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EFFECTS OF STRENGTH AND PLYOMETRIC TRAINING ON EXPLOSIVE POWER DEVELOPMENT AMONG YOUTH VOLLEYBALL PLAYERS

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Abstract

Volleyball is a group of sports dominated by anaerobic conditioning due to the short, explosive movements and high-power output demanded by the sport. An experimental (randomized pre-test post-test control group) design was used among randomly allocated 68 youth project players into four intervention groups. The training intervention underwent for ninety minutes per session 3 times per week; for 12 weeks**.** Then the spike jump, lock jump height in centimeter**,** and standing broad jump distance in meter were measured. The findings showed a significant difference between the four groups (Pre vs. Post) and the combined intervention group scored highest result compared to the other groups. The current study indicated that 12 weeks involvement in training meaningfully enriched explosive power on the performance of young volleyball players. Thus, it is concluded that a 12-week PT and ST intervention with the range of exercise intensity from 60% to 90% can positively impacts explosive power of the lower legs, and thus boosts the vertical jumping abilities.

Keywords: Explosive power; plyometric training; strength training; vertical jump, volleyball.

1. INTRODUCTION

Volleyball is a group of sports that has gained its' place in every competitive stage, depending on speed and explosive actions, such as jumping, hitting, diving and blocking (Marques et al., 2009). The sport is dominated by anaerobic conditioning due to the short, explosive movements and high-power output demanded by the sport. However, games may need to be played for a long period of time (60 to 90 minutes), which is interrupted by numerous brief rest periods (Scates et al., 2003; Polglaze, T., and B. Dawson, 1992).

Apart from this, the physical and technical demands of the sport are not dependent on the playing position of players. For instance, middles were more prone to blocking skills than setters and outsiders (Sheppard, JM., et al., 2009), whereas setters performed modest jump sets and maximum jumps relative to middles and outsiders (Sheppard, JM., et al., 2007).

On the other hand middles demand more spiking, blocking jumping, and landing performance than any other position players (Sheppard, JM., et al 2009).

Generally, the execution of attacks and block jumps is found to vary according to the location of players in the court (Black, 1995). This might be caused by the anthropometric, muscular strength, and power characteristics of volleyball athletes (Marques et al.). Therefore, it is possible to conclude that volleyball players are subjected to various motor activities, such as plenty of vertical jumping and frequent changes in running direction (Forthomme B et al., 2005), and explosive power and strength are two of the determinant physical qualities demanded by the sport (Sheppard, JM., et al., 2008).
That is why this investigation is intended to wards on combined strength and polymeric training to augment explosive power of volleyball players.

Plyometric training is a stretch shortening cycle(SSC) that quick, powerful movement involving an eccentric contraction, followed by rapid explosive concentric contraction (Foqhaa B, Brini S, Alhaq IA, 2021)(Malisoux, L. et al 2006). The training combined strength and speed by including jumping-type exercise such as hooping, counter movement jump, counter jump with hand swinging, drop jump, alternate leg bounding and other SSC exercise.(De Villarreal et al., 2008) Fleck, S. J., & Kraemer, W. J. (2004). In conclusion the polymeric training results a significant and relevant improvement in vertical jump height of players (Markovic G. 2007)

Strength in the arms and shoulders as-well as abdominal and hip are important for fundamental skill, jumping and for offensivee and defensive performance (Zhang, 2010)(Dennis, 2020). In passing the ball, the strength of fingers, wrists, arms, and shoulder are also important (Bizuneh & Dechasa, 2005). Thus the strength training is considered as integral part of volleyball preparation. Strength training is the stimulus imposed by external resistance, which has the aim to develop strength and related aspects, usually using free weight, machines, or own body weight (Mosby, 2009). it is a means of preparing or helping volleyball players to develop performance in volleyball sports (Garzón, 2009).

