

**Research Article**

## **EFFECT OF CONSUMING IBUPROFEN ON SENSE DUE TO DELAYED ONSET MUSCLE SORENESS IN YOUNG MEN**

**Seyed Abdol Afzali and \*Asghar Nikseresht**

*Department of Exercise Physiology, Jahrom Branch, Islamic Azad University, Jahrom, Iran*

*\*Author for Correspondence*

### **ABSTRACT**

Delayed onset muscle soreness is muscular pain which is occurred after eccentric exercises. Aim of present research is study about effect of consuming ibuprofen on indexes (DOMS) after eccentric exercises. 20 young people in age range of 17 to 18 participated in present research. Triables were in form of two practical group (2400 mg of ibuprofen, n=10) and false drug (in the same amount, n=10) were used. Pain due to soreness, motion range of knee, power in masculine in leg, was measured before, immediately after and 48 hours after eccentric exercises. Masculine pain, in both group, immediately after eccentric exercise was increased and knee's motion range in both group, immediately after eccentric exercise meaningly was decreased ( $P<0.05$ ). Ibuprofen consuming causes reduction in amount of pain and meaningly increases of motion range than after eccentric ( $P<0.05$ ), but it had no sensitive effect on improvement in masculine power. Generally, consumption of ibuprofen is effective on regulation of DOMS indexes, after eccentric exercise.

**Key Words:** *Delayed Onset Muscle Soreness, Eccentric Exercise, Motion Range, Muscle Power, Ibuprofen*

### **INTRODUCTION**

Delayed onset muscle soreness for novice and for professional sportmen, is a familiar event. Effect range and indicators of such soreness varies from sensitivity and fervor to intoreable pain. Research shows that, execution of such unusual exercises or exercises which one's body has no addict for it, cause delayed onset soreness and cause some changes in amount of some special anzyme of blood, reduction in motion range and cause pain and fervor (Cox *et al.*, 1991).

When DOMS (Delayed onset muscle soreness) occurs; if body again starts to act before improvement, risk of more severs harms increases. Indirect indexes of muscle injuries, such as pain, muscle tightness, 24 to 48 hours after exercise, are: reduction of muscle power, elbow motion range, and peak poin of muscle torque and liberation of few proteins in muscle and fervor factor in blood (Armstrong *et al.*, 1983). Researchers preferred application of contradiction eccentric exercise models for studying about DOMS effects and they often refer one of soreness's reasons to microscopic damage which is occurred consequently after eccentric contradictions (Armstrong *et al.*, 1991). Answer to damage is fervor, inflation, and pain which is slowly happens after exercise (Armstrong *et al.*, 1991). Various damages reported after exercises are such as: Collapse Sarkulma, inflation in Sarkutobular, deformation of contradiction constituents, cell skeleton damage, and matrix abnormality of miofiberly outside of cell, and emerge of muscle fibers in Z area (Bansil *et al.*, 1985). According to present information about delayed onset muscle soreness after exercise, in addition of muscle pain, motion range of organ is also highly decreased.

Many people tried complementary and paregoric for decreasing soreness and pain effects. Application of vitamin C and vitamin E complementary is introduced as an effective factor for alleviating of pain. In addition of complementary, consumption of some paregoric such as aspirine, acetaminophen, and ibuprofen also are prevalent for reduction of DOMS effects. However, generally, all of these substances have some anti fervor properties, but their effects for alleviation of DOMS effects have been remained for more discussions and up to now, best substance for fast elimination of DOMS effects has not been defined. Ibuprofen is a non-steroid and anti fervor drug which its consumption is recommended for

### **Research Article**

alleviation of muscle fatigue and soreness due to sport exercises. Although it is mentioned that ibuprofen prevents from production of Prostaglandins and decreases Neurophil activities, (Bobbert *et al.*, 1986) and reduces Lysosomal enzymes of cells, (Byrnes and Clarkson, 1986) but its effect on improvement of delayed soreness effect is not clearly defined. For example, Peterson *et al.*, (2003), mentioned that consumption of 1200 mg of ibuprofen has not meaningfully affected on amount of fervor and pain due to eccentric contradictions in young men (Peterson *et al.*, 2003). Stone *et al.*, (2002) also showed that consumption of 400 mg of ibuprofen was not effective (Stone *et al.*, 2002) in reduction of pain and motion range of arm pivot after delayed soreness due to eccentric contradiction.

