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The effects of Versa Gripp® on pull-ups failure and surface electromyography during pull-ups in strength trained females

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Abstract. This study compared the effects of Versa Gripps® compared to no grips on pull-ups to failure in and surface electromyographic (sEMG) signal amplitude during pull-ups on the wrist flexors (WF), wrist extensors (WE), latissimus dorsi (LAT), and infraspinatus (INF) muscles in strength-trained females. *Material and Method.* Seventeen healthy females volunteered to participate in the study. Pull-ups were performed to failure to the beat of a metronome. Surface EMG was computed using the root-mean-square (RMS) of the signal intensity with a sampling frequency of 1000 Hz, integrated over 500 ms, and normalized to the maximum voluntary contraction (MVC) for the muscles being investigated. EMG data from the four muscles and number of pull-ups performed were analyzed using paired two tailed t-tests for Grip and No Grip conditions for each muscle and for the number of pull-ups performed. *Results.* There was a significant decrease ($p = 0.035$) in EMG activation of the wrist extensors with grips (102.6 ± 65.5% MVC) compared to no grips (89.5 ± 49.2% MVC). No change was noted in EMG activation during pull-ups of the infraspinatus, latissimus dorsi, wrist flexors, or in the number of pull-ups to failure. *Conclusion.* Wrist straps may be effective at decreasing the demand of the wrist extensors during pull-ups. This may be beneficial for those strength-training participants recovering from lateral epicondylitis who wish to perform pulling exercises and need to unload the wrist extensors. Furthermore, strength-training participants may be able to more effectively recruit larger muscle groups in pulling exercises as smaller muscle groups may be a limiting component when performing pulling exercises.
Key Words: *lateral epicondylitis, latissimus dorsi, infraspinatus, wrist straps*

Introduction

Resistance training has been shown to be an effective intervention to improve athletic performance and reduce the risk of injury by improving muscular imbalances, increasing strength, and helping to stabilize vulnerable joints. The American College of Sports Medicine recommends that all adults should perform activities that maintain or increase muscular strength and endurance a minimum of two days per week (1). Although there are many benefits associated with resistance training, there are also potential risks of sustaining injuries. Research suggests that the most common acute, non-urgent injuries that occur during strength training are muscular strains and ligamentous sprains, accounting for 46-60% of all acute injuries (2-3).

When performing strength training, hand grip strength has been demonstrated to be an essential part of most exercises (4). During pull-ups and other pulling exercise motions, the hand grip must be strong enough to maintain the grip on the bar to perform the exercise. Research has indicated that individuals with more grip strength can perform more pull-ups (5). Hence, activation of the wrist flexor and extensor muscles is an important component of successfully performing pulling exercises such as pull-ups. Weakness or injuries to one of these two muscle groups could impede pull-up performance or the ability to perform a pulling exercise.

The effects of using Versa Gripps® in strength trained males was previously reported (6). In this investigation the results revealed that the WF and WE had a significantly lower activation ($p = 0.040$ and $p = 0.001$, respectively) when comparing the Grip condition with the No Grip condition. No differences were noted between the conditions for the LAT and INF. In order to further test the effectiveness of the Versa

Gripps® on sEMG signal amplitude in the same muscles, females were recruited for this study. Furthermore, the hypothesis of performing more pull-ups to failure, defined as unable to complete a full range of motion pull-up to the beat of a metronome, with the use of the grips was also investigated in this study.

Material and Method

Experimental Approach to the Problem

Similar to the study reporting the effects of Versa Gripps® in males (6), this study was also conducted using a repeated measures, within-subjects design. The subjects performed as many full range of motion pull-ups as possible to the beat of a metronome with and without the Versa Gripps®. The order of the Versa Gripps® condition was randomly assigned for each participant to control for any bias due to order.

Seventeen healthy strength trained females (Age = 32.1 yrs +/- 9.9 yrs, height = 1.66 m +/-.067 m, weight = 61.9 kg +/- 7.0 kg, body fat = 16.5% +/- 3.9%) volunteered for this study. Before testing, all subjects reviewed, completed, and signed an informed consent approved by the Institutional Review Committees at both Rocky Mountain University of Health Professions and at Western University of Health Sciences. In order to meet the inclusion criteria for this study the subjects had to be females between the ages of 18-49 years of age who actively participated in strength training two to three times per week (6-7) for the last 12 months with the self-reported ability to perform at least one or more full range of motion pull-up (s) from a dead hang with a pronated grip.

