

How to Overcome Muscle Spasm during Sports Activities

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Abstract

One of the problem which often happens when someone doing sports activity is injured. Injury at the time of exercising usually occurs in part of the muscles. one of an injury that often occurs in muscle body is muscle spasms often also called the cramps. The causes of muscle spasms during exercise usually happens because someone is lacking to do warming up or even not doing it first before doing sport activity. This article is aimed to give knowledge to the people about how to overcome muscle spasms before doing sport activity and at the time of doing it. Hopefully with this article, the readers could understand the causes of the occurrence of muscles and aware of how to tackle of muscles spasms when they will do sport activity and to overcome muscles spasms at the time they are doing activity. The best solution to avoid muscles spasms during sport is by conducting the right warming up right before doing sport activity following with stretching muscles. If someone had muscles spasms while doing sport, the first aid to do is to rest the muscular parts as soon as possible, then stretch muscles slowly opposite to the direction of muscle contraction which get spasms experienced and it has to be in line with the heart position due to to counteract the forces of land gravitation and the flow of blood to an artery become slow, the pain in the muscle spasms experienced will be reduced.

Keywords: Muscle spasms, sport activities, warming up & stretching

1. INTRODUCTION

Exercise is very important for our health. It is better to do warm up and stretching before doing exercise. By doing so, one has prepared it's body to be ready to do some activities so he can potentially avoid injury and reduced pain on muscle when doing exercise. One of the injury that mostly happen when doing exercise is muscle spasms or cramp.

Muscle spasm commonly happens to a person who always does physical activities. Physical activities any movement of the body produced by a skeletal muscle that requires an expenditure of energy. Physical activity can be boomerang on human's body when a person doing heavy activity so that will cause the muscle spasm. Muscle spasms usually often experienced by the athletes or someone who performs sports activities. To prevent muscle spasm required warming up and stretching before starting the activity. When someone only doing short warming up and stretching still possibly will experience muscle spasm and cramp.

During exercises or perform physical movements the muscles will also get contraction. The elasticity muscle depends on the blood supply in the muscle. The number of blood is reduce in the cold blood so that will be easily to get injury than the heat muscle (the muscle's warming up). Sport injuries is all kinds of injury occurred either on practice time and in the ordinary exercise. Injury that often happens is bone, muscle, a tendon and ligament. Therefore, based on the problems above. The writer is encourage to write a scientific article overcome muscle cramps during exercise in order to provide the knowledge and solution of the muscle spasms problems when someone doing sport activities.

The aim of the article is to give knowledge to people on how to overcome muscle spasms properly during sports activities and how to overcome muscle spasms. Hopefully this article can be useful for the reader to find out some factors that cause the muscle spasm and to find out the best way to handle it in time.

2. THEORETICAL STUDIES

2.1. Muscle Spasms

Muscles in human body is composed by muscle fibres. The sum of muscle in human body are half of its body. The main function of muscle is contracts (elongated and retracts) so in its functions the muscle contracts can do the movement. With its muscle contracts hence someone able to carry out or do other activities such as walking, holding, throwing etc.

As described by Syarifuddin (1977) that muscle contraction causes by stimuli or come together from nerve adjacent. Therefore, when the muscles always move regularly by itself, it will reacts and getting bigger and growing stronger. When people do activities, in this case is moving, then the muscle will do its contraction influential well as on the heartbeat. When it contracts, the heartbeat will increase quickly hence circulatory or blood stream will flow quickly as well, which is necessary to dispatch glycogen and astringent oxygen to the muscles.

Frequently happen when doing exercise, people having muscle spasms, this is because some muscle fibers can not have relaxation. Due to blood supply muscle fibers bankrupt because blood vessels flanked by those unrelax muscle. It is causing neuromuscular tension and inflict pain on some area or certain muscles. Muscle spasms is continuously contraction experiences by a muscle or a group of muscles and resulting pain. The cause of muscle spasms or cramp is due to the muscles are too tired, Lacks of warming up and stretching up and any interruption circulation of blood to the muscles, generates muscle spasms in particular. It is also caused by neuromuscular nerves, this is to be expected by declining excitative that increasing impulse frequency on certain muscles.