For verifying of two previous researches, Danely *et al.*, 1990 also mentioned that consumption of 600 mg of ibuprofen could not be effective for reduction of pain and aggregated Kinaz kratine level due to delayed soreness because of running in downhill by young non athletic men (Donnelly *et al.*, 1990). Although, Tokmakids *et al.*, (2003) showed that consumption of 400 mg of ibuprofen has reduced Kinaz kratin level due to delayed soreness as result of eccentric exercise of elbow. However, it was not effective one motion range increase (Tokmakids *et al.*, 2003). Delayed soreness is more prevalent in early of season, when sportmand do exercise after a time of rest. In addition, this is observed in novice people who had high exercises, without considering that they are in which season of train-exercise (Donnelly *et al.*, 1988). In spite of many researches which is done for understanding of DOMS, but its initial mechanism, its effect on sportman's performance and cure way for it, are not yet completely understood. If soreness occurs for person so soon, and before again recovery start to act, risk of more sever damages increases. But, many methods such as, cure massage, cold and electrical cure, ultrasound, and application of anti fervor non steroid drug and also consumption of some vitamins are recommended for alleviation of DOMS and its effect, but which way is better, is not clear. Today, ibuprofen is mentioned as a anti fervor non steroid drug which its consumption is effective in reduction of muscle fatigue and soreness due to sport exercise. However, some researches says ibuprofen consumption in reduction of effects due to DOMS is effective (Bobbert *et al.*, 1986; Byrnes and Clarkson, 1986; Cox *et al.*, 1998), but some other donot verify such subject (Byrnes *et al.*, 1985; Heung *et al.*, 2003; Clarkson and Newman, 1995). Therefore, more knowledge about DOMS emerge mechanism, knowledge about its effects and finally, study and accurate definition of ibuprofen consumption on DOMS needs some researches about this field. In present research it is tried to clarify effects due to DOMS and effect of ibuprofen consumption on them.

## **MATERIALS AND METHODS**

### **Methodology**

This research is semi-practical and applicable type which its statistical society is all healthy 17-18years old students in Shiraz city who had no (effective for this research) disease, had no sport experience or consumption of sport complementary, specially asprine, ibuprofen or anti-sensitivity, and they are randomly separated in two 10-member group of ibuprofen consumption (age  $17/5 \pm 0/52$ ) and false drug age ( $17/4 \pm 0/51$ ).

### **Caffeine Consumption Control by Triables**

Since caffeine affects on paregoric absorption, it was requested before studying about triables, that during usage of ibuprofen, they prevent from consumption of caffeine containing substances such as, chocolate, tea, coffee, Nescafe.

### **Method for Executing of Eccentric Test and DOMS**

According to studying about internal and external existing sources, since there are many researches in relation with studying about effect of soreness in types of eccentric, isotonic, isometric contradiction in various muscle groups by exhausting exercises for hand and wrist muscle, stamina running, downhill running, and working with static bicycle. In this research, for studying about soreness effect, step test schedule was used. For this purpose, according to leg length for each triables, some platforms were considered which their height is 110 percent of length for each triables' leg. It should be mentioned that

### **Research Article**

each person was going upward and downward one time by right leg and one time by left leg. A metronom was used for setting each step (Riasati *et al.*, 2010).

After finishing of eccentric test, persons in practical group used 400 mg ibuprofen for 48 hours by 8 hours spans, whereas control group, used false drug. For this purpose, 400 mg ibuprofen and 400 mg sugar were placed in empty capsules, and they were prepared for triables. It was requested from all triables that they use capsules 48 hours after eccentric exercise in 8 hours spans. Therefore, practical group person, during this time, used 2400 mg of ibuprofen and control group members used the same amount of false drug.

Related measurement for body weight, body mass index, fat mass, fat percent, and mass without fat, from body composition analysis, and by application of analyzer equipment, Boca XI made in Korea, were measured.

For measurement of amount of pain and soreness due to exercise, it was requested from triables to complete questionnaire of Talag's (Talag, 1973) pain sense before, immediately after and 48 hours after finishing eccentric. In reformed Talag's mental scale, zero score means absence of the pain and number 6 indicates maximum pain which someone felt after exercising.