Similar to the earlier published study performed with male participants (6), subjects were excluded from the study if they had a previous shoulder, wrist, or hand subluxation, dislocation, or fracture, joint instability, tendinitis, bursitis, impingement, adhesive capsulitis, neurovascular complications. Other exclusions included any condition that limited physical activity for greater than two days over the last six months, current complaints of neuromuscular pain, numbness, or tingling in the upper extremity, neck, or back during the pull-up testing (7), and/or a known allergy to tape. Subjects were asked in advance of their testing date to avoid performing any upper body physical activities for two days prior to participating in the study in order to avoid fatigue and soreness prior to the investigation.

Procedures

sEMG

The sEMG data collection and processing was performed in the same manner as described in the previous investigation with males (6). A Noraxon Myosystem Software and Myosystem 1200 equipment (Noraxon USA, Inc, Scottsdale, AZ) was used for this study. The Myosystem 1200, a four channel sEMG unit, and the MyoResearch software were used to process the sEMG signal. The Noraxon signal detection and processing system utilized an eighth-order Butterworth low-pass filter of 500 Hz (±1%), first order high pass filter of 10 Hz (±10%), a sampling frequency of 1000 Hz, a common-mode rejection ratio of greater than 100dB, a gain of 1000, a baseline noise of less than 1 microvolt RMS, and an input impedance of greater than 100 MΩ. The MyoResearch software algorithm rectified and smoothed the signal by calculating the RMS using a 50-ms moving window. The mean RMS, integrated over 500 milliseconds for each muscle, was normalized to a maximum voluntary isometric contraction (MVIC). The peak sEMG for the concentric contraction of the first repetition was recorded with and without the grips. Only the first pull-up was analyzed because only five of the seventeen women were able to successfully perform more than three strict full range of motion pull-ups to the beat of the metronome. The software normalized the RMS of each muscle's signal for the first repetition to its respective MVIC. Peak RMS values were calculated over one repetition for each of the four muscles for each grip condition.

Specific electrode placement was based on the suggested electrode placements established by Noraxon USA, Inc. as cited by Konrad (8) and as described in our previous investigation with males (6). Noraxon blue sensor dual (bipolar, single differential) electrodes were utilized for each muscle being evaluated. Each electrode in the Noraxon dual sensory electrode set was one centimeter in diameter with a one centimeter separation between the edges of the conducting surfaces, or two centimeters between the centers of each electrode. A dual electrode set was positioned directly over each of the four muscles and aligned parallel to the fiber direction. The electrodes for the WF were placed approximately eight centimeters below and four centimeters medial to the midpoint of the imaginary line bisecting the antecubital fossa. The electrode placements for the WE were placed approximately eight centimeters below and seven centimeters lateral to the midpoint of the imaginary line bisecting the distal portion of the olecranon process.

The electrodes for the latissimus dorsi muscle were placed approximately 12 cm lateral to T11. The electrodes for the infraspinatus were placed approximately four centimeters inferior to the spine of the scapula over the infraspinatus fossa on the lateral aspect of the muscle. All electrodes were placed superficially parallel to the direction of the muscle fibers on the subject's hand dominant side. A Noraxon single electrode was also placed over the spine of the scapula; this single electrode was used as the reference electrode (6, 8).

Following the same protocol as the investigation performed with male participants (6), an outline of each electrode was traced with a permanent marker on the subject's skin and fastened by athletic tape to prevent them from falling off once the electrodes were properly placed. No other external force, i.e. clothing, was permitted over the electrode to ensure the accuracy of the sEMG signal. These procedures were followed in order for the electrodes to be easily replaced in the same location as the original electrodes in the event that the original electrodes failed to remain adhered to the skin during the testing procedures. Since the reliability and validity of the sEMG would be compromised if the electrodes fell off, properly marking the original electrode placement helped ensure that the replacement electrodes were not placed over different motor units in the event that the original electrodes fell off the subject. However, no electrodes fell off of any subject during the course of this investigation.

