Analysis Biomechanics on Three Point Shooting and Preventive Training Strategies For Lower Risk Shoulder Injury

Analisis Biomekanika pada Latihan Menembak Tiga Titik dan Strategi Pelatihan Pencegahan untuk Menurunkan Risiko Cedera Bahu

Original Article

Tania Arlita Safitri Prastiwi* Universitas Negeri Semarang,, Indonesia

Fajar Awang Irawan Universitas Negeri Semarang,, Indonesia

Abstract.

Background	Three-Point Shooting Movement To Reach Effective and efficient techniques to reduce the risk of shoulder injury.
Objectives	The purpose of this study was to analyze the motion of three-point shooting. The research method used was quantitative with a descriptive approach.
Methods	The research method used was quantitative with a descriptive approach. The population used in this study was 20 people, and the sampling technique used was purposive sampling. The sample size for this study was 10 individuals, with the following requirements: they were Dubas club athletes, were in the U-21 age category, and had participated in the Regency POPDA (Sports Activity Development Program).
Results	The results of this study indicate that the average effective shoulder angle during shooting ranges from 108° to 117.5°.
Conclusion	For produce effective and efficient shooting required exercise intense , will but exercises performed Keep going continuously will increase risk of overuse.

Keywords: basketball, shooting three point, biomechaniics, shoulder injury

Received: July 28, 2025. Accepted: August 28, 2025
*Correspondence: taniaasp43@gmail.com
Tania Arlita Safitri Prastiwi
Universitas Negeri Semarang, Indonesia

INTRODUCTION

In basketball, winning A team determined by the number the score printed on each match. The team that wins score most in A match, then team that's what it says as winner. Shooting is technique the necessary basics For print score. This is also supported by the opinion from [1], in his research stated that that shooting has sufficient role important in A basketball game compared with kete rampilan another basis. This is due to through shooting, points For A team will increased. According to [2], a player who can shooting in position wherever is A threat for opponent. There is a number of factor affecting victory A team, including : shooting, turnover (mistakes), rebounding, and free throws. Among the 4 factors the shooting has presentation highest in matter influence victory A team. For can control shooting techniques, required exercise intensely carried out repetitively. The movements performed can be repeated repetitively become one of the factors that occur overuse injuries due to existence imbalance muscles used [3]. For avoid matter said, athletes can combine some strategies such as sufficient recovery as well as practice strength muscle [4].

Biomechanics is one of the clump the science used For learn movement in creatures life [5]. In the field of sports, biomechanics can be one of method in the process of improvement performance athletes. This is in line with research conducted by [6], that biomechanics needed since implementation selection athletes and coaching achievement. One of the method For do coaching performance with do analysis movement reviewed from perspective biomechanics. There are 2 perspectives in biomechanics, namely kinetics and kinematics. The kinetic perspective is classified as difficult study observed. This is due to perspective This focus on the consequences from A the style caused by a movement. While in perspective kinematics , focusing on related data displacement, velocity , and acceleration [7]. The role of biomechanics in evaluate movement is also useful as prevention injury. Opinion This supported by research conducted by [8]; [9], which states that with learn A movement For reach A effective and efficient techniques can prevent occurrence something injury. Through progress technology today , analysis biomechanics can done with easy [10].

METHOD

Study This use method descriptive quantitative For knowing the kinematic data of three-point shooting without give influence. Population in research This consists of from athlete Dubas club in the Regency Magelang, which consists of 20 people. Researchers use purposive sampling technique that aims For choose sample with condition certain, such as : sample is member active Dubas club, is in the category under 21 years of age, and have ever take part in a competition event official minimum POPDA Regency. Number samples that have been filtered of 10 athletes. Research This held on November 8, 2021, which took place at the Ztofia basketball court, District Muntilan, Regency Magelang. Every samples in research This willing For become subject and follow research process with sign informed consent. There is a number of supporting tools study These include : 1) Canon EOS 750D digital camera , 2) Samsung A31 cellphone camera, 3) Camera & cellphone tripod , 4) cone, 5) Stationery , 6) Laptop with application Kinovea. Data collection techniques use observation and documentation. Video analysis every the indicators using Kinovea software version 0.9.4. The results of data analysis using Kinovea Then processed Again using IBM SPSS Statistics Software version 25 for knowing the mean and standard data deviation , minimum value and maximum value maximum on each the indicators . The indicators studied by the author such as , right angles , angles leg angle , shoulder angle , ball height , and height leap . Research This has get agreement from Committee Ethics Semarang State University Health Research with number letter 364/KEPK/EC/202.