Motion range amount of pivot in right and left leg were defined by meter-rul. For this, person lied down on his stomach and stretched his legs. One meter-rule was placed in external axis of leg bone and in along with leg's tubercle and center of meter-rule was placed on external candil of leg. Another leg of meter-rule was placed on external axis of thin part and in along with outer ankle and amount of fluctuation in elbow was measured (ACSM, 2005).

For measurement of four-head leg-muscle powers in triables, simple vertical jump test (Sarjent test) was used. Each person after preparing himself, jumped three times and best one was recorded. Peak power in four-head-leg muscle was calculated by Luise formula (Harman *et al.*, 1991).

### **Statistical Analysis**

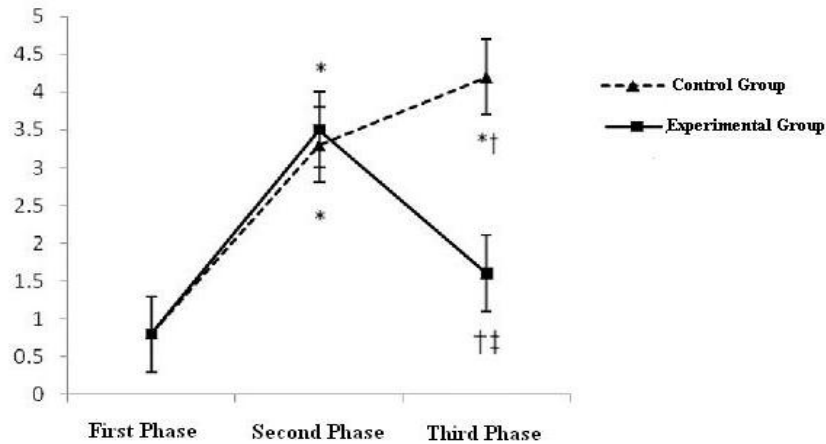
For studying about homogeneity of groups in various variables, Kulmogrove-Smironove test was used. Since any significant difference between groups, considering various factors in pretest, was not observed, parametric test was used. In present research, for studying of average difference of variables, t independent test and variance analyzing by repeating  $2 \times 3$  ( $2 \times 3$  repeated measures ANOVA) analyses was used. All of tests was done in meaning level of  $<0/05P$  and by SPSS, version 17.

## **RESULTS AND DISCUSSION**

### **Results**

Comparison between muscle pain and soreness in control and practical triable groups is shown in figure 1. Variance analysis test by repeating measurement shows that, there is a significant change in both groups on amount of muscle soreness and pain during various stages in research ( $F=55/8$ ,  $P=0/001$ ). Pursuing Bonfruni test results shows that amount of muscle pain and soreness in control group, immediately after eccentric test was significantly increased ( $P=0.001$ ) and up to 48 hours after, has the same amount ( $P=0/001$ ), and it is significantly higher in second stage ( $P=0.04$ ). Beside this, pursuing Bonfruni test results shows that amount of muscle pain and soreness in practical group, immediately after eccentric test was significantly increased ( $P=0.001$ ) and up to 48 hours after test was significantly improved in which respect to second stage, pain is significantly reduced ( $P=0.2$ ) and amount of muscle pain and soreness, 48 hours after test was reached to natural status. Also these results showed that pain and soreness has significant reduction 48 hours after consumption of ibuprofen, therefore, ibuprofen consumption has meaningfully affected on recovery in soreness and pain amount.

**Research Article**



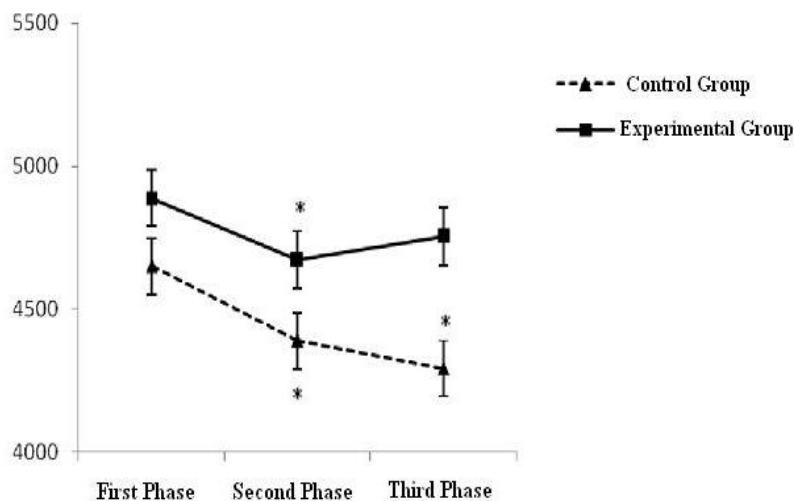
**Figure 1: Changes in muscle soreness and pain amount in different stage of measurement**

