



EFFECT OF PROGRESSIVE MUSCLE RELAXATION ON PAIN THRESHOLD AND EFFECTIVENESS OF FOOTBALLERS' TRAINING

doi: 10.1515/humo-2015-0043

LILIANNA JAWORSKA*, ARLETTA HAWRYLAK, BARTOSZ BURZYŃSKI,
JOANNA SZCZEPAŃSKA-GIERACHA

Department of Physiotherapy, University School of Physical Education, Wrocław, Poland

ABSTRACT

Purpose. Relaxing in the athlete's training process is underutilized. Relaxation techniques, however, should be taught from the very beginning of the footballer's training career. The main aim of this study was to present the effect of progressive muscle relaxation on pressure pain threshold levels and the effectiveness of the footballer's training. **Methods.** A sample of 32 football players participated in the therapeutic program consisting of 8 PMR sessions. Before and after applying a pressure therapy, the pain threshold in the lumbar region was measured by a dolorimeter and the Cooper test was carried out to determine the footballers' level of endurance. **Results.** PMR training did not increase significantly the pain threshold level in the experimental group ($p > 0.05$), but it increased significantly the distance covered in the Cooper test ($p = 0.04$). Analysis of the Spearman rank correlation was also carried out ($p = 0.81$). **Conclusions.** PMR does not lower pain perception threshold. PMR therapy increases the distance measured by the Cooper test. In order to determine the role of PMR in injury prevention, further research is necessary.

Key words: progressive muscle relaxation, pain threshold, effectiveness of training, football players

Introduction

Nowadays football is the most popular team game, played worldwide by almost 200 thousand professional footballers and 240 million amateurs. About 80% of them are men [1, 2]. Young adepts start their first training at the age of 5–6 years enrolling in special football academies established by football clubs from top leagues. The main aim of such schools is to identify new talents, whose demand is growing rapidly due to overseas expansion of the game. As more and more recruited adolescents undergo intense training, the number of injuries among young athletes increases dramatically. Some statistics report that about 44% of football injuries occur at the age of 15 years [3].

Coaches have started to put greater pressure on their team's results. Consequently, each player in the team is psychologically overloaded. It can lead to injuries of the joints, muscles, tendons and fascia. The most common injuries in football are those caused by direct contact with an opponent [4, 5]. Most of the accidents occur in the last 15 minutes of each half when the body is considerably overloaded. This can suggest that exercise can have substantial impact on changes in nervous and muscular systems and stabilization of the joints of the lower limbs [6]. Sporting events (including atmospherics, active participation of the spectators, as well as the sports competition itself) exert, to a great extent, a psychological pressure on the player. Relaxation training in the athlete's training process is a underutilized element. Relaxation should

be taught from the very beginning of the footballer's career. The pressure to be a top player creates stress. In many different sport disciplines already pre-schoolers begin training. This means that the player who has reached a championship level is often not fully emotionally mature. It is not sufficient to have achieved the high level of physical fitness, technical or tactical perfection to reach the championship level in sports competition. Mental preparation plays a fundamental role. The ability to focus attention, emotional control, confidence and quick decision-making may turn out to be key elements of the athlete's training.

Psychological skills training should include: stress management, courage and decisive actions, interpersonal communication, self-confidence, imagination, visualization, mental preparation and concentration of attention [7]. Many studies have confirmed the positive effects of relaxation techniques in sport [8, 9]. Our test was designed to assess the effect of progressive muscle relaxation (PMR) on pressure pain threshold levels measured by dolorimeter and the effectiveness of training measured by the Cooper test – a distance covered by football players aged 15–16 years.

Material and methods

A group of 32 boys playing in the top league of 'Senior Youth' age category participated in the study. Their average age was 15.68 years (± 0.47), mean body weight 58.41 kg (± 4.76).

The main inclusion criteria were as follows: parent/guardian's written consent, age of 15–16 years, member of an association football club, no previous participation

* Corresponding author.

in relaxation sessions. The exclusion criteria included: injuries being treated, lack of a parent/guardian's consent.