The new offense and defense roles brought about a need for an intensive study of volleyball abilities, especially the ability of the leg muscles to produce explosive type strength, vertical jump. It's obvious that training changes the spiking/blocking heights of volleyball players. However, the specific training with better effect is not yet reach on conclusion among researchers and coaches (Herrero JA et al 2006, Kotzamanidis C 2006). It's found out that strength training improved explosive power (Ramin A., 2014); (Abebaw, 2019) In contrary to this, Cetin her colleagues concluded that strength preparation has no important effect on the explosive capacity of players(Emel Cetin a *, 2010).

The philosophers model, (Marques et al., 2009) established that only game-based preparation has no important effect on the bodily conditioning characteristics of volleyball players. (Szabó, 2016). The warn that cultivating physical conditioning to influence a sound effect on players' acting are

lively limits behind instructing. The skills were broken in results with various philosopher, thus investigator search for a compromise and to fill the gap of these issues that appears questionable.

One of the primary training goals for any volleyball player or coach is to increase the vertical jump height and have the explosive power (Kang, 2009). Therefore this experimental research is investigate the effectiveness of the eight weeks plyometric, strength and combined plyometric strength training on augmenting of explosive power of U-17 volleyball players.

2. METHODS

2.1 Participant

After written informed consent, 56 male, less than seventeen-year-old volleyball players from a government volleyball project located in Bahir Dar city participated as a study unit in this experimental investigation. Subjects had no regular exercise training one month before the experiment; in science, it's off season for the projects. Apart from this, participants were subjected to fill out a physical activity and redness questionnaire (PAR-Q), and only healthy subjects were recruited. Subjects who had acute or chronic injuries and potential medical problems that compromised participation or performance were excluded. Three project players were excluded from the study by these criteria. To this end, parents or legal guardians and subjects were informed about the experiment, the possible risks, the benefits of participation in the study, and a signed consent form at the beginning of the study. Finally, subjects were randomly assigned to the strength intervention group (SG), the polyometric intervention group (PLG), the combined strength and playometric group (CSPLG), and the control group (CG) by SPSS software.

2.2 Study design

An experimental randomised pre-post-test research design was employed to test the effect of twelve-week polymeric strength and combined polymeric strength training on the explosive power of subjects. After ethical clearance was obtained from Bahir Dar University Human Research Ethics Committee participants (SG, PLG, and CSPLG), intervention sessions lasted from 60 to 80 minutes, four days per week, and for twelve weeks. The plyometric intervention, developed based on previous research (Foqhaa B, Brini S, Alhaq IA, 2021) (Malisoux, L. et al., 2006), includes jumping-type exercise, ball-pass type exercise, and push-up type exercise, whereas the strength intervention consists of squat type exercise, push-up type exercise, plank type exercise, and sit-up type exercise. A training programme consisting of proportional plyometric and strength exercises was developed based on the existing literature. The intervention training was delivered by researchers and two assistance fitness trainers in the morning from 8:00 a.m. to 9:20 a.m.

2.3 Experimental Procedure

After the pre-test (PT) was implemented, participants were randomly assigned to four groups by computer-based randomization. Next, the PT result was analysed by ANOVA to determine whether each group was identical in performance or not. The groups registered no significant difference ($P < 0.5$) in all block jump (BJ), skip jump (SJ), and standing liner jump (SLJ) tests. Having this in mind, the groups were assigned to SG, PLG, and CSPLG randomly by the lottery method.

The SG was subjected to squat, push-up, plank, and sit-up types of exercise training for twelve weeks. The training was designed to address all major muscle groups proportionally, and the load of training was managed by counting sets and repetitions. The PLG also engaged in jumping-type exercises, medicine ball passes, and modified push-up types of exercise in which the load was managed by counting sets and repetition. Whereas, CSPLG was engaged in fifty-fifty present combined strength and polymeric training. The training was delivered four days a week (Monday, Wednesday, Friday, and Saturday) in the morning (8 AM to 9:20 AM) for twelve weeks. Each session consists of a 10’ warm-up, a 5’ stretching 40'main activity (letter in each four weeks it increased by 10’) cool-down, and stretching 5’.

