Impact of strength training on basketball athletes

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Thesis for BS degree
Faculty of Sport and Social Education
Impact of strength training on basketball athletes

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Thesis for BS degree in Sports & Health Science

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June 2020
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This thesis satisfies 5 credits towards a BS in Sports & Health Science in the faculty of Sport and Social Education, University of Iceland School of Education

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Abstract

In this review, various studies and research on the effects of strength training on basketball athletes were examined. The review showed that individuals who added plyometrics and strength training to their regime increased their performance in vertical jump, box jump, and explosiveness. Electro-myo-stimulation or neuromuscular electrical stimulation, which is primarily used in rehabilitation, is also shown to increase muscle regeneration, which leads to higher performance.

Strength training helped increase overall muscle strength and endurance among female athletes who had a high tendency to injure their anterior cruciate ligament (ACL), which consequently reduced the likelihood of injury. Studies concluded that strength training reduced the chance of ankle injury and gains in performance. The overall conclusion from the previous studies is that strength training is an almost essential part of the sport, keeping athletes strong, and helping them to maintain their maximum performance level. Strength training was positively related to better performance, and less injuries. As strength training and plyometric training had virtually no adverse effects, teams at all levels with players ranging from young adulthood to older should implement some sort of strength training combined with plyometric work.
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Foreword

This thesis was written solely by me, the undersigned. I have read and understand the University of Iceland Code of Ethics (https://english.hi.is/university/university_of_iceland_code_of_ethics) and have followed them to the best of my knowledge. I have correctly cited to all other works or previous work of my own, including, but not limited to, written works, figures, data or tables. I thank all who have worked with me and take full responsibility for any mistakes contained in this work. Signed:

Dovydas Strasunskas

Reykjavik, 17. May 2020
1 Introduction

Basketball athletes are at high risk of injury because of intense physical contact in a limited space (Esco, 2020). It is suggested that strength training increases strength and endurance among basketball athletes, which in turn increases performance and reduces risk of injury (Jack Ransone, 2017). It is also essential to know how individual athletes should adapt the strength training regime to their usual practice routine.

During on-season, athletes focus more on endurance and maintenance of the fitness level they developed during the off-season rather than on improving the fitness level (Fulton, 1992). Most basketball teams implement strength training during the off-season, when teams have less stress related to basketball games. There is more time to improve both strength and endurance during the off-season. Adding strength training to the regular training program proved to be valuable in competitive sports in general because it helped athletes to perform at a higher level and prevented injuries (Helming, 2019).

The current study will investigate research outcomes related to the impact of adding strength training to regular training programs for basketball athletes and whether it has any effect on their performance. It will evaluate various studies to provide evidence for the benefit of adding strength training to basketball training programs.

1.1 Style sheet

Basketball is a physically demanding sport and has developed a hugely competitive nature (Jack Ransone, 2017). The competing teams in a basketball game aim to score points by shooting the ball into the opponent’s basket (Siddell, 2014). Two teams consisting of 5 players each play against each other. Players must be skilled in all parts of the game, including dribbling, shooting, passing the ball, defense, and offense against the opponent team. The coach draws up offensive and defensive schemes to help players protect the hoop. Players are not allowed to reach, grab, or stop the opposing player with aggressive physical actions. Players move their feet and slide in a defensive stance to help
contain attackers. The only way to obtain the ball from another player is to grab it without physically harming him/her or block a shot attempt.

Possible benefits of strength training for basketball players are listed below (Scanlan, 2019).

1. Elite players often try to do everything that is possible to help them attain the edge over the competition, and the best way to do so is to implement strength training within the training program.

2. Strength training helps overall health. Increased strength and muscle size are developed by increasing the weights over time.

3. Strength training also helps with the prevention and rehabilitation of injuries, bone density, blood flow, mental health, and confidence.

4. Basketball is closely linked to the individual's athletic performance in short maximum speed sprints and frequent jumps of various levels of intensity, man-on-man contact, and the ability to change pace quickly. Overuse and injuries are common and usually they can be traced to a lack of physical additional training (Decathlon, 2020)
2 Strength training and plyometrics

2.1 General strength training methods for basketball athletes

During the basketball game, athletes use explosive muscular power at their maximum strength levels for short periods of time (Siddle, 2014). Strength and plyometric training can be used in conjunction to develop this ability. Investigations have shown that such training increases the height and explosiveness of vertical jumps if implemented correctly within the training regime (Jack Ransone, 2017).