The athletes eligible for the experiment underwent PMR training, measurement of pressure pain threshold in the lumbar spine executed by dolorimeter and the Cooper test.

Measurement of pressure pain threshold level and the Cooper test were carried out before the first relaxation session and repeated after eight relaxation cycles approximately at the same time of day. All measurements were made by the same physiotherapist. Relaxation sessions were carried out in a separate room, where participants were lying in the supine position on a comfortable relaxation mat. Each time relaxation was performed following the same procedure in accordance with the requirements of PMR training.

Statistical analysis was made using *Statistica 10* program. Test results were presented using descriptive statistics – the mean and standard deviation. As the analysed data was not normally distributed, in order to determine the significance of differences in the tests performed before and after the applied relaxation, the nonparametric Wilcoxon matched pairs test was used. To analyze the correlation between the random variables Spearman's rank correlation test was used. The level of statistical significance was set at $\alpha < 0.05$.

Results

The level of pressure pain threshold was measured in six points of the lumbar spine (L1, L3, L5) on both sides of the spine: right (R) and left (L). Analysis performed using the Wilcoxon test did not show statistically significant differences for any of the segments of the lumbar spine after eight PMR sessions (Table 1). PMR training did not significantly increase the pain threshold in the sample ($p > 0.05$).

Analysis of the data collected in the Cooper test showed that the distances covered by athletes increased significantly after eight PMR sessions ($p = 0.04$). Also Spearman's rank correlation coefficient was calculated ($p = 0.81$). The only strongly correlated parameters were the results of the two Cooper tests: before and after PMR training (Table 2).

Discussion

This study showed the efficacy of PMR training in increasing effectiveness of football training. Also the results of other authors point to the benefits of this type of intervention. First at all, it leads to anxiety reduction and general relaxation, but on the other hand it raises the pain threshold (and thus reduces tissue sensitivity to painful stimuli). That should lead to an increase in efficiency of training. This study demonstrated a statistically significant prolongation of the distance in the Cooper test but did not prove that relaxation training raises the pain threshold.

Williams and Andersen have shown that various emotional states can affect the risk of injury in athletes. According to their study, the injured athlete has a higher level of anxiety that may reduce their ability to produce a variety of motor tasks and overload the musculoskeletal system [10]. Their tests were also performed on a group of young football players. Players with a higher level of stress overload, in comparison with their competitors with a lower level, had a higher injury risk, directly proportional to the stress level. It can be caused by a reduced ability to respond to the peripheral nervous system [11]. Johnson and Ivarsson showed there was a relationship between physical trauma and somatic trait anxiety. The study was carried out on a group of young football players. It showed that the personality of the footballer can determine, to a great extent, the incidence of injuries [12].

Table 1. Measurements of pain threshold before and after PRM training

Feature	Before <i>M</i> (\pm <i>SD</i>)	After <i>M</i> (\pm <i>SD</i>)	Wilcoxon	
			<i>Z</i>	<i>p</i>
L1(R)	78.1 (\pm 15.9)	78.4 (\pm 16.8)	0.54	0.59
L1(L)	80.8 (\pm 15.1)	80.8 (\pm 14.9)	0.05	0.95
L3(R)	78.6 (\pm 14.2)	78.3 (\pm 15.0)	0.03	0.97
L3(L)	81.7 (\pm 13.3)	82.0 (\pm 13.4)	0.41	0.68
L5(R)	77.4 (\pm 13.9)	77.8 (\pm 14.1)	0.43	0.66
L5(L)	79.2 (\pm 12.8)	79.4 (\pm 12.8)	0.24	0.80

L – the lumbar spine; 1, 3, 5 – number of lumbar vertebrae; (R) – right side of the spine; (L) – left side of the spine