Study of Arsani et al (2014) about training how to handle injury sports for coach or badminton athletes, explained that muscle spasms is the most often experienced by sportsmen, that is why is not immediately clear. There are several factors affecting this muscular spasms :

1. At the time muscles experience fatigue and suddenly stretching, then they unwittingly going to stretch in full and this can lead to the cramps.
2. Imperfection of body biomechanics because there is not go in line parts of the lower leg, or because of a muscle that too tight.
3. Lack of some kind of certain minerals as sodium, potassium, iron and phosphor.
4. Because of the limited blood supply in the muscles, causes the cramps.

It caused race tension in the nerve muscle. The race tension of muscle nerve has to be immediately stopped by conducting stretching gradually. By doing stretching will stop or block that nerve race. Thus, to reduce pain and then the muscle fibers relax as well. Therefore, the first aid which have to do when someone having muscle spasms is stretch the muscles slowly, and must be remembered that the principle to handle muscle spasms is to pull a muscle that contract opposite to the direction of muscle contraction. Mirkin and Hoffman (1984) in previous research related to sport health explained that the structure of tissues in the body often gets injure when exercising are muscles, tendons, bones, joints, ligaments and fascias. furthermore,

Arsani et al (2014) explained also in his research when someone gets injure during exercising can be divided based on weight casually, namely :

1. Minor Injury: is an injure without mean damage to our tissue body. For example : stiffness of a muscle and fatigue. In this injury, it does not need any treatment, and will heal itself after taking a rest for a while.
2. Massive injury: is a serious injury, where wounded we find the damage tissue in our body. For example: torn muscle, ligament, and a fracture or broken bones. The criterias are : a). Losing substance or continuity, b). The damage or the torn of blood vessels, c). Localized inflammation.

Therefore, doing warming up is important to do. so that the muscles get flexibility affects the stimulate of blood vessel and respiratory. After doing warming up advisable to do stretching up to get the best result and to reduce injury risk. Thus, the body will be ready to do physical or sports movements. Finally, the accident and the injury will not possibly happen. As explained by Sumardjuno (1992) appears that hemoglobin doses quicker and definitely perfect if the temperature is up. Similarly oxidizing process will be increase on a muscle that work actively. The hemoglobin existence which is addition of oxygen in skeleton muscles and heart muscle will also reduce a rise in a higher temperature.

A rise of temperature also will reduce the viscosity of internal muscle protoplasma, so that can improve the efficiency of muscles contraction mechanism. Muscles can contract quicker and harder if muscle temperature a little higher than body temperature. But, if muscle temperature lower than a normal body temperature, muscle plasma viscosity will increase. As a result that muscle will get slower and less contract.

2.2. Sport activity

Sport activity is human physical activity that influences to the human personality. Certainly the physical activity in sport is an activity demands certain physical ability to use the body thoroughly. As explained by Mariyanto (2010) on its scientific study about the benefit of warming up in exercise sport explained that physical activity that people do leads to body motion that do regularly called as a sport. Doing sport benefits to salubrious body and to ensure organs healthy. Everyone has different ways to do sport activity depends to a lifestyle and other factors. Basically, sport functions is to keep, increases and balances physical and spiritual health system at once increases togetherness and competitiveness among people or individual.

Mariyanto (2010) also explained that those who do sport, still do not know whether what they do can stimulate their physical organs or not. This thing must be understood so they who do sport activity has value or purpose. In general sports is expected to keep health and to boost their body fitness. According to Kenneth (1983) the sport activity based on virtue oxygen consumption, divides into two activities which are aerobic and anaerobic.

Aerobic is the activity that needs oxygen, while anaerobic needs physical activity and does not need oxygen. Whereas according to Soebroto (1977) kind in sport activities divided into three Categories:

1. Health sport. This sport activity is to maintain to keep or recover health. The activity of this sport is taken organ functionalization principle to support which is boosts organs to get over back to its function.
2. Recreation sport. Recreation in sport is recreates. More precisely called as a recovery balance, as the meaning and the purpose of recreation. This activity helping to restore a balance until someone being reinstated dynamic with the spirit to do daily activities. Recreation can be as game exercises and match which has easy rules such as achievement sport. It also can help someone in reduces anxiety and anger controls.
3. Achievement Sport. It purposes to increases someone achievement which is called an athlete. The achievement is someone's appearance in sport itself. The purpose of it is an absolute namely the purpose will be achieved if an athlete could bring trophy or medal as an achievement result in following a game.