\* Significant difference respect to first stage ( $P < 0.05$ )

† Significant difference respect to second stage ( $P < 0.05$ )

‡ Significant difference between two group ( $P < 0.05$ )

Comparison of four-head leg muscle power, in practical and control group in figure 2 shows that, there is significant reduction during different stage of research for both group in amount of four-head leg muscle power ( $P = 0.006$ ,  $F = 7.14$ ). Four-head leg muscle power in practical group immediately after eccentric test is significantly decreased ( $P = 0.02$ ) and up to 48 hours after test it is significantly lower than before the test ( $P = 0.03$ ). However, there is no significant difference between second and third stage in measurement ( $P = 0.1$ ). Bonfruni pursuing test results in practical group shows that, four head leg muscle power, is significantly decreased immediately after eccentric test ( $P = 0.03$ ) but 48 hours after test, it is improved in a way that no significant difference between third and first measurement ( $P = 0.2$ ) was observed. Although since, 48 hours after ibuprofen and false drug consumption, no significant difference in four-head leg muscle between two groups was observed, therefore it seems that ibuprofen has no meaningly affected on recovey of these muscles.

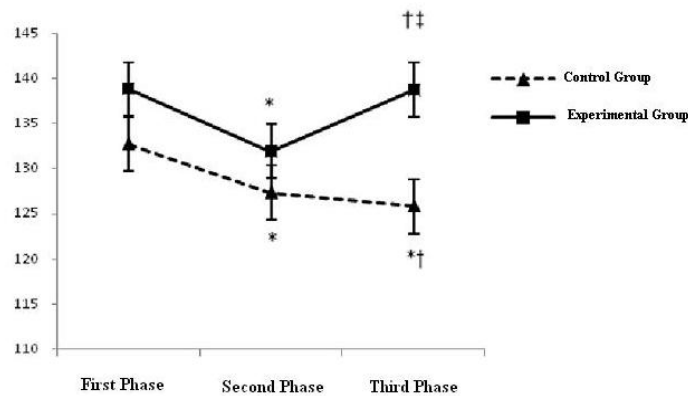


**Figure 2: Changes in power of four-head leg muscle during various stage of measurement**

\* Significant difference compared to pre-test ( $P < 0.05$ )

**Research Article**

Comparison between motion range of ankle in right leg in control and practical triable groups is shown in figure 3. Variance analysis test by repeating measurement shows that, there is a significant change in both groups on amount motion range of ankle in right leg during various stages in research (P-.001, F-30.2). Pursuing Bonfruni test results shows that amount of motion range of ankle in right leg in control group, immediately after eccentric test was significantly decreased(P-0.02) and up to 48 hours after, has the lower amount(P-0.001) than before the test, and it is significantly lower in second stage(P-.005). Besides this, pursuing Bonfruni test results shows that amount of motion range of ankle in right leg in practical group, immediately after eccentric test was significantly decreased(P-0.001), but up to 48 hours after test it was significantly improved in which respect to second stage, motion range of ankle in right leg is significantly increased(P-0.2) and amount of motion range of ankle in right leg, 48 hours after ibuprofen consuming, reached to natural status.



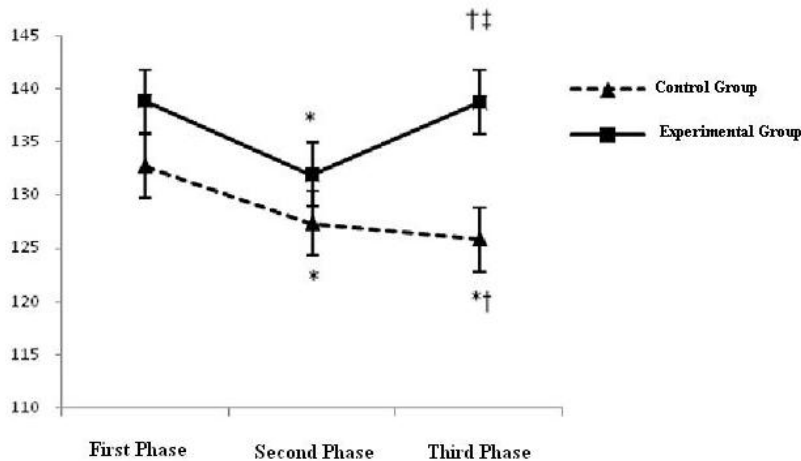
**Figure 3: Changes in motion range of ankle in right leg during various stage of measurement**

\* Significant difference respect to first stage (P<0.05)

† Significant difference respect to second stage (P<.05)

‡ Significant difference between two group (P<0.05)

Comparison between motion range of ankle in left leg in control and practical triable groups is shown in figure 4.