Many forms of training are used mostly in a combination known as “super sets” which means that a person follows an exercise up with another lighter movement (Tucker, 2016). An example of this could be five repetitions of heavy squats followed by 3-5 explosive vertical box jumps (Wubben, 2018). This enables the body to work on maximal strength and work on jumping while pre-exhausted, which ultimately leads to a higher overall jump with adequate rest and nutrition. (Wuebben 2018) focused on a similar implementation of training by combining plyometrics during on-court practice, followed by weight training afterwards.

One study combined plyometrics during on-court practice with subsequent weight training for 14-15-year-old male athletes for ten weeks. The team underwent strength training followed by plyometrics twice weekly while practicing basketball as well (Santos E. J., 2008). A control group did not participate in the strength training and plyometrics program but continued training basketball regularly. At the end of the training period subjects were tested on the squat jump, countermovement jump, Abalakov test, depth jump from a 40cm box, mechanical power, and medicine ball throw. They were measured before and after the ten weeks training program (Fulton, 1992). Results in table 1 showed that there were significant increases of height in jumps, whether vertically or horizontally (distance). It was noted that this could have been the result of increased strength and also more rigid movements, better neurological responses, coordination, and synchronization of muscles. Also the added strength training improved athletes’ performance on court (Fulton, 1992).
Female athletes have a higher chance of injuring their anterior cruciate ligament than males in sports which involve a lot of landing and pivoting. One study examined whether injury prevention training could decrease the likelihood of injury and instead develop stronger, more robust muscles around the weak areas of the foot (Lim, 2009). They chose 22 high school female basketball athletes and divided them into control and experimental groups. The experimental group was instructed to follow a 6-part training program that lasted for eight weeks and was performed 20 minutes before the usual practice. At the end of the 8-week cycle, the two groups were tested on rebound-jump, differences in strength, and flexibility in some regions of the leg. The research concluded that the experimental group had benefited in all areas of the tests and had increased their strength, endurance and flexibility. This could also lower the risk of other possible injuries such as ACL tear and others (Lim, 2009).

2.2 Strength training for knee extensors and vertical jump performance

Electro-myo-stimulation (EMS), which is mostly used for rehabilitation programs, could be added to training programs to enhance the strength of knee extensors and vertical jump performance in basketball athletes (Maffiuletti NA, 2000). Recently this type
of training has been used in various sports such as cycling and swimming and one study showed 0-44% increases in strength (Huzar, 2020). In this study twenty individuals took part in a four weeks training program and were afterwards tested for quadriceps strength and vertical jump. The study also examined whether the gains could be maintained or increased after another round of 4-week regular basketball training.

Participants were split into a control group and an experimental group. The experimental group was exposed to additional EMS training sessions three times per week in addition to a regular basketball training routine. Results showed that the experimental group had had quite a significant increase in the strength of the knee extensors under eccentric, concentric, and isometric conditions, “the isokinetic strength increased significantly under eccentric and concentric conditions at high velocities but not under concentric conditions at low rates, the isometric strength increased significantly only at the two angles adjacent to the training angle, the squat jump performance increased by 14 % (Temfemo, 2009). Four weeks after the end of the EMS training program, standardized basketball training continued and athletes were able to maintain their isokinetic gain, isometric strength, and SJ performance, as well as enhancing counter movement jump performance by 17 %.

Table 2. Squat jump and counter movement jump performances (Mean values ± SD) for the electro stimulated and control group. Table adjusted from: (Temfemo, 2009).

<table>
<thead>
<tr>
<th></th>
<th>ES</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sj (cm) Before</td>
<td>44.8 ± 1.0</td>
<td>44.1 ± 1.8</td>
</tr>
<tr>
<td>Week 4</td>
<td>51.0 ± 1.3*</td>
<td>46.1 ± 1.8</td>
</tr>
<tr>
<td>Week 8</td>
<td>53.0 ± 2.0**</td>
<td>44.9 ± 0.9</td>
</tr>
<tr>
<td>CMJ (cm) Before</td>
<td>53.0 ± 1.3</td>
<td>51.0 ± 1.3</td>
</tr>
<tr>
<td>Week 4</td>
<td>52.8 ± 1.1</td>
<td>52.5 ± 1.6</td>
</tr>
<tr>
<td>Week 8</td>
<td>62.2 ± 1.2**</td>
<td>51.9 ± 1.1</td>
</tr>
</tbody>
</table>

* ** indicate significant difference from values before training (p < 0.01)