2.3. Warming up and stretching

Warming up is one of the basic parts of beginning program which are consists of physical activity sequences before do sport activities. It is very important to do warming up before do sport activities, because it is useful to adjust between physical and spiritual when doing sport activities. Warming up should be done in the right steps, firstly do warming up before doing sport activity followed by doing stretching up intended to make muscles, which are stiff and tense, get ready to do the other steps of sport activity. There are three bases of warming up that can be used in preparing doing sport activity, each of them are effective to heat rectal and muscle temperature. Those are (Arma, 1981):

1. Passive. On this type, warming up is conducted by an external thing, such as a warm bath or sleep with a warm pillow.
2. Nonspecific (general). Body temperature heats with some large active muscle movements, e.g. gymnastic, which is not directly associated with muscle components and nerve that will be used in doing sport. an excess of this type is heating body temperature increases more effective than passive.
3. Specific. On specific type, warming up is devoted to part of muscle and body nerve that will be used upon sport activity. For example, a weightlifting athlete will prepare maximum capacity at benchpress match. Then he must do warming up from the lightest load then gradually to the maximum utmost limits (approximately 70-80% of maximum load).

Mariyanto (2010) on his scientific study exposed about warming up techniques. According to him, warming up and stretching up is an integral. But there are a number of factors determined elections and limits the type of warming up. Those factors are the existence of relation between technique, determinant, and consideration to do effective warming up. There are various warming up technique can be used to increase the local temperature or the entire body to prepare some exercises, e.g:

1. passive warming up. here involved kinds of tools from external of body to increase body temperature. Which include diathermy (current, flow, or vibration electricity to heat inside part) heating attached, steam baths, sauna, and hot showers or hot bath. Although just a few of athletes do that, the appearance or physical performance will be raise than do not do that. If body temperature.
2. General warming up. Warming up process with intensity exercise must be improved gradually, which is to increase organism capacity works through the autonomic nerves system functional augmentation, which later the process of metabolism extend thoroughly will occur more quickly. As a result the flow of blood will get increase, body temperature will increase and it will stimulate the respiratory center, so that lead to increase of supply O₂ on organism. The increasing of supply and bloodstream will expand the potential of organism work, which can help athletes go on strike work more effectively. As increase body temperature of the movement, it is also followed by the increasing of muscle groups temperature effectively.

The exposure of Mariyanto about those warming up techniques are supported by the research of the Ariani (2011) said that in every implement exercise, there are three steps to do namely warming up, exercise, and cooling down. exercise should be started of a large muscle group then continue to a small muscle group. Warming up also aims to increase body temperature and bloodstream to an active skeleton muscle. In its implementation, warming up is not necessary take in a long period. It is around five to fifteen minutes enough for making body sweating and breathing in, as a sign that metabolism increases and body is ready to follow the next exercises.

The increasing of tissue temperature which is produced during warming up will reduce muscle injury possibility (Junaidi, 2013). Untreated muscle will make blood volume become low as it easily to get injury or damage compare to high blood volume. Movement space around joint motion also increases to the higher

temperature due to the increasing of extensibility from tendon, ligament, and other connective smooth muscle tissue.

So, it is very important for everybody, after doing warming up also have to do consecutive movements to increase flexibility by conducting stretching up regularly. Study result of Nurdianti et al (2015) stated that stretching up can help increasing strengthen muscles flexibility and affecting nerves. It is also helps to keep body health and fit in a long period. In addition, this exercise increases blood circulation and oxygenation cell because it emphasis to constructs the lower muscle back method so it become relax and stonger. By doing stretching up exercise reduces lack of oxygent cell symptom which causing the rise of lactic acid that can inflict of pain.

Study research above supported by previous research conducted by Putra et al (2014) about stretching up exercise influence against back pain complaint stated that it exercise can reduce joint sprain and muscle injury (spasms), back injury, tension muscle and pain in muscle.

Stretching up has the benefit for someone who has done the warming up as explained by Suharjana (2013) in his study expressed that the benefit of stretching up exercise improves physical fitness, because stretched muscles will facilitate substances transportation needed by our body so that the body become fit in order to reduce joint and muscle injury risk. It is because of the range of joints movement is wider and the muscle is more elastic. So the possibility of joint injury or muscle become smaller.

3. DISCUSSION

3.1. Warming Up and Streaching Of Prevention Muscle spasms

Warming up before doing exercises is an activity to slowly increase heart frequency, so there is enough time to fill the working muscle with blood that full of oxygen. Having enough warming up can prevent muscle injuries, a tendon, and ligament. Therefor, it is possibly advised for individuals to do warming up before doing exercise.