2.4 Testing protocol

Including the control group (CG), all groups were evaluated before (Pre) and after the intervention period (Post) using a test battery performed in the following sequence: block jump (BJ), spike jump (SJ). The validity was proven by Pushparajan (2010), Borges TO., et al. (2017), and standing line jump (SLJ) by Ab Rahman, Z., et al. (2021). After a standardised warm-up, ten minutes of self-selected intensity jogging, and a five-minute mobility workout, subjects were allowed three trials, and the best result was registered as a score of performance. However, all subjects were allowed to become familiar with the test procedures of voluntary force and power production through frequent trials a few days before the actual measurement was obtained. Simultaneously, subjects were aware to take 48 hours of complete rest before the test and not use any stimulants, such as caffeine, eight hours before the test. The testing session was performed in a single session on the costumed training field from 8:00 a.m. to 10:00 a.m. under the same environmental conditions for each group.

2.5 Data analysis

The Statistical Package for Social Sciences (SPSS) version 26 software was used to organise and analyse the data. Descriptive and inferential statistics were employed for the analysis of quantitative data collected through experimental tests. The test score on each subscale was added in order to see the expected mean difference. A univariate analysis of variance was employed to determine whether differences existed among groups in the changes in each

variable from the base line to the post-test. The statistical significance for all the tests was set at $p < 0.05$.

3. Results

After a twelve-week intervention of strength training, plyometeric training, and combined plyometric and strength training post-test results are as follows:

3.1 Standing liner jump performance

The descriptive statistical analysis of standing liner jump (SLJ) performance for the plyometric group (PG) is 2.387 +0.210 m, whereas the strength group (SG) and the combined strength plyometric groups (CSPG) achieved a mean performance score of 1.985+ 0.2911 and 2.384+ 0.131 m, respectively. Apart from this, the control group (CG) registered 1.984 m+0.306 m. The numeric result indicates that PG achieved a higher score on the SLJ test relative to CSPG, SG, and CG.

Table 1: Descriptive Statistics summary of Broad jump performance

Type of training given/ groups	Mean	Std. Deviation	N
PG	2.3872	.21046	14
SG	1.9850	.29144	14
CPSG	2.3842	.13171	14
CG	1.9842	.30625	14

***PG** (polyometric intervention group). **SG** (strength intervention group) **CPSG** (combined strength and polymeric group training CG control group.*

ANCOVAs were carried out to test how different the three groups are based on their performance gain or development ($F(3, 53) = 47.509$, $P < .001$, $nP2 = 0.430$). This result indicates that the performance of young volleyball players increases with each parametric factor. The results of each group show a significant difference between subjects.

The output of SLJ for the F measures provides statistics for the subject effects of different training types. The statistics show a measure of the linear relationship between different training models and performance. Types of training and performance are statistically significant. The F statistic ($3, 53) = 2.833$, $p = .05$, $nP\ 2 = 0.119$, is associated with the performance of players. This allows us to reject the null hypothesis that there is no linear relationship between types of training and performance. In conclusion, there is a positive relationship between the two variables, indicating that as the number of training day's increases, the player's performance increases.

Table 2: Tests of Between-Subjects Effects
Dependent Variable: Broad jump post (Ancova)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3.994[a]	4	.999	33.562	.000	.681
Intercept	.126	1	.126	4.230	.044	.063
Broad jump pre	1.413	1	1.413	47.509	.000	.430
Type of training	.253	3	.084	2.833	.045	.119
Error	1.874	53	.030			
Total	344.695	55				
Corrected Total	5.868	56				

a. R Squared = .681 (Adjusted R Squared = .660)

3.2 Spike jump performance

As the statistical analysis of the spike jump indicates, the PG attains 2.515 + 0.106m and the SG attains 2.491+ 0.111m. While the CSPG achieves 2.778+ 0.089m and the CG registers 2.373 + 0.081 m,The CSPG had a higher mean score than all other groups.