Table 2. The Cooper test results (metres) before and after PMR training

Feature	Before <i>M</i> (\pm <i>SD</i>)	After <i>M</i> (\pm <i>SD</i>)	Wilcoxon		Spearman's rank correlation
			<i>Z</i>	<i>p</i>	
Cooper test	2518.12 (\pm 200.72)	2552.50 (\pm 221.53)	2.01	0.04	0.815941

Junge [13] said that the athlete's emotional stress and fitness level can affect injury risk. A highly annoyed athlete perceives subsequent events as being increasingly stressful. As a result there is an increase in negative feelings such as anger and aggression, and it can lead to injury [13]. The athlete's effectiveness is diminishing. Additionally, younger players during a match are more prone to stress than older ones, which can be the reason why the injury incidence is more frequent among young players [14]. Therefore the study included a group of junior footballers. A high aerobic endurance is essential as it can often determine who will eventually win the match. Having much endurance one can do a lot of things, e.g. bypass, dribble or evade the opposing team player. The Cooper test measures and verifies the maximal aerobic power of footballers. The parameter that determines the distance is maximal oxygen uptake (VO_{2max}) [15, 16].

Higher levels of tissue sensitivity to pain may be associated with the accumulation of tension at one point of the muscle. Benson's [17] study showed a beneficial analgesic effect of PMR. It is believed that when the skeletal muscle afferent endings diminish, the activity of the sympathetic nervous system is reduced [17]. Reduction in pain affliction, according to McGuigan, is associated with a decrease in the neuromuscular activity related to pain perception [18]. In their research, Emery et al. [19] also confirmed that PMR is an effective form of pain reduction. The tests were performed on an objective scale. They consisted in changing the threshold of pain in spinal reflex when a stimulus was applied to the foot [19]. The measurement points (3 cm to the right or left of the spinous processes of the lumbar spine individual segments L1, L3, L5) used in this experiment are selected in many tests. Also Fisher [20] studied pain threshold. He exerted axial pressure on the muscles and ligaments using a dolorimeter. This research was designed to test a subjective sensation of pain. Fisher [20] said that the minimum pressure which causes discomfort or pain in the test expresses the degree of sensitivity of nerve fibres stimulated by some irritating factors. The critical value of oppression was assessed at the level of 4 kg/cm^2 . Feelings associated with a smaller value may be associated with pathologies within the muscle or ligament. According to Fisher [20], trigger points were responsible for the areas where the most intense muscle pain was perceived. He described them as hypersensitive areas within the belly muscle or muscle fascia. Trigger points may result from: microtraumas, stress, trauma, or even fatigue. Also post-operative system disorders and muscle inefficiency are the cause of the formation of these points [20].

In the present study, the average value of pressure pain threshold was about 7.5 kg/cm^2 and that implies the participants did not have hypersensitive pain areas. Perhaps this fact explains the lack of a rise in pain threshold in young footballers under the influence of PMR. The pain threshold in this sample was already at a very good level, and it was impossible to improve something that

objectively was already very good. Probably this can be accounted for by the young age of the athletes. The effectiveness of football training depends highly on the athlete's oxygen uptake and physical fitness. Vempati and Telles showed the effect of PMR training on the lungs [21]. Another important element is the cardiovascular fitness. Lehrer et al. [22] said that biofeedback can have a huge impact on heart rate changes. This interrelationship can improve lung function and the whole respiratory tract. The parasympathetic nervous system is better controlled by the human. Breathing becomes smoother, quieter and more prominent, and as a consequence the body gets more oxygen [22].

