The Effects of Wrestling Competition on Muscle Damage with Reference to Weight and Body Mass Index

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Abstract: The purpose of this study is to evaluate the muscle damages resulted from wrestling competitions according to the classification of body mass index (BMI) and weight. Voluntary 18 male sportsmen, all of whom participated in international competitions, with age of 20,4 ± 2,8, (years), height of 174 ± 0,5, (cm), weight of 77,4 ± 16,22, (kg), age of beginning to training of 7,45 ± 4,29 (years), and BMI of 21,12±1,01 averagely were selected as subjects for the study. The rules of FILA were applied for the wrestling competitions. The times of meal and resting were taken under control, and therefore, care was taken for submitting similar diets to the subjects. In the study, the levels of serum AST, ALT, LDH, and CK were analyzed so that skeletal muscle damages of the subjects involved in the study could be determined accordingly. Some blood samples were collected from fore arm veins before competitions, immediately after competitions, and 24, 48 and 72 hours after competitions respectively in order to identify the activations of those enzymes. No meaningful difference was observed when the AST, ALT, LDH, and CK levels of the groups were compared with reference to weights and BMI values (p>0, 05), but it was found, when the same time measurements of the groups were checked, that there were some numerical increases at certain time intervals, and then afore stated levels returned to the baseline values at 72nd hour. Consequently, while no statistical difference were identified among the groups as a result of the measurements accomplished for the aspects of both weight and body mass index, some numerical differences were, on the other hand, determined. It has been considered that the reason for having more increased levels, during post-exercise times, for both light and middle weights was due to increased numbers of technical application of competitions for both of these weights, and therefore, the reason for lagging gathering strength times for heavy weight group was due to, with great possibility, increased mechanical loads applied on the muscles for the ones having body fats at excessive amounts without having simultaneous power increase within the cross-sectional area of weight-bearing muscles.[C.Berkan Alpay. **The Effects of Wrestling Competition on Muscle Damage with Reference to Weight and Body Mass Index**. *Life Sci J* 2013;10(5s):306-312] (ISSN:1097-8135). http://www.lifesciencesite.com. 56

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1. Introduction

It's a well known fact that exercises cause muscle damages at different levels. The studies are available especially for identifying the damages on the skeletal muscles (Newham et al., 1986; Nosaka et al. 1997). The muscle damages appear, after unaccustomed and heavy exercises, as exhaustion, loss of function, weakness, and soreness on the muscles. The trainings performed cause, per their type and intensity, some muscle damages at different levels. Besides, the eccentric contraction causes much more muscle damages than other types of contraction (Brown et al., 1999). The wrestling has been defined as a kind of sports in which two opponents try to take under his/her control the opportunities and chances at high intensity pressurizes with short breaks (Horswill et al., 1994). The changes those have been introduced recently for the rules shortened the time periods of competitions, gave preference to the aspects of power and isometric contractions for its technical applications, and as a result of these, usage of anaerobic energy has shown some increases (Sharratt et al., 1986). The rules applied currently, however, shortened break times between tours for the competitions. For that reason, the aspects of endurance of sportsmen/sports women have got more importance. The wrestling includes severe eccentric contractions during struggles for falling and resisting of sportsmen/sportswomen (Horswill et al., 1994). The eccentric contraction, one of the special contraction types for skeletal muscles, has an important place under this coverage since it causes prominent damages at cellular level on the skeletal muscles. The gathering strength for muscle damages those appearing after some physical activities during which eccentric contractions are accomplished effectively may last, depending also upon the level of damage, several days or several weeks. The long-term tiredness formed at stated time interval shows itself with a decrease of power, flexibility, and speed on skeletal muscles (Stupka et al., 2001; Skurvydas et al.,1985). For the wide muscle ruptures, some increases are observed for the levels of some enzymes, indicating damages on muscle fibres. The damages on the skeletal muscles cause specific muscle components to be leaked through membrane and into the circulation of blood. Therefore, the constituents those used widely during