**Figure 4: Changes in motion range of ankle in left leg's elbow during various stage of measurement**

\* Significant difference respect to first stage (P<0.05)

† Significant difference respect to second stage (P<.05)

‡ Significant difference between two group (P<0.05)

### **Research Article**

Variance analysis test by repeating measurement shows that, there is a significant change in both groups on amount motion range of ankle in left leg during various stages in research ( $P=0.001$ ,  $F=32.01$ ). Pursuing Bonfruni test results shows that amount of motion range of ankle in left leg in control group, immediately after eccentric test was significantly decreased ( $P=0.02$ ) and up to 48 hours after, has the lower amount ( $P=0.001$ ) than before the test, and it is significantly lower in second stage ( $P=0.005$ ). Besides this, pursuing Bonfruni test results shows that amount of motion range of ankle in left leg in practical group, immediately after eccentric test was significantly decreased ( $P=0.002$ ), but up to 48 hours after test it was significantly improved in which respect to second stage, motion range of ankle in left leg is significantly increased ( $P=0.02$ ) and amount of motion range of ankle in right leg, 48 hours after ibuprofen consuming, reached to natural status. Also, results showed that 48 hours after consuming of ibuprofen, amount of motion range in elbow of left leg is significantly increased than false drug group, therefore ibuprofen consuming has significantly affected on improvement in motion range of left leg's elbow.

### **Conclusion**

When a sportman, for the first time after a rest period, presents in the first exercise session, he may suffer from the pain in his muscles one or two days after session. But it is worthy to say that, this pain, fervor or disease is not just for sportmen, but novice ones also may face to this pain in the first exercising session in the muscles. Therefore, it is possible to say that, answers which occurred after a harming exercise, usually does not happen in the same session, but they may be postponed. This even is called as DOMS. Various methods, such as massaging, drug, warming, water cure etc. are used for preventing or curing of DOMS. Ibuprofen is one of effective drugs for preventing or curing of DOMS, but results of research which is done on effects of this drug on DOMS is not clear. Aim of this research is study about effect of effects of consuming ibuprofen on sense due to delayed onset muscle soreness in young men.

### **Index Changes for Muscular Soreness and Pain**

Present research shows that there is no special muscle pain or soreness before eccentric test in different triable groups, but immediately after eccentric test, pain and soreness due to exercise in triable of both group was meaningfully emerged ( $P<0.05$ ). These effects after 48 hours, shows increase in false drug group, whereas in consuming ibuprofen group, it approximately reached to its natural status. Muscle pain and soreness difference was significant between two group ( $P<0.05$ ). Present research result is similar to results of some researches such as Rahmaninia *et al.*, (2000), Quiebz (1985), and Michele (1980). Rahmaninia *et al.*, (2000) showed that after two day consuming of ibuprofen, pain due to eccentric contradiction of arm pivot was significantly improved. Quiebz (1985) said that, by consuming of ibuprofen, there is a considerable reduction in muscle soreness during 24-48 hours after exercising. For verifying of results obtained by Michele, it is reported that football players who uses 2400 mg ibuprofen during three days after race, can play in the next game without pain or suffering. Although, Stone *et al.*, (2002), Danely *et al.*, (1990), Grassman *et al.*, (1995), Niman *et al.*, (2006), have not observed useful results in consuming ibuprofen after DOMS occurring. For example, Stone *et al.*, (2002) said that, consuming bromaine and ibuprofen has no significant effect on pain amount of fixer arm muscle after eccentric contradiction. Danely *et al.*, 's research results also showed that after three days consuming of ibuprofen, pain amount due to exercises had no significant reduction in both group of false drug and practical group.