Another research was conducted to see the effects of ten weeks strength training on running and jumping (Helming, 2019). Twenty-six junior basketball players were tested to see the impact of heavy strength training and specific running training on running speed and vertical jump. The players were split into a control group and an experimental group with 13 individuals in each group. The experimental group performed squats and sprints, one after the other. The individuals were tested twice during the training regime after five
and ten weeks. Results showed significant improvements in all areas after both five and ten weeks of additional training. The study also showed that by combining running training with strength training, individuals developed a more optimal transfer of power and strength. (Verkhoshanski and Tatyana 2011) suggest that this is because combined training puts our body’s mechanism in sync with twitch torque and force development to our muscles, which have previously had stress from strength training and use the same pre-exhausted powers to transfer energy in the form of sprint or jump. Our bodies allow us to train the motor units to act in a way where we can adapt the strength gained to an explosive performance (Tsimahidis, 2011).

2.3 Plyometrics as efficient way to develop explosive power

Researcher implemented plyometric training to a usual basketball training routine to see how it would affect the explosiveness of young teenage basketball players. Also, they wanted to see what results would show after detraining and reducing the plyometric training once the initial study was finished (Chris Iliades, 2019).

The experimental group had a 10-week plyometric program assigned during regular basketball training (Santos E. J., 2011). Subjects performed plyometrics twice a week. After the initial study, this group of experimental subjects was divided into detraining and reduced training groups. All individuals were tested before, during, and after the training to measure their explosive power capabilities such as multiple forms of jumps, medicine ball toss, and Abalakov test. Results concluded that the experimental group had a significant increase in performance and was also able to maintain their gains in the following weeks, even with less amount of training. This study showed that basketball training alone has a unique ability to maintain achieved performance increases.
Table 3. Performance differences table.
Table adjusted from: (Santos E. J., 2011).

<table>
<thead>
<tr>
<th>Test</th>
<th>Groups</th>
<th>T1</th>
<th>T4</th>
<th>T8</th>
<th>T12</th>
<th>T16</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJ (cm)</td>
<td>DTR</td>
<td>28.80 ± 4.6†</td>
<td>30.60 ± 4.3¶</td>
<td>29.22 ± 4.2</td>
<td>28.69 ± 3.6</td>
<td>29.71 ± 2.9¶</td>
</tr>
<tr>
<td></td>
<td>RT</td>
<td>29.50 ± 3.9§</td>
<td>31.92 ± 3.9¶</td>
<td>30.97 ± 4.2¶</td>
<td>31.28 ± 4.4¶</td>
<td>31.90 ± 4.7§</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>20.74 ± 3.9</td>
<td>23.32 ± 3.9*</td>
<td>24.94 ± 2.4*</td>
<td>24.06 ± 3.1‡</td>
<td>21.96 ± 3.5</td>
</tr>
<tr>
<td>CMJ (cm)</td>
<td>DTR</td>
<td>34.11 ± 5.7</td>
<td>34.47 ± 4.5</td>
<td>33.63 ± 4.7</td>
<td>33.54 ± 4.5</td>
<td>34.83 ± 4.3</td>
</tr>
<tr>
<td></td>
<td>RT</td>
<td>34.92 ± 4.5¶</td>
<td>37.36 ± 4.8¶</td>
<td>37.84 ± 5.0¶</td>
<td>38.76 ± 5.1¶</td>
<td>39.33 ± 5.5¶</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>28.40 ± 4.0</td>
<td>30.87 ± 5.3*</td>
<td>30.70 ± 4.5</td>
<td>30.53 ± 4.7</td>
<td>28.68 ± 4.9</td>
</tr>
<tr>
<td>ABA (cm)</td>
<td>DTR</td>
<td>39.60 ± 5.2</td>
<td>39.07 ± 4.0</td>
<td>38.50 ± 4.5</td>
<td>38.97 ± 4.3</td>
<td>40.07 ± 4.9</td>
</tr>
<tr>
<td></td>
<td>RT</td>
<td>41.59 ± 2.8¶</td>
<td>43.17 ± 2.9¶</td>
<td>42.49 ± 4.2¶</td>
<td>43.10 ± 4.2¶</td>
<td>44.24 ± 4.3¶</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>34.32 ± 4.8</td>
<td>36.04 ± 5.8</td>
<td>35.85 ± 5.3</td>
<td>35.85 ± 6.2</td>
<td>34.97 ± 5.6</td>
</tr>
<tr>
<td>DJ (cm)</td>
<td>DTR</td>
<td>36.93 ± 3.7¶</td>
<td>38.24 ± 3.1¶</td>
<td>38.81 ± 3.0†</td>
<td>39.46 ± 3.4¶</td>
<td>39.59 ± 4.0¶</td>
</tr>
<tr>
<td></td>
<td>RT</td>
<td>38.46 ± 5.7¶</td>
<td>40.90 ± 4.9¶</td>
<td>40.97 ± 6.6¶</td>
<td>43.51 ± 5.4¶</td>
<td>44.27 ± 5.8¶</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>30.75 ± 4.1</td>
<td>30.86 ± 5.4</td>
<td>32.92 ± 5.1</td>
<td>32.36 ± 4.5</td>
<td>31.51 ± 5.3</td>
</tr>
<tr>
<td>MP (W/kg)</td>
<td>DTR</td>
<td>25.46 ± 5.8</td>
<td>23.69 ± 3.7</td>
<td>24.18 ± 5.1</td>
<td>22.18 ± 3.2</td>
<td>24.54 ± 2.7</td>
</tr>
<tr>
<td></td>
<td>RT</td>
<td>25.78 ± 4.8</td>
<td>24.67 ± 3.0</td>
<td>26.35 ± 3.0</td>
<td>26.0 ± 3.1</td>
<td>27.62 ± 5.3</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>23.14 ± 5.7</td>
<td>22.51 ± 6.2</td>
<td>21.80 ± 5.6</td>
<td>22.91 ± 6.8</td>
<td>22.73 ± 6.0</td>
</tr>
<tr>
<td>MBT (m)</td>
<td>DTR</td>
<td>4.11 ± 0.42¶</td>
<td>4.14 ± 0.41¶</td>
<td>4.28 ± 0.47¶</td>
<td>4.26 ± 0.47¶</td>
<td>4.23 ± 0.46¶</td>
</tr>
<tr>
<td></td>
<td>RT</td>
<td>3.77 ± 0.31¶</td>
<td>3.87 ± 0.27¶</td>
<td>4.13 ± 0.43¶†</td>
<td>4.18 ± 0.33¶†</td>
<td>4.17 ± 0.29¶§</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>3.27 ± 0.35</td>
<td>3.29 ± 0.35</td>
<td>3.19 ± 0.26</td>
<td>3.21 ± 0.41</td>
<td>3.19 ± 0.47</td>
</tr>
</tbody>
</table>