MVIC

The MVIC for the WF and WE was performed utilizing a hydraulic hand dynamometer (JAMAR®, Clifton, NJ) as similarly described by the study with males (6): 1) the shoulder was positioned in 180° of flexion and the elbow at full extension, and 2) the dynamometer was placed on setting II. A second MVIC for the WF and WE was performed using the hand held dynamometer with the shoulder positioned at 0° of shoulder flexion and the elbow bent to 90°; the highest of these values was used as the MVIC for each muscle group. The MVIC for the LAT and INF was performed as described previously (6) by placing the shoulder in 90° of abduction, 90° of external rotation, and the elbow flexed to 90° before the subject applied a downward force by pulling down on an immobile weighted pulley to activate the LAT. The MVIC for the INF was performed like a manual muscle test for the INF is performed, applying medial pressure to the wrist with the subject in a seated position with the upper extremity held at 0° of shoulder flexion and abduction (at least two fingers away from the trunk so subjects did not press the arm against the trunk) and 90° of elbow flexion (6).

Pull-up Test

The pull-ups were performed on the P-123B Eight Stack Total Body Gym (Promaxima, Houston, TX) pull-up bar station as described by Escalante et al. (6). Hand placement and orientation for the pull-ups were performed with a pronated grip (irrespective of grip width). A thumb over bar hand position was also used for the pull-ups in this study. In order to minimize error, the variables that were standardized were load, range of motion, and velocity. Load was controlled because the subjects pulled the same load, their body weight. Range of motion was controlled by ensuring that pull-ups were consistently performed utilizing a full range of motion as described below. Velocity was controlled by utilizing a metronome, also described below. In this study, a full range of motion pull-up began when the subject grabbed the horizontal bar (with a pronated, thumb-over bar, carrying width grip) with the elbows in full extension. Next, the subject flexed her knees to about 90 degrees while she was suspended from the pull-up apparatus by the upper extremities and the lower extremities were then non-weight bearing. The subject began the concentric phase of the pull-up by lifting her torso until the lower ear-lobe was raised even with the horizontal pull-up bar; the end of the concentric portion of the pull-up was when the subject's upward movement of their head/body came to a stop at the top portion of the pull-up. The eccentric portion of the pull up began when the lower ear-lobe began to descend and was completed when the upper extremities returned to the starting position. Velocity of the pull-ups was controlled by utilizing a metronome (6) where the metronome was set at 50 beats per minute. Each beat of the metronome counted as one concentric repetition to the top. The second beat counted as one eccentric repetition to the bottom or start position. Participants performed the pull-ups to failure to the beat of the metronome.

A Logitech webcam was used to film the subjects while they performed the pull-ups. The location of the camera relative to the subject was the same for all subjects during the completion of the pull-ups with the two grip conditions; it was placed directly in front of them.

Myovideo software was used to process the video signal. The video signal was used to identify the concentric and eccentric portions of the pull-ups to assist in defining the time period used to derive the RMS for each portion of the pull-ups performed.

Testing Session
All data was collected in one testing session as described in the previous investigation with males (6). The beginning of the testing day consisted of obtaining an informed consent, health history questionnaire, and demographic/anthropometric data (age, sex, height, weight, body composition, and carrying width) for each subject. Body composition was obtained using Lange Skinfold Calipers (Beta Technology, Santa Cruz, CA) with the gender-specific three site Jackson-Pollock skinfold equations utilized by Johnson et al (9).
To ensure standardization of all instructions, subjects watched a pre-recorded instructional 13-minute video that explained all essential information to the subjects. The video contained pertinent information such as hand placement, grip width, thumb position, definition/demonstration of a full range of motion pull-up using a metronome set at 50 beats per minute, proper use of the Versa Gripps® Pro, rest periods between testing conditions, and a brief five minute warm-up consisting of low intensity aerobic exercise performed before testing was conducted. The appropriate size Versa Gripps® Pro, according to the manufacturer's guidelines, was also determined at this time.
After reviewing the instructional video, the subjects performed the five minute warm-up described in the video. Following the warm-up, the subject's skin was prepared for electrode application, which included: shaving, if necessary, to remove any visible hair, and abraded with an alcohol wipe until erythema was attained. Electrodes were then placed at each muscle site.
After a brief three minute period, to allow for the electrode to skin contact to reach a stable electrical condition (8), a validity check was verified by performing an informal manual muscle break test for two to three seconds for each muscle being investigated. An inspection of the raw sEMG signal was performed by having the subject sit completely relaxed on a bench to allow the amplifier to pick up a raw sEMG signal no greater than 15 microvolts, but ideally less than 3.5 microvolts.
A formal MVIC for the WF, WE, LAT, and INF was conducted. Following the normalization phase and a five-minute rest period to minimize fatigue, the participant stood in the anatomical position where a 10-second static trial was recorded to establish baseline muscle activity as described by Konrad (9). Each subject then performed the pull-ups to failure to the beat of the metronome with and without the grips. The order in which the pull-ups were performed (Grips vs. No Grips) was randomly assigned.
Since all of the testing for each subject took place on the same day, the rest time between the conditions (Grips vs. No Grips) was 10 minutes. As reported by Escalante et al (6) previously, 10 minutes of rest time between sets was selected to maximize ATP-CP recovery since that is the energy system used during pull-ups to failure when failure is reached within 7 repetitions (only one female performed 7 repetitions; a majority of the participants performed less than 3 repetitions).