studies for identifying damages of the skeletal muscles and cardiac muscles (myocardium) are creatine kinase (CK) and its sub-isoforms at most, and myoglobine, aspartate aminotransferase (AST), lactate dehydrogenase (LDH), brain natriuretic peptide (BNP), atrial natriuretic peptide (ANP), carbonic anhydrase, troponin, and muscle structural proteins. The most important and most widely used one among aforespecified structures is CK (Murray et al., 1998; Aydın et al., 2000; Wals et al.,2000). There are many studies about muscle damages in the literature, including mostly styles of contraction, and types and intensities of exercises concerned. It is not clear whether the BMI containing some components such as weight and height of body is an effective factor on the subject of evaluating muscle damages or not. Meanwhile, an excessive increase on the amount of body fat without having simultaneous power increase within the cross-sectional area of weight-bearing muscles causes, with great possibility, the mechanical loads applied on the muscles to increase (Bernardi et al., 2003). It is not clear, also, whether a classification as light, middle and heavy for weight sports' affects the muscle damages or not. For that aspect, it carries importance to investigate for the effects of body mass index and weight classification on the muscle damages appearing during similar kind of pressurizing. The study accomplished for such a reason aims to evaluate the muscle damages resulted from wrestling competitions with reference to the classification of body mass index and weight thereby.

2.METHOD

2.1.Selecting the Subjects

18 male sportsmen, all of whom participated in international competitions, with age of 20,4 ± 2,8, (years), height of 174 ± 0,5, (cm), weight of 77,4 ± 16,22, (kg), age of beginning to training of 7,45 ± 4,29 (years), and BMI of 21,12±1,01 averagely were selected as voluntary subjects for this study. Before beginning the study, the subjects were given detailed info about the study, and the World Medical Association Declaration of Helsinki was read for them. Then, signatures showing their voluntary acceptance this study were taken.

The sportsmen were given a resting period of a week prior to the study, and they were prevented from participating in physical activities except the competitions applied during this study and, taking measurements following relevant competitions; and from taking drugs or ergogenic aides beginning 6 months prior to and during the study in order to ensure a standardization for them accordingly. Two different grouping methods were applied to the study. First, a concept centered (light, middle and heavy) grouping were preferred instead of a weight grouping of kilogram centered. The subjects were divided into three groups according to this study, the ones wrestling at 55 to 60 kg as light weight, 66 to 74 to 84 kg as middle weight, and 96 to 120 kg as heavy weight. The grouping method of the World Medical Association was used for the BMI grouping. The ones <18,5 were accepted as thin, 18,5 to 24,9 as middle, 25.0 to 29,9 as fat, and above as obese ones according to the aforespecified method. The participants to the study were divided into two groups per that classification.

2.2. The Competition Schedule Applied

The rules of FILA were applied accordingly. (Each competitor performed 5 competitions total beginning at 13.00 o'clock and relaxing 80 to 90 minutes between 1st and 2nd tours; 60 to 70 minutes between tours 2nd and 3rd; 35 to 40 minutes between tours 3rd and 4th; and 3 to 4 hours between 4th and 5th tours). The sportsmen released free for their warm-up exercises during the study. In addition, the times of meals and resting were taken under control, and therefore, care was taken for applying similar diets to the subjects.

2.3. Biochemical Measurements

The levels of serums CK, LDH, AST, and ALT were taken into consideration so that skeletal muscle damages on the subjects those participated in the study could be determined thereby. Some blood samples of the participants were gathered from front arm veins at same hours of relevant days prior to competitions, immediately after competitions, and 24, 48 and 72 hours after competitions respectively in order to identify the activations of those enzymes. The blood samples were gathered from fore arm veins by means of the vacutainer (method of closed blood sampling) system, and the samples were decomposed into serums by centrifuging them at 1000 revolution for 20 minutes in conformance with laboratory terms. Then, the enzyme levels of the blood samples those decomposed into serums were determined by means of the biochemistry autoanalyzer, brand SIEMENS ADVIA using a brand SIEMENS kit on it.

2.3. Statistical Analysis

The comparisons for blood samples taken at just same times from light and middle weight groups of the competitions were performed with reference to BMI was carried out applying Mann-Whitney U testing method. The method of Kuruskal Wallis variance analysis was applied, therefore, for the classification made according to the weights. The confidence interval was selected as 95%, and levels $p<0.05$ and below accepted as meaningful statistically. Meanwhile, all of the statistical calculations were made using the software package SPSS 16.0 for Windows.