The body temperature will increase By doing warming up, that is why its become a factor that easily enable people to do exercises. Moreover this warming up will stimulate the system activity of central nervous that coordinate organism system, boost the motorick reaction and coordination concern.

The time and intensity of warming up is very individual, that is depend on physical athletes or others. The increasing of rectal temperature (temperature measured on anal). 1-2 °C is enough to run warming up. An easy way to find out whether the warming up activity is enough or not by the beginning of sweat.

The effective of warming up started from the lowest to medium and and around 15-30 minutes.on the other hand, a person should occurs his body temperature to determine the optimum time. It can be seen by the sweat appears from the body. The instrument that generally used in warming up is the activity of the muscle itself and where people do their various exercise also use the sports uniform, dry and warm.

Warming up before doing sports activities is necessary to conduct because the organism system when resting time has a certain inersia and someone should not letting efficiency of one's function that can be increased suddenly. This matter is similar to explanation described by Taylor and Taylor (1997) when muscles are too fatigue, the muscle will stretch suddenly and quickly that will cause muscles spasms and cramp. The muscles spasms happen because of the unstability of body mechanical, unsincronized lower leg or the strengthen muscle. As a matter of fact, muscle spasms happens because of the accumulation of lactic acid in the muscle due to exhausted condition. To avoid possible injury during exercise , someone has to do warming up movement which begins by running slowly and some variation to move to the side, backwards and also forward. Those movements can boost blood circulation also speed up the body temperature to rise higher to whole body especially to the muscle.

After having run slowly for about 5-10 minutes, and then we have to do calistenik activity start from neck, arm and shoulder, limb and the back side continuously. Next activity is practicing flexibility ending by jumping activity with a light tap and continue to the rest session and muscle relaxation. The body flexibility is needed when doing sport or other activity. Flexibility is the elasticity of the muscle so that its ability can be extended quite far and allows joints to action optimally in normal range and the result of the movement will not cause injury.

A Flexibility is the elasticity of the body to adjust himself in doing all body activity and the extend ability, especially in the muscle ligaments around joints. An Elasticity is needed in doing sport activity and others. If a person has less elasticit, it will result the muscles tention , disturb the important nerve muscle, easily to get injury or muscle spasms and cramp. One of the exercise to adjust body elasticity is stretching that can be conducted after warming up.

In line with the research conducted by Ibrahim et al (2015) about the influence of stretch-and-flex exercise to flexibility explains that flexibility is the capability of joints, muscles, ligaments to move maximumly

and freely. The less flexibility can cause slow movement and vulnerable to get muscle injury, ligament and other tissue. The best way to improve flexibility is stretching. Therefore, doing enough warming up and stretching can reasonably prevent muscle, tendons, ligament and tissues.

Elasticity muscle depends on the sufficient of the blood in the muscle. Thus, the cold muscle is readily to get injured than the heat muscle (warming up muscle). There are some stretching activities that can be conducted to improve elasticity of body muscle in order to avoid muscle spasms namely. The ballistic stretching covers the muscle agonis contraction (inline) to produce stretching faster than muscle antogonis (opposite side). This stretching can be done by adjusting broader movement that reached by the series of tapping and pulling in the muscle tissues. for instance, stretching at once in the muscle of the body between the other part of the back muscle and feet.

Use the table, chair or other thing that has the same level as feet. Stand up facing the table and open your leg as wide as your shoulder and put your hand on the corner of the table and centered the weight of the body around the shoulder. Move some steps backwards until the backbone parallel to the floor. Pull the hip away from the table so the shoulder and belly ar pulled up and down for about 10 seconds.

A static stretching is the stretching done passively in the antogonis muscle wich focus on the maximum position and hold it for a while. The optimal time that allowed to hold the position is various around 3-60 seconds. (depend on the individual ability.) for examples stretch on the hands' muscle: both hands are met and locked up between left and right fingers and opened towards, hold for few seconds. The next movement is stretched up and hold for few seconds, and go backwards for few seconds depend on the individual ability. Technique Proprioceptive Neuromuscular Fasillitation (PNF). This technique is done by others help. Normally is around 10 seconds for pushing step and 10 seconds for relaxations step. Technique hold and slow turning could be done as follows: a person lies on and the knee is straight and the ankle is put 90 ° and bend the hip joint until get a little pushed in the muscle. This tecnique is done by pushing for 10 seconds and stretch it for about 10 seconds. Do it repeatedly for three times.