Statistical Analysis. All statistical procedures were conducted using SPSS software v19 (SPSS Inc., Chicago IL). An a-priori power analysis was performed utilizing a medium effect size ($f = 0.50$). The power analysis revealed that a sample size of eight female subjects was required to detect a mean difference in sEMG recruitment between conditions with a statistical power ($1 - \beta$) equal to 0.80 at $\alpha = 0.05$ and a correlation coefficient among repetitions of $r = 0.66$. The data were evaluated for outliers, homogeneity of variance, and normality. Since the data were normal, homogenous, and revealed no significant outliers, skewness, nor kurtosis, the data were analyzed using paired two-tailed t-tests to compare the number of pull-ups performed to failure and the sEMG of the four muscles (WF, WE, LAT, and INF) individually with and without grips.

Results
The paired t-tests for each individual muscle tested with the Grip compared to the No Grip conditions revealed the following:

- The WE had a significantly lower activation ($p = 0.035$) when comparing the Grip condition with the No Grip condition (Table 2).
  There were no significant differences ($p > 0.05$) in activation between the Grip and No Grip conditions in the WF, LAT, and INF (Table 1).

Table 1: Mean Normalized EMG Activity (%MVIC Mean +/- SD) of the WF, WE, LAT, INF and Number of Pull-Ups to Failure (Mean +/- SD)				
Muscle	No Straps	Straps	Difference	Significance ψ
WF	127.5 +/- 41.2	125.7 +/- 41.2	1.8	0.783
WE	102.6 +/- 65.5	89.5 +/- 49.2	13.1	0.035*
LAT	124.2 +/- 56.9	116.8 +/- 40.1	7.4	0.524
INF	83.8 +/- 24.5	81.3 +/- 28.0	2.5	0.358
PU	2.82 +/- 1.63	3.12 +/- 1.87	0.3	0.172

p = 0.05, * denotes a significant difference, WF = Wrist flexors, WE = Wrist extensors, LAT = Latssimus dorsi, INF = Infraspinatus, PU = Pull-Ups to failure

- Table 1 also displays the values of peak activation for the Grip and No Grip conditions for the subjects for the first repetition. Table 2 displays the results of the paired t-tests for the subjects.