Table 3 **Descriptive statistics result of Spike jump performance**

Type of training given	Mean	Std. Deviation	N
PG	2.5147	.10548	14
SG	2.4907	.11076	14
CPSG	2.7750	.08876	14
CG	2.3733	.08072	14

PG *(polyometric intervention group).* ***SG*** *(strength intervention group)* ***CPSG*** *(combined strength and polymeric group training CG control group.*

The linear relationship between different training methods and the performance of players is statistically significant. The F statistic (3, 53) =69.316, P-value < 0.001, nP2 = 0.770. This shows that for every specific training, there is an improvement in the performance of players.

3.3 Standing block jump performance

The mean result of BJ for the PG is 2.591+ 0.120m, while the CSPG attains 2.733+0.086. The strength group executes 2.457 + 0.114m. Likewise, CG gains 2.618+ 0. 146. The combined group had a higher mean score than all of the groups.

4. DISCUSSION

The ultimate intention of this investigation was to test the effect of twelve-week strength, plyometric, combined strength, and plyometric training on the explosive power of young U-17 volleyball players. For this purpose, 56 volleyball project players were randomly assigned to SG, PG, CPSG, and CG and engaged in strength, plyometric, and combined strength and plyometric training with a frequency of four days per week and a duration of 60–80 minutes. Finally, the standing liner test, standing block jump, and skip jump test were used to quantify the explosive power performance of subjects.

We can spot that by using the set of plyometric and strength exercises training for the development of explosive power in the case of the experimental group, an increase in broad jumping was noted. Likewise, this researcher's objectives go with the studies conducted by (Çımenlı O, Koç H, Çımenlı F, 2016), which revealed a significant increase in horizontal jump performance after the plyometric training intervention. But contraindicated other studies did not show significant differences in this regard (Idrizovic K, Gjinovci B, Sekulic D, 2018), and the study carried out by Ginovci B, Idrizovic K, and Uljevic O (2017), presented only a small effect of plyometric training on horizontal jump performance. This difference might be due to the training protocol or sample size.

However, the authors also confirmed the importance of plyometric exercise to improving the broad jump ability of athletes as follows: the benefits of plyometric exercise on horizontal jump were observed in both sexes and across the ages: standing long jump, depth leap long jump (Idrizovic K, Gjinovci B, Sekulic D, 2018), triple standing jump (Ahmad et al., 2018), and unilateral jumps with either no steps or one step taken (Myer et al., 2006) were used as tests. In the standing long jump, meaningful improvements of 7.6% were observed in senior female players after 12 weeks of plyometric training (Gjinovci et al., 2017); a 7.6% improvement was observed in under-16 players after six weeks of training (Myer et al., 2006); and a 3.6% improvement was seen in 12- to 19-year-old players after 16 weeks of training (Idrizovic K, Gjinovci B, Sekulic D, 2018).Thus, twelve-week strength and plyometric training interventions are important for the explosive power development of young volleyball (U-17) players.

Regarding the jump spike, the statistical analysis indicates that the PG attains 2.515 + 0.106m. On the other hand, the SG achieves 2.491+ 0.111 m, and the CPSG achieves 2.778+ 0.089m. The CG gets 2.373 + 0.081 m. This finding is associated with the fact that the combination of strength and plyometric exercises is shown to be more beneficial for vertical jump improvement than either individually, which is in line with the findings of Kukric et al. (2012) or Kyröläinen et al. (2005).

The three (strength, plyometric, and combined) training methods were found to be statistically significant (p-value<0.001, to develop spike jump ability and explosive power) in athletes. This finding is also confirmed by Silva and his friends study (Silva et al., 2014). During the game, the volleyball players performed several different types of jumping movements, differentiated by execution and height of the jump reached. Based on this information, the greatest improvement in this study was the explosive power of the spike jump.