RESULTS AND DISCUSSION

[11] state that athletes who can do three-point shooting from side wherever become things to do anticipated by the opponent. The success rate of three-point shooting can influenced by beliefs self, rhythmic movement, and evaluation after do shot. Rhythmic movements consists of from coordination body, balance, and followthrough moment do shooting [12].

Table 1. Three-point shooting

n=10	Information	
	Successful	Unsuccessful
Sample 1		✓
Sample 2		✓
Sample 3		✓
Sample 4		✓
Sample 5		✓
Sample 6	✓	
Sample 7		✓
Sample 8		✓
Sample 9		✓
Sample 10	✓	

Analysis results movement reviewed from aspect kinematics of three-point shooting motion is divided in 3 phases , namely : phase preparation , release phase , and phase follow-through.

Table 2. Release phase

n=10	angle (°)
Sample 1	122
Sample 2	106.6
Sample 3	94
Sample 4	125.4
Sample 5	117.7
Sample 6	110.7
Sample 7	122.9
Sample 8	91.9
Sample 9	136

Sample 10	108

Table 3. Follow-through phases

n=10	angle (◦)
Sample 1	139.9
Sample 2	128.2
Sample 3	121.6
Sample 4	139.9
Sample 5	135.1
Sample 6	125.7
Sample 7	137.8
Sample 8	143.4
Sample 9	145.5
Sample 10	131.2

Discussion

Shooting three points become the only one scoring attack points highest in basketball [13]; [14]. Ability in do shot influenced a number of things , such as: anthropometry (shape physique body), technique shooting , postural stability , and level fatigue [15]. Magnitude shoulder angle is one of the component in technique shooting . Based on Table 2 shows that the angles produced by sample 6 and sample 10 at the moment release phase 110.7 ◦ and 108 ◦ . Findings This in line with [13] who put forward that shoulder angle that produces shot succeed around 117.5 ◦ . Both findings the produce effective shoulder angle moment shooting three points is in the range of 108 ◦ -117.5 ◦ . The shoulder angle is too high big or too small will affect energy transfer when do 3 -point shot [11]; [16]. For getting maximum energy transfer is also necessary strength and power a powerful explosion . When the shoulder angle is too small , then the ball is shot will fall in front of the ring (airball). This can also happen happen If strength muscles in the shoulder are not capable For push the ball up enter to in the ring. Series shooting movement is movement complicated interconnected sustainable , so that execution technique the need experience , expertise and muscle strength . Shoulder injuries are one of the frequent injuries experienced by basketball athletes . Basketball athletes are required For shooting , dribbling and rebounding so that the shoulders are required For do movement with fast and precise in a way repetitive . The movements performed requires the shoulders to can dampen style from outside so that cause joints become No stable [17]. Instability joints can trigger more injuries critical other like damage to the ligaments , subluxation , even dislocation [17]. When shooting , sequence movement of the extremities on will influential to corner trajectory moment ball release and ball rotation . Change small one corners , especially at shoulder angles will give influence to level shooting success . Because of that that , Practice regularly continuously required by athletes For can give knowledge and experience moment shooting from all corner direction [18]. That matter can increase risk injury *overuse* that occurs consequence exercises performed Keep going continuous . Interference pathology of the shoulder joint can give influence to performance athlete [19]. There are 72% of NBA athletes reported suffer shoulder injury and remains endure until retirement , while 24% of them feel that No can reach performance beginning like before injury [20]. 56% of shoulder injuries in NBA athletes are more Lots found on the arm dominant than non- dominant [19]. That matter can happen Because excessive use of one arm . In addition , the dominant arm can also happen imbalance between muscles in the shoulder joint . When shooting , the shoulders do movement flexion accompanied by with internal rotation causing existence *instability* between agonist and antagonist shoulder muscles [21]. Instability this can also increase risk injury to the shoulder [19] joint . Injury to the shoulder will also enlarge risk injuries to other regions such as LBP due to arrangement anatomy from muscles , where arrangement the latissimus dorsi and trapezius muscles which are interconnected intersects on the dorsal medial [22] side.