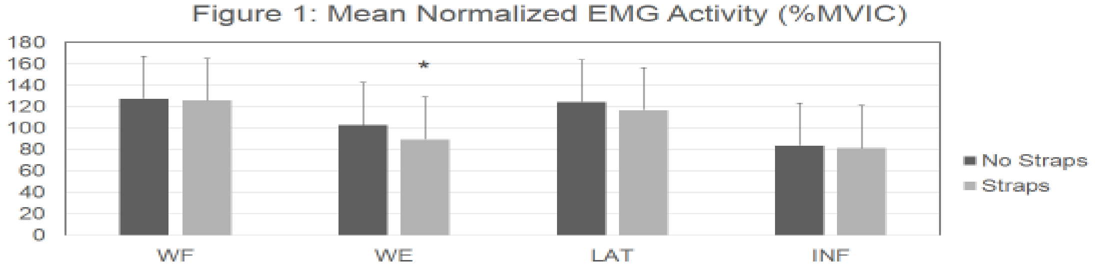
Table 2: Paired Samples Test

		Paired Differences							
					95% Conf. Int. of the Dif.				
		Mean	Std. Dev.	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	INFCNG - INFCG	2.48824	10.8348	2.6278	-3.08252	8.0589	.947	16	.358
Pair 2	WECNG - WECG	13.15882	23.5054	5.7009	1.07345	25.2442	2.308	16	.035*
Pair 3	LATCNG - LATCG	7.44706	47.0794	11.4184	-16.7589	31.6530	.652	16	.524
Pair 4	WFCNG - WFCG	1.78824	26.3680	6.3952	-11.7689	15.3454	.280	16	.783
Pair 5	PUNG - PUG	-.29412	0.8488	0.2058	-.73057	0.1423	-1.429	16	.172

p = 0.05, * denotes a significant difference, INFCNG = Infraspinatus concentric no grip, INFCG = Infraspinatus concentric grip, WECNG = Wrist extensors concentric no grip, WECG = Wrist extensors concentric grip LATCNG = Latissimus dorsi concentric no grip, LATCG = Latissimus dorsi concentric grip, WFCNG = Wrist flexors concentric no grip, WFCG = Wrist flexors concentric grip, PUNG = Pull-Ups No Grip, PUG = Pull-Ups Grip

- Figure 1 displays the values of the peak activation (percentage of MVIC) data for the first repetition for the Grip and No Grip conditions for the subjects.
- There was no significant difference between the Grip and No Grip conditions for pull-ups to failure (Table 1).

Figure 1: Mean Normalized EMG Activity (%MVIC)



WF= Wrist Flexors, WE= Wrist Extensors, LAT= Latissimus Dorsi, INF= Infraspinatus. * denotes significant difference (p = 0.035)

Discussion

The use of wrist straps during pull-ups has been shown to be effective at reducing the sEMG activity of the WF and WE in strength trained males (6). It has also been suggested that the use of wrist straps during pull-ups may potentially lead to better performance in maximum number of pull-ups performed if hand grip strength is the limiting factor (6). Similar to the results found with males in the previous investigation, the results of this data also revealed that the WE showed a significant decrease in sEMG signal amplitude between the No Grip and Grip conditions. However, the in strength trained females no significant differences in activation between the Grip and No Grip conditions in the WF, LAT, and INF were demonstrated. A trend toward more pull-ups performed to failure was noted, but it failed to reach a significance.

One limitation of this study was that only the first pull-up was analyzed due to a majority of the females not being able to perform more than two pull-ups; this was done to analyze the data consistently between all participants. According to Cram et. al. (10), correlations between the first movement peak amplitude and the other four movement peak amplitudes have been reported to be relatively low (<0.40); however, the correlation between the second to fifth movement peak amplitudes has been reported as very high (>0.90). Hence, the peak amplitudes analyzed in the first repetition may have been inconsistent due to the variance observed in peak amplitudes between the first repetition and repetitions two through five. In order to analyze the data consistently between all participants.

Another limitation of this study was the experience of the subjects with using the wrist straps to perform the exercise. Although the subjects were instructed in the proper use of the grips before performing any pull-ups, some subjects did not use the grips to their advantage. Some participants reported squeezing the pull-up bar more with the grips as opposed to without the grips. This is the opposite of what is intended to occur when using grips because the purpose of the grips is to reduce some of the workload from the WF and WE, not increase it. Thus, the potential learning curve for some subjects using the Versa Gripps® for the first time may have influenced the results.

A third limitation of the study was that performing one pull-up for the participants was a maximum to near maximum effort; hence, all muscles involved during the pull-up for the participants were working at maximum or near maximum efforts. Previous sEMG research of the pull-up revealed that the shoulder muscles involved in the early and late stages of the pull-up include the latissimus dorsi, infraspinatus, and teres major (11). Other major muscles involved in the exercise include the rhomboids, trapezius, biceps brachii, pectoralis major, wrist flexors, and wrist extensors. Since all of the muscles involved during the pull-up were likely working at maximum or near maximum effort for this study, grip strength may not have been the limiting factor for the participants when performing pull-ups to failure. If prime movers such as the LAT or the biceps brachii were not strong enough to allow the participant to perform the pull-ups, the grips would not have helped the participant perform the pull-ups because they have only been shown to decrease the demand of the forearm muscles. Conversely, if the prime movers during the exercise were strong enough to allow the participants to perform the movement, then the grips may have helped to unload the WF and WE to potentially allow the participants to perform more pull-ups.

