and wrist muscles are essential for effectively grasp, pull-push, throw and pin opponents down to the mat. Thus, these muscle

groups play roles in coordination during holding an opponent and twisting²⁰. Training for maximum strength for wrist flexors and extensors are one among major regimens for wrestlers. In addition, when these muscles become weak, elbow flexors and extensors will be easily injured²¹. This study shows increments in wrist flexor and extensor muscle strength because the forearm is decisive route to success in wrestling¹¹ and the main muscle used in wrestling match¹⁴.

Muscle strength of lower extremity

From this study, the average gain increased in left quadriceps muscle strength, which was found only in RET. Increasing in muscle strength from previous study⁶ found the similar results, in particular on the non-dominant side. In addition, when compared H/Q ratio in both groups in this study, it was found that the average gain in right and left sides are all in normal ranges of 0.5-0.8, similar to previously report¹⁵. This agonist-antagonist relationship is the most critical successful factor for lower extremity. The acceptable ranges for H/Q ratio are 0.6 to 10²². It is because this ratio represents the safety co-activation of lower extremity big muscle groups, where hamstring is always weaker than quadriceps muscle but hamstring is a fast contracting muscle²³. Large variations of H/Q ratio are often seen among athletes participating in different sports, gender, age, muscle cross-sectional area and testing velocity²⁴.

Anaerobic performance

Anaerobic power and capacity of wrestlers have been estimated for both upper and lower limbs¹. The present study expressed in absolute unit (watts) where RET showed remarkable effectiveness of elastic band after training. From this study, the average post-training values gained in PP and AP in RET are about 18% and 16% respectively. It is the fact that the development in anaerobic performance derived from arm cranking training. This mode of exercise for arm strength has been previously proposed using a 30-sec load on standing crank-arm ergometer²⁵. Effectiveness of arm cranking exercise in wrestlers had been identified to incorporate as a main part of training program¹⁹.

Blood lactate concentration

Blood lactate concentration is used to demonstrate optimal strength and power⁵⁵ during anaerobic exercise testing¹⁸. It was reported that during a wrestling match, an elevation of blood lactate concentration may be up to $20 \text{ mmol} \cdot \text{l}^{-1}$ ¹⁶. This confirmed that wrestling is a type of highly anaerobic sports. From this study, blood lactate level at post training in both groups increased up to $5-7 \text{ mmol} \cdot \text{l}^{-1}$ which indicated the high range of training intensity but not the vigorous intensity. Lactate levels in RET group declined from initial phase for two possible reasons: a) because the wrestlers may be able to buffer the high-acidic muscle and blood lactate concentrations in order to demonstrate optimal strength and power during training¹³ and b)

there is a super-compensation of phosphagens system following training¹². This suggests that the training program may be appropriated for wrestling performance improvement with less lactate production. Therefore, wrestling is one of the most demanding sports from a metabolic perspective and it is a sport where the requirement of absolute strength and power is critical¹⁷.

CONCLUSION

The results of this study indicate that adding elastic band training into the routine training program could have improvement of muscle strength, upper limb (wrist flex and extensor) in both routine with and without additional elastic band training, lower limb (hamstring) the only routine without elastic band training that remarkable the main muscle used in wrestling. In addition, following 3 months of elastic band training, youth wrestlers develops higher peak and averaged anaerobic powers, in both absolute and relative units, than in control group. Blood lactate concentrations in both groups were similar.

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