Risk injury to the shoulder joint can minimized with method notice distance between matches that can influence burden exercises performed athlete [21]. The distance of the match is too long near will demand athlete For train Keep going continuously without pay attention to the necessary recovery For body . Training that only focus on tactics without notice How condition fitness physical athletes will also give influence to performance athlete . When executing a shot, the athlete need combination component fitness physical such as power, strength, speed , agility , and Power aerobic endurance as

well as anaerob [23]. According to [24], found that there is correlation positive in athletes who do bench press with shooting results . When shooting three points, it is necessary corner flexion at the elbow and shoulder. When the ball is about to released , the thrust on the elbow and shoulder will affects the resulting release angle . The release angle when shooting three points more A little compared to moment shooting two points [25]. The resulting impulse can influenced by power from muscle biceps and deltoids. Bench press and overhead press can become alternative exercises that can used For increase muscle extremities on especially in the muscles biceps and deltoids [26]; [27]; [28]. In case athletes who have own history injury , required exercise with evaluate level severity injuries suffered . Found that combination between manual therapy and exercise therapy more give effect positive compared to just exercise therapy [29]. Manual therapy given in the study the in the form of mobilization in accordance with shoulder ROM as well exercises performed is in the category free pain . Isometric exercises can also become alternative For injury I for pain control with notice duration , frequency , location injury , number contractions , as well as response individual to exercise [30].

CONCLUSION

Effective shoulder angle moment shooting three points is in the range of 108^{o} - 117.5^{o} for produce maximum energy transfer . In addition , it is necessary corner large elbow flexion so that can combined with shoulder angle to produce higher release angle low compared to shooting two points. For produce effective and efficient shooting required exercise intense , will but exercises performed Keep going continuously will increase risk of overuse. Strategies that can done For avoid overuse injury is with make sufficient recovery as well as give exercise strengthening of muscles.

ACKNOWLEDGMENT

A big thank you to the co-authors who have contributed to the completion of the manuscript.

AUTHOR CONTRIBUTION STATEMENT

The writing of this article involved roles in devising the research concept and design, reviewing and analyzing relevant literature, and drafting the overall manuscript.

CONFLICT OF INTEREST AND FUNDING

There is no conflict of interest.

REFERENCES

[1] R. A. K. Winata, M. Yunus, and Saichudin, “Analisis Gerakan Three Point Shoot (Studi Komparasi Pada Pemain Basket Kyrie Irving Dengan Sandy Kurniawan),” *J. Sport Sci.*, 2018, file:///C:/Users/User/Downloads/7932-21113-1-SM.pdf

[2] H. Rustanto, “Meningkatkan Pembelajaran Shooting Bola Basket Dengan Menggunakan Media Gambar,” *J. Pendidik. Olahraga*, vol. 6, no. 2, pp. 75–86, 2017, https://journal.upgripnk.ac.id/index.php/olahraga/article/view/668/625

[3] T. Crookes, C. Wall, J. Byrnes, T. Johnson, and D. Gill, “Chronic shoulder pain,” *Aust. J. Gen. Pract.*, 2023, doi: 10.31128/AJGP-04-23-6790