3.2. Handling muscle spasms during exercise

The areas of the body that vulnerable to get injury are neck,shoulder and hand. It usually happens in the part of the body that feel spasm during exercise is leg. Its because leg is used to support body. It Normally happens when a person doing muscle activity and the (gastrocnemius) will get spasms.to overcome this, is by stretching the muscle slowly. Thesufferer is suggested to sit with the straight leg. The helper takes position beside the sufferer's leg. Hold the sufferer's heel and swing backwards slowly. If the spasms still happen then redo it slowly until the muscle loosen and do massage and give ice cube by putting in the paint part or spraying the spray ice to the spasms. By doing so, the spasms will get better.

Some mistakes that mostly done when spasms are by doing massage strongly to the spasms and hit the spasms. This way is useful but otherwise this will cause torn muscle and become worst. When spasms happen during sports activities, the first aids is to stretch muscle straightly and then swing slowly or bend and stretch slowly step by step until better. Those ways can be done repeatedly by ourself or by helper. According to Hastuti (2013) in her research how to overcome and help the injury says that when helping the sports injury firstly we have to know the injury area and how bad is the injury.

The injury of the muscle when exercise usually appears on the pain, swelling, cramps, bruised, stiff and the limitation of joint movement and the lack of power in the injury area. Before going to the hospital, the first aid is to evaluate the first action and the general condition of the sufferer. To determine wether there is a serious injury problem. after we know that the sufferer is safe, so we continue to do RICE, namely:

1. Rest, to rest the part of the body that get the injury and to avoid getting wider.
2. Ice, to give cold effect in the injury part in order to reduce pain.
3. Compression, to bend the part of the injury in order to reduce swollen.
4. Elevation, to rise the injury part of the body and to reduce swollen.

As mentioned by Arsani and et al (2014) in his research says that the first aid to the sufferer's spasms or athlete is to bring the sufferer to the side and the next steps are as follows do contraction in the opposite muscle (the muscle works directly opposite to the injury muscle). Do gradually stretching starts from the injury muscle, until its reached normal length. Do not tap the foot up, because it will cause the injury become worst.

Do massage, start with soft touch to the heart to fix the blood's flow, if the cramp has getting better. Explanation described by Martin et al (1998) effect sport massage it can serve to stimulate circulation and thus increase the amount of oxygenated blood reaching the muscle tissues. According to Paolini at Bridges and Roos (2014) massage it can serve to stimulate circulation Additionally, massage can decrease heart rate and blood pressure, and alleviate pain. Pain in the myofascial tissues is common for runners due to their long, strenuous

bouts of exercise. Myofascial release focuses on removing tension and tightness from a region of soft tissue, which is commonly caused by a spasm.

Weerapong et al (2005) explain massage might help to rearrange muscle fibres and increase microcirculation. The realignment of fibres helps to reduce muscle spasm that stimulates pain receptors and helps to reduce the pressure on blood vessels. The next steps to handle the injury is to give heat treatment during 24 – 36 hours right after the injury happened. The aim of heat treatment is to break the traumatic effusion or blood plasma liquid that come and out in the part of the injury. Until it can be carried out by vena and limfe, in addition, it can smooth the healing process and reduce pain and caused by muscle spasms.

4. CONCLUSION

When someone is preparing to do sport activity it is required to do warming up and stretching up first to prepare muscle to do activities. Warming up and stretching up very important to level up the muscles temperature and to adjust muscles elasticity those can prevent the possibility injury happen during activities. When the person has muscle spasms during exercise, the first aid is to rest the muscle injury parts as soon as possible because if not it will make the injury worse and more pain. In addition, is to stretch up the muscle slowly opposite of the muscle contraction and in line with the heart position, in order to against earth gravitation, meanwhile the blood flow to the artery become slow and the pain will reduced by itself.

Try to avoid muscle spasms whether during or on going exercise. To overcome muscle spasms during physical activity is do the warming up and stretching up first. If the muscle spasms happen at the glance, the best way is to lift up and to stretch the muscle spasms in line with heart position, in order to against earth gravitation, meanwhile the blood flow to the artery become slow and the pain will reduced by itself. The best way to lift up and to stretch up the muscle spasms that is, it should be conducted slowly and the thing should be remember in doing first aid to the sufferer is prohibited to massage hardly to the muscle spasms. It will cause torn in the muscles tissue or even worse the damage of the parts of the muscle.