The preceding studies observed the effects of combined (plyometric and strength) training on the performance of vertical jump (explosive power) athletes. For example, studies by Markovic et al.

(2007) confirm that the players need a minimum of 2 weeks to adapt to the increased load and to achieve improvement. This result does differ from that of other studies, such as by Shaji J. (2009), where a maximal vertical jump has shown an increase of 4.8 cm. It was similar to that in the studies conducted by Lehnert, M., and Lamrova, I. (2009), where the improvement in height was about 4.9 cm. In their experiment, Faigenbaum AD, McFarland JE, and Keiper FB (2007), achieved an increase in vertical jump of about 3.4 cm.

5. CONCLUSIONS

Thus, the researcher has proved that 12-week plyometric training, strength training intervention, and combined strength and plyometric training are effective in augmenting the explosive power of the lower legs on vertical jumping and horizontal jumping abilities. Apart from this, combined strength and plyometric training are significantly better than plyometric training and strength training at improving explosive power. In general, there was a statistically significant difference between the EGs (SG, PG, and CSPG) and CG group in regards to explosive power performance in the pre-test and post-test totals of the performance.

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Authors' Contributions:

Dr.Aemero Asmamaw, Dr.Belayneh Cheklie, and carried out in supervising this study. Astatkie Bogale developed the original study idea for the project and wrote the study manuscript with input from all authors. All authors read and approved the manuscript and agreed to submit it.

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The data and materials supporting the study's findings are available upon request from the corresponding author.

Ethics approval and consent to participate:

The research project was approved by the Bahir Dar University Sport Academy's Research Council Approval Committee by SARCAC Ref. No 1001 on December 25, 2020. Written informed consent was obtained from all participants.

Consent for publication:

No individual details were reported; therefore, consent for publication was not required. Competing Interests: The authors declare that they have no competing interests.

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References

Abebaw Wubet. (2019). *Bahir Dar University library catalogue › Details for: Effects of strength training on specific physical fitness qualities& skills performance in team....* https://catalog.bdu.edu.et/cgi-bin/koha/opac-detail.pl?biblionumber=81154

Ab Rahman, Z., Kamal, A. A., Noor, M. A. M., & Geok, S. K. (2021). Reliability, Validity, and Norm References of Standing Broad Jump. *REVISTA GEINTEC-GESTAO INOVACAO E TECNOLOGIAS*, *11*(3), 1340-1354.

Baechle, T. R., Ed.D., & Earle, R. W. (2000). *Essentials of Strength and Conditioning, Second Edition*. 8–12. http://books.google.com/books?id=zw_-9QgKTeYC&pgis=1

Black. (1995). *The Game Of Volleyball Physical Education Essay.docx - Volleyball is a team sport that has earned his place in every competitive level, based on very | Course Hero*. https://www.coursehero.com/file/92545920/The-Game-Of-Volleyball-Physical-Education-Essaydocx/

Bogdanis, G. C., Tsoukos, A., Kaloheri, O., Terzis, G., Veligekas, P., & Brown, L. E. (2019). Comparison Between Unilateral and Bilateral Plyometric Training on Single- and Double-Leg Jumping Performance and Strength. *Journal of Strength and Conditioning Research*, *33*(3), 633–640. https://doi.org/10.1519/JSC.0000000000001962

Borges TO, Moreira A, Bacchi R et al. Validation of the VERT wearable jump monitor device in elite youth volleyball players. Biol Sport. 2017;34(3):239–242.

Çımenlı O, Koç H, Çımenlı F, K. C. (2016). Effect of an eight-week plyometric training on different surfaces on the jumping performance of male volleyball players. *J Phys Educ Sport*, *16*(1), 162–169.