3. Results

Table 1. Comparison of AST Values of Groups with Reference to Weights

Variables		Time / Mean±ss				
		B.E	I.A.E	24h	48h	72h
Groups	Lightweight (n:6)	26,37±10,43	39,50±11,25	34,00±4,20	25,87±5,22	23,25±4,68
	Middleweight(n:6)	25,66±8,35	31,66±5,95	29,50±8,82	24,66±6,97	21,66±5,85
	Overweight (n:6)	21,66±5,98	35,00±8,22	34,50±7,71	28,00±8,87	24,33±7,84
	X^2	1,25	2,33	1,57	0,83	0,65
	Sig	0,53	0,31	0,45	0,66	0,72

No meaningful difference was found for the levels of AST measurements taken at same times on relevant groups per the results of the variance analysis testing performed hereby. (p>0,05) .

Table 2. Comparison of AST Values of Groups with Reference to BMI

Variables		Time / Mean±ss				
		B.E	I.A.E	24h	48h	72h
Groups	Middleweight(n:9)	25,66±9,98	38,44±10,98	33,11±4,75	25,33±5,14	22,55±4,85
	Overweight(n:9)	24,00±7,49	33,63±7,32	32,54±8,50	26,81±7,99	23,54±6,78
	Z	-0,57	-1,06	0,76	-,114	,00
	Sig	0,56	0,28	0,93	0,90	1,00

No meaningful difference was found, as a result of bilateral comparison performed, for the levels of AST measurements taken at same times on relevant groups. (p>0,05).

Table 3. Comparison of ALT Values of Groups with Reference to Weights

Variables		Time / Mean±ss				
		B.E	I.A.E	24h	48h	72h
Groups	Lightweight(n:6)	26,87±16,86	33,00±16,53	29,87±13,23	26,00±12,72	23,37±11,35
	Middleweight(n:6)	24,33±11,74	27,16±13,55	26,50±11,53	24,00±10,17	22,00±9,97
	Overweight(n:6)	28,50±11,14	34,00±12,60	31,16±12,87	29,83±14,45	28,50±15,50
	X^2	0,56	1,74	0,85	0,61	0,83
	Sig	0,75	0,41	0,65	0,73	0,65

As a result of variance analysis testing accomplished , no meaningful difference was found among the levels of ALT measurements taken at same times on relevant groups. (p>0,05).

Table 4. Comparison of ALT Values of Groups with Reference to BMI

Variables		Time / Mean±ss				
		B.E	I.A.E	24h	48h	72h
Groups	Middleweight(n:9)	25,55±16,26	31,00±16,59	28,33±13,21	24,77±12,45	22,33±11,06
	Overweight(n:9)	27,45±11,04	32,00±12,60	30,00±11,74	28,00±12,28	26,27±12,99
	Z	0,72	0,45	0,49	0,53	0,72
	Sig	0,46	0,64	0,62	0,59	0,46

No meaningful difference was found, as a result of bilateral comparison performed, for the levels of AST measurements taken at same times on relevant groups. (p>0,05).

Table 5. Comparison of LDH Values of Groups with Reference to Weights

Variables		Time / Mean±ss				
		B.E	I.A.E	24h	48h	72h
Groups	Lightweight(n:6)	139,00±24,83	227,00±3036	192,75±32,52	160,62±30,96	152,75±21,44
	Middleweight(n:6)	150,33±29,59	218,66±32,86	173,50±26,80	151,50±19,86	141,83±20,63
	Overweight(n:6)	160,66±16,09	227,66±26,02	201,00±18,11	177,66±15,62	164,16±16,19
	X^2	2,34	0,50	2,97	459	4,84
	Sig	0,31	0,77	0,22	0,10	0,08

As a result of variance analysis testing accomplished, no meaningful difference was determined for the levels of LDH measurements taken at same times on relevant groups. (p>0,05).