Difference in way of exercising, difference in studied organ, amount of damage due to eccentric contradiction, difference in amount of sample's preparation, and amount and period of ibuprofen is effective in results of such researches. Therefore, difference in obtained results can be related in each of mentioned factor. Clinical studies showed that ibuprofen is so effective on reduction and alleviation of low and average pains, in a way which is reported it reduces pains due to various causes such as muscle, vasculature, pivot, and bursitis pains. Ibuprofen exerts its anti pain property combined with anti fervor effects, but it may reduce pain sense threshold in a local sub skin area. A part of ibuprofen's effect is assigned to its ability for controlling of cyclo-oxygenase and another part is assigned to its metabolic effect, i.e. salicylate, which is done by both cyclo-oxygenase and other ways such as oxygen radical removing. This

### **Research Article**

effect is occurred by permanent blocking of cyclooxygenase enzyme (synthes prostaglandine). Besides this, by consuming ibuprofen, granulocyte connection to vasculature bed is controlled and cause lysosomal stability. White globule of macrophages and polymorphonuclear leukocytes to fever area is also controlled.

#### **Changes in Four-head Leg Muscle's Power**

According to obtained results, it is clear that four-head leg muscle's power had no significant change in control group for triables after 48 hours and also, it was significantly lower than first turn, but in practical group, this was improved to some extent. But since no significant difference between two groups was observed, it seems that ibuprofen has not significantly affected on re-increase of power in that muscle. Just during Quipers research, it is shown that by consuming of ibuprofen consuming, there is a lower reduction in static, eccentric and concentric power during 24 to 48 hours after exercising. In the other hand, Stone *et al.*, (2002) said that, 4 day consuming of ibuprofen has not affected on flexor torque peak of hand after DOMS occurring. Rahmaninia *et al.*, (2000) also mentioned that ibuprofen consuming has not affected on flexor muscle power of hand after DOMS.

Considering low amount of studies in this field, it seems that more researches should be done about effect of ibuprofen on muscle power after DOMS occurring. However, muscle damage and consequently, fever due to delayed onset muscle soreness can reduce muscle power. If drugs can effectively recover muscle damage and soreness, they can also be effective for missed muscle power. Klarkson *et al.*, (1988), believes about power reduction immediately after exercising activity, it is related to both fatigue and/or muscle soreness. They believe that too stretching of Sarkomers reduces power. Stanford said that muscle power reduction due to reduction of depth receiver's power during days after eccentric contradiction, is negatively affecting on muscle-neural performance.

#### **Change in Motion Range of Elbow's Pivot**

Another result of present research is: 48 hours after consuming ibuprofen, elbow pivot motion range in right and left leg, there is a significant reduction on eccentric contradiction, which again significantly improves. Along to the obtained results, Rahmaninia *et al.*, (2000) also showed that after two days consuming of ibuprofen, reduction in motion range of arm pivot due to DOMS effect has significantly improved. In contrast to these results, Stone *et al.*, (2002) mentioned that three days consuming of ibuprofen had not positively affected on recovery of arm pivot motion range reduction after eccentric contradiction. Grossman *et al.*, (1995) also showed in another research that 5 day consumption of ibuprofen had not significantly affected on motion range after eccentric contradiction. Also, Tukmakidis *et al.*, (2003) observed that, motion range of elbow pivot after two day consuming of ibuprofen had not significantly affected on recovery. For justifying of obtained results it should be mentioned that, pain due to feeling a motion chain after eccentric exercises, cause muscle spasm. In this status, Golgi-vestri organs are activated and limit organ's motion. So, motion range in organ after eccentric contradiction decreases. Considering obtained results, consuming of ibuprofen may affect on Golgi-vestri muscles or by elimination of muscle spasm, organ's motion range return to its initial status.

### **REFERENCES**

- ACSM (2005)**. Guidelines for exercise testing and prescription. Philadelphia: Lippincott Williams & Wilkins 57-90.
- Armstrong RB, Ogilvie RW and Schwan JA (1983)**. Eccentric exercise –induced injury to rat skeletal muscle. *Journal of Applied Physiology* **54** 90-93.
- Armstrong RB, warren GL and Warren JA (1991)**. Mechanisms of exercise induced muscle fiber injury. *Sports Medicine* **12** 148-207.
- Bansil CK, Wilson AD and Stone MH (1985)**. Role of prostaglandins E and F2 alpha in exercise induced delayed muscle soreness. *Medicine & Science in Sports & Exercise* **17** 276.
- Bobbert MF, Hoolaer AP and Huge PA (1986)**. Factor in delayed onset of muscle soreness of man. *Medicine & Science in Sports & Exercise* **18** 75-81.