REFERENCES

- Arma, Abdoellah. (1981). *Olahraga Untuk Perguruan Tinggi*. Yogyakarta: PT. Sastra Hudaya
- Ariani, Tuti, Luh, Putu. (2011). *Tesis: Pelatihan Menarik Katrol Beban Lima Kg Dua Belas repetisi. Tiga Set Lebih Baik Daripada Sembilan Repetisi Empat Set Dalam Meningkatkan Daya Ledak otot Lengan Siswa SMK 1 Denpasar*. Bali: Universitas Udayana
- Arsani, Alit, Kadek, Ni Luh. Agustini, Mestri, Ni Nyoman. & Sadarmada I Nyoman. (2014). *Laporan Akhir Program Pengabdian Pada Masyarakat : Pelatihan Penanganan Cedera Olahraga Bagi Pelatih Atau Atlet Bulutangkis*. Singaraja : Universitas Pendidikan Ganesha
- Bridges, Emma. & Roos Katie. (2014). *The Impact of Massage on Athletic Performance for Runners*. Colorado University: CWHF Health & Fitness Journal Fall Issue 2014
- Hastuti, Ani, Tri. (2013). *Artikel Ilmiah Pengabdian Pada Masyarakat: Penanganan Atau Pertolongan Terhadap Cedera*. Yogyakarta: FIK UNY
- Ibrahim, C, Renold. Polii, Hedison. & Wungouw, Herlina. (2015). *Pengaruh Latihan Peregangan Terhadap Fleksibilitas Lansia*. Manado: Jurnal e-Biomedik (eBm) Volume 3 No. 1, Januari-April 2015
- Junaidi. (2013). *Cedera Olahraga Pada Atlet PELATDA PON XVIII DKI Jakarta*. Jakarta: Jurnal Fisioterapi Volume 13 No. 1, April 2013
- Kenneth, Cooper. (1983). *Aerobic*. Jakarta: Gramedia
- Mariyanto, Muhammad. (2010). *Artikel Ilmiah : Manfaat Pemanasan Sebelum Olahraga*. Surakarta: Fakultas Keguruan dan Ilmu Pendidikan Universitas Sebelas Maret
- Martin, A, Nancy. Zoeller, F. Robert. Robertson, J. Robert. & Lephart, M. Scott. (1998). *The Comparative Effects of Sports Massage, Active Recovery, and Rest in Promoting Blood Lactate Clearance After Supramaximal Leg Exercise*. Pittsburgh: Journal of Athletic Training Volume 33 Number 1 March 1998
- Mirkin, Gabe & Hoffman, Marshan. (1984). *Kesehatan Olahraga*. Jakarta: PT. Grafindian Jaya
- Nurdiati, Wiwit. Utami, Tri, Gamy & Utami, Sri. (2015). *Pengaruh Latihan Peregangan terhadap Penurunan Intensitas Nyeri Pada Perawat Yang Menderita Low Back Pain (LBP)*. Riau: Jurnal JOM Volume 2 No.1 Januari 2015
- Putra, Adi, Sumitro. & Hamid, A. Nasir. (2014). *Artikel Penelitian : Pengaruh Pelatihan Peregangan Terhadap Keluhan Nyeri Punggung Bawah Pada Pekerja Las di Kec. Sebrang Ulu II Palembang*. Palembang: Poltekkes Kemenkes Palembang
- Suharjana, Fredericus. (2013). *Perbedaan Pengaruh Hasil Latihan Peregangan Statis dan Dinamis Terhadap Keletukan Togok Menurut Jenis Kelamin Anak kelas Tiga dan Empat Sekolah Dasar*. Yogyakarta: Jurnal Pendidikan Jasmani Indonesia Volume 9 No. 1 April 2013

- Sumardjuno, Sadaso. (1992). *Pengetahuan Praktis Kesehatan Dalam Olahraga*. Jakarta: Gramedia
- soebroto, Moch. (1977). *Asas-Asas Pengetahuan Umum Olahraga*. Jakarta: Depertemen Pendidikan dan Kebudayaan
- Syarifuddin, Aip. (1977). *Pengetahuan Olahraga*. Jakarta: CV. Baru-PB PGRI
- Taylor, P, M. & Taylor, D, K. (1997). *Mencegah dan Mengatasi Cedera*. Jakarta: PT. Grafindo Persada
- Weerapong, Pornratshanee. Hume, A. Patria. & Kolt, S. Gregory. (2005). *The Mechanisms of Massage and Effects on Performance, Muscle Recovery and Injury Prevention*. New Zealand: Sports Med