Table 6. Comparison of LDH Values of Groups with Reference to BMI

Variables		Time / Mean±ss				
		B.E	I.A.E	24h	48h	72h
Groups	Middleweight(n:9)	139,33±23,25	224,55±29,33	189,33±32,10	158,77±29,49	150,88±20,82
	Overweight(n:9)	156,727±24,07	224,81±29,44	189,54±26,08	166,45±21,87	154,54±21,49
	Z	-1,40	-,38	-,26	-1,02	-,34
	Sig	0,15	0,70	0,79	0,30	0,73

No meaningful difference was observed, as a result of relevant bilateral comparison, for the levels of LDH measurements taken at same hours on members of relevant groups. (p>0,05).

Table 7. Comparison of CK Values of Groups with Reference to Weights

Variables		Time / Mean±ss				
		B.E	I.A.E	24h	48h	72h
Groups	Lightweight(n:6)	121,96±32,29	463,42±181,81	468,38±178,98	224,38±80,84	224,38±80,84
	Middleweight(n:6)	124,50±39,46	439,60±189,83	429,21±142,32	211,63±69,57	211,63±69,57
	Overweight(n:6)	136,85±40,51	513,86±193,14	589,85±188,48	335,16±146,24	335,16±146,24
	X^2	0,55	0,98	2,46	3,34	1,82
	Sig	0,75	0,61	0,29	0,18	0,40

It was determined as a result of variance analysis testing accomplished that there was no meaningful difference for CK measurements taken at same hours on relevant groups. (p>0,05).

Table 8. Comparison of CK Values of Groups with Reference to BMI

Variables		Time / Mean±ss				
		B.E	I.A.E	24h	48h	72h
Groups	Middleweight(n:9)	119,28±31,25	481,74±178,73	455,08±172,11	218,23±77,84	125,74±32,02
	Overweight(n:9)	133,65±39,08	462,95±189,26	524,15±181,13	282,89±128,46	140,62±25,34
	Z	-,684	-,190	-1,10	-1,25	-1,02
	Sig	0,49	0,84	0,27	0,21	0,30

No meaningful difference was observed, as a result of relevant bilateral comparison, for the levels of CK measurements taken at same hours on members of relevant groups. (p>0,05).

4. Discussion

It is known well that intense exercising causes some muscle damages at different levels. There are some studies available those aiming to identify the damages put on skeletal muscles (Newham et al., 1986; Nosaka et al.1997). Therefore, the anthropometric features and the intensity of training are important factors those causing severe muscle damages. It is claimed, therefore, that there have been a high correlation between the body mass index and soreness of muscle occurring following exercises (Friden et al., 2001). For aforespecified reasons, it bears importance to investigate the effects of the classifications of body mass index and weight on the muscle damages occurring during same kind of pressurizing. No meaningful difference has been observed when the comparisons of the groups for AST with reference to weights (p>0,05), but it was observed, when the same time measurements of the groups were checked, that it increased gradually immediately after and 24 hours after exercises; began to regress at 48th hour; and then aforestated levels returned to the baseline values at 72nd hour (Figure 1). Although no meaningful difference has been, meanwhile, observed when the comparisons of the groups for AST with reference to BMI (p>0,05), it was found that it increased gradually immediately after and 24 hours after exercises; began to regress at 48th hour; and then relevant levels returned to the baseline values at 72nd hour (Figure2). When the comparison of ALT levels with reference to weights of the groups have been observed, no meaningful difference was found (p>0, 05), but when the same time measurements of the groups were checked, it was observed that the values have shown an increase immediately after the exercises, began to regress after 24 hours, and returned to the baseline values at 48th and 72nd hours. (Figure3) When we checked the comparison of ALT levels with reference to BMI, although there was no meaningful difference (p>0,05) when the groups have been checked within only own members of a given group, it was observed that the levels of both groups have shown an increase soon after the exercises, began to regress 24 hours after, and returned to the baseline values at 48th and 72nd hours. (Figure 4) Many studies accomplished have shown that the levels of AST and ALT have increased after the exercises, and then returned to the baseline values after a certain time period (Friden et al., 2001; Fu et al., 2002). Although

the actions of relevant markers have been used usually for determining liver damages, they have been used also for cardiac muscles diseases, muscular dystrophy, and muscular traumas since cardiac muscles (myocardium) and skeletal muscles have contained those heavily (Lawrence et al.,1996; Wallach., 2000). Therefore, it has been claimed that the increases in those markers have been mostly caused by the stresses due to anaerobic pressurizing occurred during wrestling competitions.