SJ = squat jump; CMJ = countermovement jump; ABA = Abalakov test; DJ = depth jump; MP = mechanical power; MBT = medicine ball throw; DTR = detraining; RT = reduced training; CG = control group.

*Significant difference from T1 to T4 (p < 0.05).
†Significant difference from T1 to T8 (p < 0.05).
‡Significant difference from T1 to T12 (p < 0.05).
§Significant difference from T1 to T16 (p < 0.05).

The plyometrics has often shown positive results (Tsimahidis, 2011). It is yet to be argued whether it increases the performance of athletes who already have a high level of performance. One study used three different groups (Beenakkers, 1982). The control group only participated in regular basketball practices with no additional training. In comparison, the other two groups were subjected to additional plyometric training, which consisted of jumping variously 50cm or 100cm. The maximum vertical leap, force, and the rate of force development in the hip and knee extensors were measured before and after the research. Results showed an increase in all measurements in the experimental groups compared to the control group but there was not a significant difference between the experimental groups (Matavulj, 2001).

Here is a relationship between squats and athletic performance in certain agility-based tasks (Helming, 2019). For optimum performance in basketball, one should aim to attain a physically fit body and focus on anaerobic rather than aerobic performance. Anaerobic
exercise is characterized by quick and powerful bursts such as short sprints, jumps, and heavy lifts (Esco, 2020). Aerobic exercise is mainly endurance training where energy is expended over a longer period such as in long distance running (Fulton, 1992).

In one study, conducted on fourteen elite basketball players, there was a significant relationship between the maximum number of squats (1RM) and performance in 5, 10, and 30-meter sprints. Basketball athletes should emphasize performing basketball-specific agility drills and should implement squats as the building blocks for explosiveness and speed (Chaouachi, 2009).
3 Injury and fatigue

3.1 Effects on basketball fatigue

Strength training is important in all sports. It increases strength, power, endurance, and can help prevent injuries (Link, 2016). Basketball athletes show increases in power and height of their vertical jump while performing additional strength training alongside regular basketball practices during the season (Tucker, 2016). Proper periodization and quantity of added strength training can help, and athletes stay injury-free and perform at their peak level (Link, 2016).