[4] R. Fatchutahman, “Pengaruh Kekuatan Otot Bahu Dengan Latihan Resistance Band Terhadap Ketepatan Shooting Three Point dalam Permainan Bola Basket Pada Siswa Kelas VIII di SMP Aminah Syukur Samarinda Tahun Ajaran 2022/2023,” *Cendekia (Jurnal Pendidik. Dan Pengajaran)*, vol. 11, no. 1, pp. 9–23, 2023, https://cendikia.ikippgrikaltim.ac.id/index.php/cendikia/article/view/224/153

[5] J. Opplertid, C. Paizis, A. Papitsa, A. J. Blazevich, C. Cometti, and N. Babault, “Static stretch and dynamic muscle activity induce acute similar increase in corticospinal excitability,” *PLoS One*, 2020, doi: 10.1371/journal.pone.0230388

[6] B. Kridasuwarso, "Analisis Biomekanika Olahraga dan Belajar Motorik Pada Start Jongkok Lari Gawang," *Pros. Semin. dan Lokakarya Fak. Ilmu Keolahragaan Univ. Negeri Jakarta*, vol. Vol. 1, pp. 17–21, 2016, https://journal.unj.ac.id/unj/index.php/prosidingfik/article/view/8948/5979

[7] H. Ardiyanto and Widiyanto, "Prinsip-Prinsip Biomekanika Kualitatif: Upaya Menjembatani Teori dan Aplikasi dalam Sport Science," *Media Ilmu Keolahragaan Indones.*, vol. 9, no. 2, pp. 54–62, 2019, file:///C:/Users/User/Downloads/17757-58100-1-PB.pdf

[8] F. A. Irawan, S. Sutaryono, D. F. W. Permana, T. R. Billah, and M. A. Ma'dum, "Hand, eye, and foot coordination test untuk mendeteksi kemampuan dasar lokomotor," *J. Sport Educ.*, 2021, doi: 10.31258/jope.3.2.85-92

[9] F. A. Irawan and C. Long-Ren, "Baseball and biomechanics: Injury prevention for baseball pitcher," *J. Keolahragaan*, 2019, doi: 10.21831/jk.v7i1.24636

[10] I Dewa Made Aryananda Wijaya Kusuma, "Analisis Biomekanika Shooting pada Atlet UKM Futsal Universitas Negeri Surabaya Dius Aries Verindo*, I Dewa Made Aryananda Wijaya Kusuma," pp. 101–106, 2021, file:///C:/Users/User/Downloads/upmpko,+dius%20(1).pdf

[11] Darumoyo, "Analisis Biomekanik Gerak Three Point Shoot Klay Thompson dari Berbagai Sudut Dalam," *Jpos (Journal Power Sport.*, 2019, doi: 10.25273/JPOS.V2I2.4830

[12] A. R. Taufik, A. Ma'mun, and M. Mulyana, "Dampak Shooting Three Point Plyometric dan Ladder terhadap Hasil Shooting Three Point Bola Basket," *Gelangg. Olahraga J. Pendidik. Jasm. dan Olahraga*, 2020, doi: 10.31539/jpjo.v3i2.1302

[13] T. Vencúrik, D. Knjaz, T. Rupčić, G. Sporiš, and F. Li, "Kinematic analysis of 2-point and 3-point jump shot of elite young male and female basketball players," *Int. J. Environ. Res. Public Health*, 2021, doi: 10.3390/ijerph18030934

[14] H. Gou and H. Zhang, "Better Offensive Strategy in Basketball: A Two-Point or a Three-Point Shot?," *J. Hum. Kinet.*, 2022, doi: 10.2478/hukin-2022-0061

[15] V. H. A. Okazaki, A. L. F. Rodacki, and M. N. Satern, "A review on the basketball jump shot," *Sport. Biomech.*, 2015, doi: 10.1080/14763141.2015.1052541

[16] T. A. S. Prastiwi and F. A. Irawan, "Analisis Gerak Shooting Three Point Basket Pada Pemain Klub Dubas Di Kabupaten Magelang," *Riyadhoh J. Pendidik. Olahraga*, 2022, doi: 10.31602/rjpo.v5i1.6173