Claudz. (2020). *Volleyball Training and Conditioning Using Resistance Bands*. https://myosource.com/volleyball/

De Villarreal, E. S. S., González-Badillo, J. J., & Izquierdo, M. (2008). Low and moderate plyometric training frequency produces greater jumping and sprinting gains compared with high frequency. *Journal of Strength and Conditioning Research*, *22*(3), 715–725. https://doi.org/10.1519/JSC.0B013E318163EADE

Dennis. (2020). *Volleyball Techniques for Improving Volleyball Skills*. https://www.strength-and-power-for-volleyball.com/volleyball-techniques.html

Emel Cetin a *, Y. O. (2010). Jump shot performance and strength training in young team handball players. *Procedia - Social and Behavioural Sciences*, *46*(2012), 3187 – 3190e.

Faigenbaum AD, McFarland JE, Keiper FB, et al. (2007). Faigenbaum AD, McFarland JE, Keiper FB, et al. Effects of a short-term plyometric and resistance training program on fitness performance in boys age 12 to 15 years. J Sport Sci Med. 2007;6(4):519-525. *J Sport Sci Med.*, *6*((4):), 519-525.

Fleck, S. J., & Kraemer, W. J. (2004). Designing Resistance Training Program: Champaign, IL: Human Kinetic.

Foqhaa B, Brini S, Alhaq IA, N. Q. (2021). Eight Weeks Plyometric Training Program Effects on Lower Limbs Power and Spike Jump Performances in University Female Volleyball Players. . *Swedish J Sci Res.*, *8*((1)), 1–7.

Forthomme B, Croisier JL, Ciccarone G, Crielaard JM, Cloes M. Muscular and physical features correlated with ball velocity during the volleyball spike. Computer Method Biomec 17(Suppl 1): 105–106, 2005.

Gadeken, S. B. (1999). Off-Season Strength, Power, and Plyometric Training for Kansas State Volleyball. In *National Strength & Conditioning Association* (Vol. 49, Issue 5).

Gjinovci B, Idrizovic K, Uljevic O, S. D. (2017). Plyometric training improves sprinting, jumping and throwing capacities of high level female volleyball players better than skill-based conditioning. *J Sport Sci Med.*, *16*((4)), 527–535.

Gjinovci, B., Idrizovic, K., Uljevic, O., & Sekulic, D. (2017). Plyometric Training Improves Sprinting, Jumping and Throwing Capacities of High Level Female Volleyball Players Better Than Skill-Based Conditioning. *Journal of Sports Science & Medicine*, *16*(4), 527. /pmc/articles/PMC5721183/

Herrero JA, Izquierdo M, Maffiuletti NA, et al. Electrostimulation and plyometric training effects on jumping and sprint time. Int J Sports Med 2006;27:533–9.

Iacono, A. D., Karcher, C. ;, & Michalsik, L. B. (2018). *Physical training in team handball*. 521–535. https://doi.org/10.1007/978-3-662-55892-8_36

Idrizovic K, Gjinovci B, Sekulic D, U. O. F. r P. ee r R. (2018). *The Effects of 3-Month Skill-Based and Plyometric Conditioning on Fitness Parameters in Junior Female Volleyball Players*. Pediatric Exercise Science.

Kang, S.-H. (2009). Analysis of Spike Motion in Male Professional Volleyball foreigner Players. *Korean Journal of Sport Biomechanics*, *19*(2), 359–367. https://doi.org/10.5103/KJSB.2009.19.2.359

Kukric A, Karalejic M, Jakovljevic S, Petrovic B, M. R. (2012). Impact of different training methods to the maximum vertical jump height in junior basketball players. *Fiz Kult.*, *66*(1), 25–31.

Kyröläinen H, Avela J, McBride JM, et al. (2005). Effects of power training on muscle structure and neuromuscular performance. *Scand J Med Sci Sport.*, *15*(1), 58-64.