It is commonly believed that lifting weights before basketball can negatively affect one’s ability to compete, but studies have shown that this is not the case. In one study, (Woolstenhulme, 2004) eighteen female members were selected from Division 1 of NCAA. All members had undergone four weeks of strength training prior to the study. They were tested on vertical jump height, anaerobic power, and shooting accuracy on days with no strength training (control) and lifting days, which followed with a basketball practice/game 6 hours later. No significant changes were seen in all measurements, which lead to the belief that there is no harm done to the basketball performance of an athlete who also performs strength training on the same day (Woolstenhulme, 2004).

3.2 Ankle injury rate

Ankle injury can be determined by muscular strength and flexibility in the ankle (Chris Iliades, 2019). One study assessed ankle injury among 11 male college basketball players and 31 female players before the competitive season by measuring the ankle joint strength and flexibility (Helming, 2019). Results showed that ankle injuries could be predicted based on these measurements taken before the nine week-long season, but ankle strength and flexibility failed to determine additional variances. There were no significant differences in ankle injuries between sexes (Payne, 1997).
4 Summary of previous research findings

Strength training has been set forth and used as a basis for training among all athletes for many decades and is almost universally believed to be an essential part of any good training routine. However, the misperception persists that strength training can be bad for an athlete in ways that hurt the individual or harm his performance/alter the shot pattern. Evidence shows that all athletes, including males and females, can benefit greatly in their field of sport and that strength exercises have positive effects on their health as well (Chris Iliades, 2019).

During the season, an athlete experiences a lot of stress on muscles and tendons, and overuse can cause injuries. A well-programmed RT program can prevent these injuries. Stronger body structures function like “shock absorbers” and joint stabilizers. It is important to note that the benefits hold true for both male and female athletes because both sexes had similar muscle size gains. The combination of muscle and connective tissue strength and pliability derived from strength training is crucial in dissipating the aforementioned forces that are so prevalent in both practices and games. Additionally, stronger muscles and connective tissue tend to mend better and at a faster rate when injuries are incurred (Health, 2019). The flexibility improves in an athlete as he/she performs a full range of motion exercises in both eccentric and concentric situations. This allows the muscles to stretch and shorten, thus helping overall strength, flexibility, and mobility of muscles (Esco, 2020).

Maintaining lean muscle tissue is a crucial goal for athletes and anyone who is trying to stay healthy. Limiting the amount of fat tissue through right nutrition and endurance training, improves performance, Excessive fat tissue hinders movement and can also lead to other health-related issues (Welfare, 2019). Every pound of new muscle burns around 30-40 calories a day for tissue maintenance while the body is at rest. Three pounds of new muscle can raise your resting metabolic rate by about seven percent. Thus, muscles play a paramount role in keeping body fat in check. So, even when we are resting and not working hard in the weight room, our thermoregulatory system is so fine-tuned that it works overtime in assisting our body in maintaining our weight goal (Beenakkers, 1982).
Muscle force, when combined with movement speed, equals power. Strength training, in combination with plyometrics and skill work, can ultimately enhance one’s ability to exert explosive control. There should be a focus on progressive overload during each training session (Peterson, 2011). Progressive strength training increases protein and mineral content in the bone tissue. Strength training makes both bones and muscles stronger. To prevent damage, the bones must adapt to the added stress on the body by getting stronger. It is very beneficial for any person to develop strong bones that are more resilient to injury (Bone density, 2020).
5 Conclusion

In conclusion, the studies included in this review have shown satisfactory results to determine that strength training added to a usual training regime for basketball athletes tends to show positive outcomes for physical performance, injury prevention, and prolonged endurance. It is important to note that it is vital for athletes to have strength training in their training program since it does not show any adverse side effects or complications if the program is periodized correctly. It also showed that continued training could help athletes recover quicker and remove weaknesses that might have hindered their performance.

Untrained athletes tend to show a lack of physical stamina when they compete with trained individuals. In the game of basketball, every second counts and the amount of effort and endurance is a key factor for success, which means that more athletic players have greater chances at winning games. Older and more elite athletes tend to be stronger and of bigger build which gives them a natural advantage over younger and leaner players. In the top leagues, this can be seen to have an impact where athletes over the years develop more muscular and more robust bodies which help them increase their overall basketball performance. Studies also note that young adults benefit significantly by starting RT early in their basketball career as it helps them to adapt quicker to the greater physical demand that comes with playing in more professional leagues.
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