It is thought that such factors as anxiety or other emotional states can result in making bad decisions by the player. Such situations can lead to a decrease in the efficiency of athletes [23–25]. Other studies confirmed the usefulness of full PMR used in training football players. Due to the fact that nowadays more and more people are involved in competitive sport, the competition increases. Fierce competition imposes longer training sessions thereby increasing injury risk [26]. PMR effectiveness test could be carried out on a larger sample of footballers playing in the top leagues. In addition, it would be important to increase the duration of PMR and include it as a permanent element of the football training program. Since the number of scientific publications on the possibility of using PMR in this sport is small, there is an extreme need to further research. It seems that the PMR method can reduce the number of injuries in sport and enable individual players to perform at their maximum potential. This technique contributes to reduce perceived stress, which reinforces the feeling of a greater internal control. This may result from better coping with stress and calming the body. It allows players to make a better decision and execute accurately the intended movement. It would be advisable to carry out a similar study on a larger sample and compare to a control group. This would allow for an assessment of the effectiveness of PMR in injury risk. Also the assessment of new variables, the level of anxiety and perceived stress, should be included. In the future, the proposed therapy could also be combined with massage as, according to recent reports, massage therapy quickened recovery and improved post-exercise muscle efficiency and may serve as an effective treatment of muscle soreness. The analgesic effect of massage suggests it should be widely applied in sport, physical therapy and rehabilitation [27].

Conclusions

1. PMR does not reduce perceived pain threshold in young footballers.
2. PMR therapy increases the distance measured by the Cooper test.
3. To assess the role of PMR in the prevention of injury risk, further research is necessary.