Future research to investigate the effects of the use of Versa Gripps® on maximum pull-up performance in stronger participants where one pull-up is not a maximum or near maximum effort is needed. Additional research to investigate the effects of the use of grips on other exercises on sEMG activity of the WF and WE on other exercises that require pulling and gripping such as deadlifts, shrugs, and rows should be performed. Finally, research evaluating the effectiveness of the use of wrist straps to enhance lifting performance for maximum reps or maximum weight lifted in exercises such as the deadlift, shrug, and row could further expand the knowledge on the effectiveness of the use of grips to enhance lifting performance.

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Obesity and associated risk factors among adult males: prevalence investigation in cross-sectional study

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Abstract. The prevalence of obesity associated risk factors and lifestyle physical activities were evaluated in 1218 Public Transport Drivers (Taxi drivers) of Tehran (capital of Iran). The degree of obesity evaluated by self-reported on kg/m^2; lifestyle behaviors and demographic factors involve physical activity, marital status, house type, level of education, household income, smoking, sleep and rest status, family history of cardiovascular disease and eating attitudes by a questionnaire administrated by Adami and Corderra (2003) on Mediterranean eating style that was adopted with Iranian population lifestyle. Blood pressure measured with a handy sphygmomanometer. Range of age was between 21 to 71 years. Individuals under 35 years of age were classified as younger, from 36 to 50 as middle aged and over 50 as older. Overweight was defined as body mass index (BMI) = 25 to 29.9 kg/m^2 and obesity as BMI $\geq$30 kg/m^2. Hypertension was defined according to the WHO criteria as systolic BP >140 mm Hg, or diastolic BP >90 mm Hg, or both. Prevalence of obesity, overweight and both of them were 40.6%, 26.6%, and 67.2%, respectively.
Prevalence of obesity, overweight and high blood pressure significantly increases with increase of aging, household income, family members, and low level of education and physical activity ($p<0.05$). In all age groups, there was significant association between obesity and high blood pressure ($p<0.0001$). Highest prevalence of obesity (50.3%) and high BP (71.1%) were observed in older group. Obese persons in all groups had high BP ($p<0.05$). Furthermore, significant relationship was observed between body mass index and many food consumption habits, for example using high-fat foods, candies, snacks, desserts, and negative relationship with spending work and leisure time physical activities and being careful about what and how much is eaten.
According to these findings, it seems that it is imperative to avoid obesity as a main general health risk factor, and also reinforcing cognitive patterns and promoting Iranian lifestyle behaviors such as increase of leisure time physical activities and reformation of eating habits may be effective in the fight against hypertension and obesity.
***Key words**: obesity, lifestyle behaviors, physical activity, hypertension.*

Introduction

Obesity is an undesirable outcome of changing of lifestyle and behaviors. The prevalence of obesity and overweight is increasing in many developing countries (1,2), especially in Iran population (3). Many national population-based studies showed high prevalence of obesity in Tehranian adults (4). Obesity is related with different problems. One of the results of obesity is high blood pressure (high BP). The prevalence of high BP -even in treated subjects- is excessive in Iran (5). This increased prevalence may reflects a change in lifestyle patterns influenced by an overabundance of food choices and fatty foods, industrialization, technology (6), and convenience with decreased opportunities and motivations for regular physical activity. Evidence from epidemiological studies revealed that consumption of animal fats (7), high body mass index (BMI), aging (8), obesity (1), smoking (5,9), and inadequate physical activity (4,10) are related to hypertension. Another study, also, showed that relationship between physical activity and BP may be modified by a family history of coronary heart disease (CHD) (11).
The benefits of physical activity for public health are widely accepted by both experts and lay people (7,12). Many studies have demonstrated that regular physical activity is related to a decreased of obesity (13,14) and reduced risk of hypertension in men (15). Part of this effect is thought to be mediated through improved lipid metabolism, decreased body weight (16) and increased aerobic power (17). Also, evidence from epidemiological studies have concluded that overweight, obesity and weight gain are associated with an increased risk of hypertension (18,19).