When the comparisons of LDH levels with reference to weights of the groups have been taken into consideration, it was found that there has been no meaningful difference (p>0,05), but when the same time measurements of the groups have been checked, it increased immediately after the exercises, began to regress after 24 hours, and approached to the baseline values at 48th and 72nd hours (Figure 5). When the comparison of LDH levels with reference to BMI was observed, although there was no meaningful difference (p>0, 05) when the groups have been checked within only own members of a given group, it was observed that the levels of both groups have shown an increase soon after the exercises, began to regress 24 hours after, and returned to the baseline values at 72nd hour (Figure 6). The study of Fu et al. performed on 100 meters freestyle swimmers, male and female, between ages of 12 to 14 revealed, on the other hand, similar results (Fu et al., 2002; Jonas et al., 2008). No meaningful difference has been observed between the groups for the CK when the levels were compared with reference to weights (p>0,05), but it was found, when the same time measurements of the groups were checked, that there were some numerical increases for the heavy weight group compared to light and middle weight groups soon after the exercises and 24 hours after the exercises; some numerical decreases were observed for all of three groups at 48th hour, and for this time period, the numerical difference has been continuing for the heavy weight group when compared to light and middle weight groups. Then, it was found at 72nd hour that the levels of all of three groups approached again to the baseline values. (Figure 7) When the comparisons of CK values of the groups with reference to BMI have been observed, although there was no meaningful difference between the groups (p>0,05), the levels of both groups have increased and the numerical increase was more high for middle weight group than other groups soon after the exercises when the groups have been checked within only own members of a given group. Therefore, it was determined that the levels of middle weight group began to regress, and the increase has continued for heavy weight group 24 hours after the exercises; began to regress for both groups after 48th hour; and returned to the baseline values at 72nd hour (Figure 8). Many studies on muscle damages have claimed, meanwhile, that the levels of CK increased to its peak points during the measurements at 24th and 48th hours, and indicated a trend of decreasing for the next time intervals.(Fu et al.,2002; Craig et al.,2005; Kianmarz., 2011). When the four markers representing the muscle damages have been checked, soon after the exercises, with reference to relevant weight categories, it could be easily seen that the increase was for light weight group mostly, next for middle weight group, and last for heavy weight group. The technical applications used by sportsmen/sportswomen of light weight group during the competitions are much more in number than other groups since the wrestlers of light weight category have much more high technical capacities (Kolukısa et al., 2004). It could be assumed, for aforespecfied reason, that the members of light weight have been undergoing much more muscle damages. However, when we have checked the results of measurements taken after 24th, 48th and 72nd hours, the most rapid decrease has been shown for light, than middle, and last heavy weight respectively. It is considered according to the results obtained that the most rapid activity of gathering strength has been carried out by light weights, next by middle weights, and last by heavy weights. While the measurement values of AST and CK checked according to BMI have shown much more increase, soon after the exercises, in numbers on behalf of middle weights, a much more rapid decreasing has been observed for other time intervals. On the other hand, while an increase has been observed for both of the groups together for the measurement values of ALT and LDH, a much more rapid decreasing could be seen for the measurement values taken after 48th hour on middle weights. It is claimed according to the results obtained that the middle weights have been subjecting to much more muscle destruction with reference to body mass index as shown, similarly with weight evaluations, by the results of measurements taken soon after the exercises, and also they have much more rapid capability and mental power for gathering their strength. Consequently, while no statistical difference has been found as a result of the measurements accomplished both per weights and body mass index, some numerical differences were identified accordingly. It is assumed, finally, that the reason for having much more increasing on light and heavy weights following the times after the exercises has been due to increased numbers of technical application of competitions for both of these weights, and the reason of lagged times for gathering strength for heavy weight group was due, with great possibility, to the increased levels of mechanical loads applied on the muscles for the ones having body fats at excessive amounts without having simultaneous power increase within the cross-sectional area of their weight-bearing muscles.