[17] C. L. Martin, A. J. H. Arundale, S. Kluzek, T. Ferguson, G. S. Collins, and G. S. Bullock, "Characterization of Rookie Season Injury and Illness and Career Longevity among National Basketball Association Players," *JAMA Netw. Open*, 2021, doi: 10.1001/jamanetworkopen.2021.28199

[18] H. Okubo and M. Hubbard, "Kinematics of arm joint motions in basketball shooting," in *Procedia Engineering*, 2015, doi: 10.1016/j.proeng.2015.07.222

[19] L. H. Morikawa, S. V. Tummala, J. C. Brinkman, T. J. Crijns, C. H. Lai, and A. Chhabra, "Shoulder and Elbow Injuries in National Basketball Association Athletes and Their Effects on Player Performance," *Orthop. J. Sport. Med.*, 2023, doi: 10.1177/23259671231202973

[20] G. Chetan *et al.*, "Impact of Shoulder Injuries on Quality of Life for Retired National Basketball Association Players: A Survey Study," *Int. J. Sport. Exerc. Med.*, 2019, doi: 10.23937/2469-5718/1510154

[21] C. Tooth *et al.*, "Risk Factors of Overuse Shoulder Injuries in Overhead Athletes: A Systematic Review," *Sports Health*. 2020, doi: 10.1177/1941738120931764

[22] Y. Hagiwara *et al.*, "Upper extremity pain is associated with lower back pain among young basketball players: A cross-sectional study," *Tohoku J. Exp. Med.*, 2020, doi: 10.1620/tjem.250.79

[23] D. Cabarkapa *et al.*, "Relationship between Upper and Lower Body Strength and Basketball Shooting Performance," *Sports*, 2022, doi: 10.3390/sports10100139

[24] J. Dawes, M. Marshall, and T. Spiteri, "Relationship Between Pre-Season Testing Performance and Playing Time among NCAA DII Basketball Players," *Sport. Exerc. Med. - Open J.*, 2016, doi: 10.17140/semoj-2-138

[25] D. Cabarkapa *et al.*, "Kinematic Differences Based on Shooting Proficiency and Distance in Female Basketball Players," *J. Funct. Morphol. Kinesiol.*, 2023, doi: 10.3390/sports10100139

[26] L. Mausehund, A. Werkhausen, J. Bartsch, and T. Krosshaug, "Understanding Bench Press Biomechanics - The Necessity of Measuring Lateral Barbell Forces," *J. Strength Cond. Res.*, 2022, doi: 10.1519/JSC.0000000000003948

[27] A. Busch, X. Sarver, and K. Comstock, "Electromyographic analysis of shoulder-complex muscles performing overhead presses with dumbbell, kettlebell, and bottom-up kettlebell," *J. Bodyw. Mov. Ther.*, 2024, doi: 10.1016/j.jbmt.2023.10.001

[28] C. H. Andersen *et al.*, "Scapular muscle activity from selected strengthening exercises performed at low and high intensities," *J. Strength Cond. Res.*, 2012, doi: 10.1519/JSC.0b013e31823f8d24

[29] S. Tauqeer, A. Arooj, and H. Shakeel, "Effects of manual therapy in addition to stretching and strengthening exercises to improve scapular range of motion, functional capacity and pain in patients with shoulder impingement syndrome: a randomized controlled trial," *BMC Musculoskelet. Disord.*, 2024, doi: 10.1186/s12891-024-07294-4

[30] O. Stefanska and J. M. Jurek, "Impact of isometric exercise on pain management in acute and chronic sports injuries : A systematic review Dampak latihan isometrik terhadap manajemen nyeri pada cedera olahraga akut dan kronis : Tinjauan sistematis," vol. 2025, no. 1, pp. 7–14, 2025, https://journals.khatec.id/index.php/khater/article/view/9/40