### Research Article

**Byrnes WC and Clarkson PM (1986).** Delayed onset muscle soreness and training. *Clinical Journal of Sport Medicine* **5** 605-14.

**Byrnes WC, Clarkson PM, Hsieh SS, Frykman PN and Maughan RJ (1985).** Delayed onset muscle soreness following repeated bouts of downhill running. *Journal of Applied Physiology* **59** 710-715.

**Clarkson PM and Newman DJ (1995).** Associations between muscle soreness, damage, and fatigue. *Advances in Experimental Medicine and Biology* **384** 457-469.

**Cox SR, Gall EP and Forbes KK (1991).** Pharmacokinetics of the R (-) and S (+) Enantiomers of Ibuprofen in the Serum and Synovial Fluid of Arthritis Patient. *Journal of Clinical Pharmacology* **31** 33-94.

**Donnelly AE, Maughan RJ and Whiting PH (1990).** Effects of ibuprofen on exercise-induced muscle soreness and indices of muscle damage. *British Journal of Sports Medicine* **24** 191-195.

**Donnelly AE, McCormick K, Maughan RJ, Whiting PH and Clarkson PM (1988).** Effects of a non-steroidal anti-inflammatory drug on delayed onset muscle soreness and indices of damage. *British Journal of Sports Medicine* **22** 35-38.

**Grossman JM, Arnold BA, Perrin DH and Kahler DM (1995).** Effect of ibuprofen on pain, decreased range of motion, and decreased strength associated with delayed onset muscle soreness of the elbow flexors. *Journal of Sport Rehabilitation* **4** 253-263.

**Harman EA, Rosenstein MT, Frykman PN, Rosenstein RM and Kraemer WJ (1991).** Estimation of human power output from vertical jump. *Journal of Applied Sport Science Research* **5** 116-120.

**Heung K, Hume P and Maxwell L (2003).** Delayed onset muscle soreness: treatment strategies and performance factors, *Sports Medicine* **33** 145-64. Available: <http://www.ncbi.nlm.nih.gov/pubmed?term=%22Cheung%20K%22%5BAuthor%5DC>.

**Kuipers H, Keizer HA, Verstappen FTJ and Costill DL (1985).** Influence of a prostaglandin-inhibiting drug on muscle soreness after eccentric work. *International Journal of Sports Medicine* **6** 336-339.

**Muckle DS (1980).** A double-blind trial of ibuprofen and aspirin in the treatment of soft-tissue injuries sustained in professional football. *British Journal of Sports Medicine* **14** 46-47.

**Nieman DC, Henson DA, Dumke CL, Oley K, McAnulty SR, Davis JM, Murphy EA, Utter AC, Lind RH, McAnulty LS and Morrow JD (2006).** Ibuprofen use, endotoxemia, inflammation, and plasma cytokines during ultramarathon competition. *Brain, Behavior, and Immunity* **20** 578-84.

**Peterson JM, Terappe E, Mylona F, Lambert WJ and Events F (2003).** Ibuprofen and Acetaminophen: Effect on muscle inflammation after eccentric exercise. *Medicine & Science in Sports & Exercise* **35** 892-96.

**Rahmani-Nia F, Nikbakht H, Ibrahim K and Prdal H (2000).** Effects of selected physical activity and ibuprofen on delayed soreness after intense eccentric contractions, Olympics **1 and 2**.

**Riasati S, Moghadasi M, Torkfar A, Shirazinejad R and Arvin H (2010).** Aspirin may effective treatment for exercise-induced muscle soreness. *BRJB* **4** 206-213.

**Stone MB, Merrick MA, Ingersol CD and Edwards JE (2002).** Preliminary comparison of bromelain and ibuprofen for delayed onset muscle soreness management. *Clinical Journal of Sports Medicine* **12** 373-378.

**Talag TS (1973).** Residual muscular soreness as influenced by concentric, eccentric, and static contraction. *ResQ* **44** 458-469.

**Tokmakidis SP, Kokkinidis EA, Smilios I and Douda H (2003).** The effects of ibuprofen on delayed muscle soreness and muscular performance after eccentric exercise. *Journal of Strength and Conditioning Research* **17** 53-59.