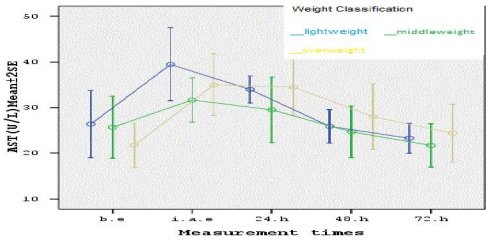

Figure1.Comparison of AST Values of Groups

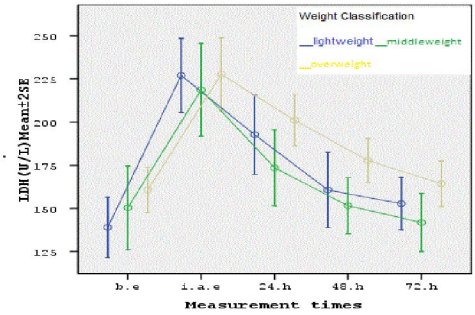

Figure5. Comparison of LDH Values of Groups

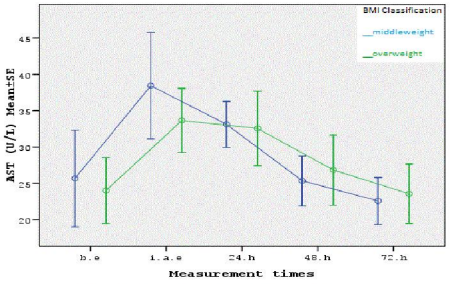

Figure2.Comparison of AST Values of Groups

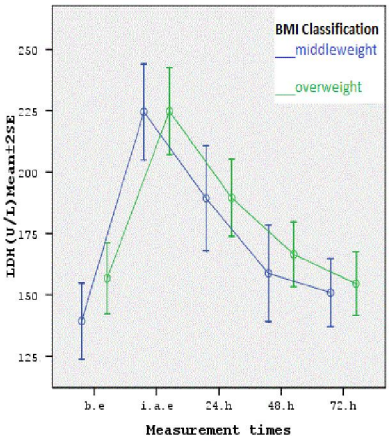

Figure6.. Comparison of LDH Values of Groups

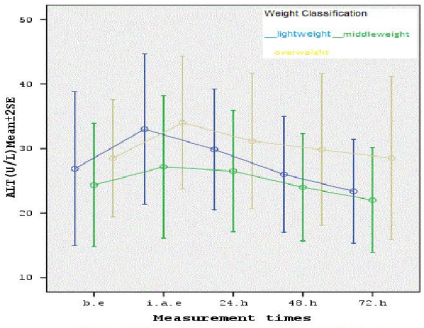

Figure3.Comparison of ALT Values of Groups

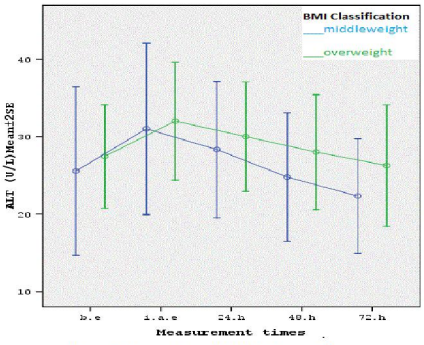

Figure4.Comparison of ALT Values of Groups

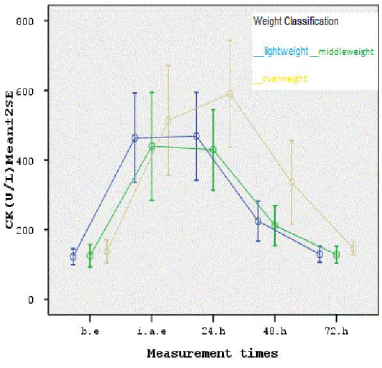

Figure7.Comparison of CK Values of Groups

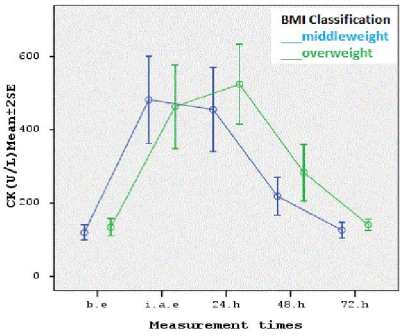

Figure8.Comparison of CK Values of Groups

References

1. A. Skurvydas VS, D Mickeviciene SK, Stanislovaitis A, Mamkus G. (1985). Effect of Age on Metabolic Fatigue and on Indirect Symptoms of Skeletal Muscle Damage After Stretch-Shortening Exercise. Journal of Sports Medicine and Physical Fitness. 13(3):889-894.
2. Aydın T. Yıldız Y. Kalyon TA. (2000). Sports Injuries. Ankara: GATA Pressing House.