References

1. Timpka T., Risto O., Björmsjö M., Boys soccer league injuries: a community-based study of time-loss from sports participation and long-term sequelae. *Eur J Public Health*, 2008, 18 (1), 19–24, doi: 10.1093/eurpub/ckm050.
2. Junge A., Dvorak J., Soccer injuries: a review on incidence and prevention. *Sports Med*, 2004, 34 (13), 929–938, doi: 10.2165/00007256-200434130-00004.
3. Bergeron M.F., Improving health through youth sports: Is participation enough? *New Directions for Youth Development*, 2007, 115 (27), 27–41, doi: 10.1002/yd.221.
4. Rzepa T., Motor activity with a ball vs. education for physical culture as a humanistic and cognitive value [in Polish]. *Studia i Monografie AWF we Wrocławiu*, Wrocław 2009, 94, 8–23.
5. Pop T., Kultys J., Tęcza T., Tabor T., The factors having an influence on frequency of occurrence osteo-muscular system injuries in football players. [in Polish]. *Pedagogics, psychology, medical-biological problems of physical training and sports*, 2008, 12, 152–155.
6. Hiemstra L.A., Lo I.K.Y., Fowler P.J., Effect of fatigue on knee proprioception: Implications for dynamic stabilization. *J Orthop Sports Phys Ther*, 2001, 31 (10), 598–605, doi: 10.2519/jospt.2001.31.10.598.
7. Weinberg R., Gould D., Foundations of Sport and Exercise Psychology 6th Edition With Web Study Guide. Human Kinetics, Champaign 2014, 664.
8. Murphy S., Joudy D., Imagery and mental practice. In: Horn T.S. (ed.), *Advances in sport psychology*. Human Kinetics, Champaign 1992, 280–284.
9. Nideffer S., Sagal M., Concentration and attention control training. In: Williams J.M. (ed.), *Applied sport psychology: personal growth to peak performance*. Mayfield Publishing, Mountain View 2001, 312–313.
10. Williams J.M., Andersen M.B., Psychosocial antecedents of sport injury: Review and critique of the stress and injury model. *J Appl Sport Psychol*, 1998, 10 (1), 5–25, doi: 10.1080/10413209808406375.
11. Andersen M.B., Williams J.M., Athletic injury, psychosocial factors and perceptual changes during stress. *J Sports Sci*, 1999, 17 (9), 735–741, doi: 10.1080/026404199365597.
12. Johnson U., Ivarsson A., Psychological predictors of sport injuries among junior soccer players. *Scand J Med Sci Sports*, 2011, 21 (1), 129–136, doi: 10.1111/j.1600-0838.2009.01057.x.
13. Junge A., The influence of psychological factors on sports injuries. Review of the literature. *Am J Sports Med*, 2000, 28 (Suppl. 5), S10–S15, doi: 10.1177/28.suppl_5.S-10.
14. Rogers T., Landers D.M., Mediating effects of peripheral vision in the life event stress/athletic injury relationship. *J Sport Exerc Psychol*, 2005, 27 (3), 271–288.
15. Weisgerber M., Danduran M., Meurer J., Hartmann K., Berger S., Flores G., Evaluation of Cooper 12-minute walk/run test as a marker of cardiorespiratory fitness in young urban children with persistent asthma. *Clin J Sport Med*, 2009, 19 (4), 300–305, doi: 10.1097/JSM.0b013e3181b2077a.
16. Calders P., Deforche B., Verschelde S., Bouckaert J., Chevalier F., Basse E. et al., Predictors of 6-minute walk test and 12-minute walk/run test in obese children and adolescents. *Eur J Pediatr*, 2008, 167 (5), 563–568, doi: 10.1007/s00431-007-0553-5.
17. Benson H., The relaxation response and norepinephrine: A new study illuminates mechanisms. *Integr Psychiatry*, 1983, 1 (1), 15–18.
18. McGuigan F.J., Progressive relaxation: origins, principles, and clinical applications. In: Lehrer P.M., Woolfolk R.L. (eds.), *Principles and practice of stress management*. Guilford Press, New York 1993, 17–52.
19. Emery C.F., Keefe F.J., France C.R., Affleck G., Waters S., Fondow M.D.M. et al., Effects of a brief coping skills training intervention on nociceptive flexion reflex threshold in patients having osteoarthritic knee pain: a preliminary laboratory study of sex differences. *Journal of Pain and Symptom Management*, 2006, 31 (3), 262–269, doi: 10.1016/j.jpainsymman.2005.07.008.
20. Fischer A., Muscle Pain Syndromes and Fibromyalgia: Pressure Algometry for Quantification of Diagnosis and Treatment Outcome. *J Musculoskelet Pain*, 1998, 6, 1–32.
21. Vempati R., Telles S., Yoga-based guided relaxation reduces sympathetic activity judged from baseline levels. *Psychological Reports*, 2002, 90 (2), 487–494, doi: 10.2466/pr0.2002.90.2.487.
22. Lehrer P., Vaschillo E., Lu S.-E., Eckberg D., Vaschillo B., Scardella A. et al., Heart rate variability biofeedback: effects of age on heart rate variability, baroreflex gain, and asthma. *Chest*, 2006, 129 (2), 278–284, doi: 10.1378/chest.129.2.278.
23. Behan M., Wilson M., State anxiety and visual attention: the role of the quiet eye period in aiming to a far target. *J Sports Sci*, 2008, 26 (2), 207–215, doi: 10.1080/02640410701446919.
24. Vickers J.N., Williams A.M., Performing under pressure: the effects of physiological arousal, cognitive anxiety, and gaze control in biathlon. *J Mot Behav*, 2007, 39 (5), 381–394, doi: 10.3200/JMBR.39.5.381-394.
25. Wilson M.R., Wood G., Vine S.J., Anxiety, attentional control, and performance impairment in penalty kicks. *J Sport Exerc Psychol*, 2009, 31 (6), 761–775.
26. Rahnama N., Reilly T., Lees A., Injury risk associated with playing actions during competitive soccer. *Br J Sports Med*, 2002, 36 (5), 354–359, doi: 10.1136/bjism.36.5.354.
27. Boguszewski D., Szkoda S., Adamczyk J., Białoszewski D., Sports massage therapy on the reduction of delayed onset muscle soreness of the quadriceps femoris. *Hum Mov*, 2014, 15 (4), 234–237, doi: 10.1515/humo-2015-0017.

Paper received by the Editor: May 12, 2015

Paper accepted for publication: November 10, 2015

Correspondence address

Lilianna Jaworska
 Wydział Fizjoterapii
 Akademia Wychowania Fizycznego
 al. I.J. Paderewskiego 35
 51-612 Wrocław, Poland
 e-mail: lilianna.jaworska@op.pl