Bernardi M, Castellano V, Ferrara MS, Sbriccoli P, Sera F, Marchetti M.(2003).Muscle Pain in Athletes with Locomotor Disability, Med. Sci. Sports Science.35 (2); 199-206.

3. Brown S., Day S., Donelly A.(1999). Indirect Evidence of Human Skeletal Muscle Damage and Collogen Breakdown After Eccentric Muscle Action. J Sport Science.17(5):397-402.
4. Craig Twist, Roger. Eston.(2005).The Effects of Exercise-Induced Muscle Damage on Maximal Intensity Intermittent Exercise Performance. European Journal of Applied Physiology, August; Volume 94, Issue 5-6, Pp 652-658.
5. Friden J., Lieber RL. (2001). Eccentric Exercise-Induced Injuries to Contractile and Cytoskeletal Muscle Fibre Components. Acta Physiol Scand. 171: 321-326.
6. Fu, F.H, You Cy, Kong Zw.(2002).Acute Changeslected Serum Enzyme and Metabolic Concentration in 12 to 14 Years Old. Perceptual and Motor Skills.; 95:1171- 1178.
7. Horswill CA. (1994). Physiology and Nutrition for Wrestling. In: Lamb DR, Knuttgen HG, Murray R (Eds) Physiology and Nutrition for Competitive Sport. Cooper Publishing, Carmel,; Pp 131–180.
8. Jonas P, Ulf H, Paula P, Thomas B, Ulf M, Viktoria W, and Mats E.(2008). Muscular Exercise Can Cause Highly Pathological Liver Function Tests in Healthy Men. British Journal of Clinical Pharmacology.; Volume 65, Issue 2, Pages 253–259, February.
9. Kianmarz V. (2011)The Effects of LPG Massage System on Delayed Onset Muscle Soreness and Muscular Performance after Resistance Exercise. HealthMED Journal of Society for development in new net environment in B&H;Volume 5. Number 6 .1474-1478
10. Lawrence A. Kaplan A. Pesce J. (1996).Clinical Chemistry Third ed. Theory Analysis and Correlation.
11. Murray RK. Granner DK. Mayes PA. Rodwel VW. (1998). Biochemistry of Harper. Edition 24, İstanbul: Barış Bookstore.
12. Newham DJ, Jones DA and Edwards RH. (1986). Plasma Creatine Kinase Changes After Eccentric and Concentric Contractions. Muscle Nerve. 59–63.
13. Nosaka K, Clarkson PM.(1997). Influence of Previous Concentric Exercise on Eccentric Exercise-Induced Muscle Damage. J Sports Sci.15(5):477-83.
14. Ş. Kolukısa, M. A. Ziyagil, O. İmamoğlu, N. F. Kishalı.(2004). 49. Avrupa Greko-Romen Güreş Şampiyonasi Müsabaka Teknik Analizi / A Technical Analysis for Competitions of 49th 15. Europan Greco-Roman Wrestling Championship. Beden Eğitimi ve Spor Bilimleri Dergisi / Journal of Physical Education and Sports Sciences.Volume 6, Issue 3.
16. Sharratt MT, Taylor AW, Song TMK. A. (1986). Physiological Profile of Elite Canadian Freestyle Wrestlers. Can J Appl. Sports Sci,11:100–115.
17. Stupka N, Tarnopolsky MA, Yardley NJ, Phillips SM. (2001).Cellular Adaptation to Repeated Eccentric Exercise Induced Muscle Damage, J Appl Physiol.91:1669-1678.
18. Wallach A.(2000). Interpretation of Diagnostic Tests. Seventh Edition. Philadelphia, PA: Lippincott Williams & Wilkins.
19. Wals B. Tonkonogı M. Malm C.(2000). Effect of Eccentric Exercise on Muscle Oxidative Metabolism in Humans. Medicine and Science in Sports and Exercise. 33(3):1067–72

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