Kotzamanidis C. Effect of plyometric training on running performance and vertical jumping in prepubertal boys. J Strength Cond Res 2006;20:441–5

Lehnert, M., Lamrova, I., and E. M. (2009). Changes in Speed and Strength in Female Volleyball Players During and After a Plyometric Training Program. : *Acta Univ Palacki Olomuc Gymnica.*, *39*((1)), 59–66.

M., M. (2013). The Biomechanics of the Volleyball Spike / Attack. *J Chem Inf Model.*, *53*((9)), 1689-1699.

Malisoux, L., Francaux, M., Nielens, H., & Theisen, D. (2006). Stretch-shortening cycle exercises: an effective training paradigm to enhance power output of human single muscle fibers. *Journal of applied physiology*, *100*(3), 771-779.

Manuel J Castillo Garzón. (2009). *The ALPHA Health-Related Fitness Test Battery for Children and Adolescents Test Manual*. www.thealphaproject.eu

Markovic, G., Jukic, I., Milanovic, D., & Metikos, D. (2007). Effects of sprint and plyometric training on muscle function and athletic performance. *Journal of Strength and Conditioning Research*, *21*(2), 543–549. https://doi.org/10.1519/R-19535.1

Marques MC, Van Den Tillaar R, Gabbett TJ, Reis VM, G.-B. J. (2009). Physical fitness qualities of professional volleyball players: Determination of positional differences. : *J Strength Cond Res.*, *23*((4)), 1106-1111.

Mosby. (2009). *Mosby's medical dictionary*. 1998 p.

Myer, G. D., Ford, K. R., Brent, J. L., & Hewett, T. E. (2006). The effects of plyometric vs. dynamic stabilization and balance training on power, balance, and landing force in female athletes. *Journal of Strength and Conditioning Research*, *20*(2), 345–353. https://doi.org/10.1519/R-17955.1

Polglaze, T., and B. Dawson. "The physiological requirements of the positions in state league volleyball." *Sports Coach* 15 (1992): 32-32.

Pushparajan. (2010). Effects of Plyometric Training on the Development the Vertical Jump in Volleyball Players. *J Phys Educ Sport*, *28*((3)), 65-69.

Ramin A., Z. H. and A. E. (2014). The effects of resistance and polymeric training on explosive power of young male volleyball players. *Annals of Applied Sport Science*, *2*((1)), 45-52.

Sahilemichael Bizuneh and Araya Dechasa. (2005). *Ethiopian Grade 9 Textbook For Students [PDF Download]*. https://www.neaea.com/ethiopian-grade-9-textbook/

Scates, A., Linn, M., & Kowalick, V. (2003). *Complete Conditioning for Volleyball*. https://books.google.com/books?hl=pl&lr=&id=BQ4dL43ovPIC&pgis=1

Shaji J, I. S. (2009). Comparative analysis of plyometric training program and dynamic stretching on vertical jump and agility in male collegiate basketball player. *Al Ameen J Med Sci.*, *2*((1)), 36–46.

Sheppard, Jeremy M1,2,3; Gabbett, Tim J4; Stanganelli, Luiz-Claudio Reeberg5. An Analysis of Playing Positions in Elite Men's Volleyball: Considerations for Competition Demands and Physiologic Characteristics. Journal of Strength and Conditioning Research: September 2009 - Volume 23 - Issue 6 - p 1858-1866 doi: 10.1519/JSC.0b013e3181b45c6a

Sheppard, Jeremy M1,2; Cronin, John B2,3; Gabbett, Tim J4; McGuigan, Michael R2; Etxebarria, Naroa1; Newton, Robert U2. Relative Importance of Strength, Power, and Anthropometric

Measures to Jump Performance of Elite Volleyball Players. Journal of Strength and Conditioning Research: May 2008 - Volume 22 - Issue 3 - p 758-765 doi: 10.1519/JSC.0b013e31816a8440

Sheppard, JM, Gabbett, TJ, Taylor, KL, Dorman, J, and Lebedew, AJ. Development of a repeated-effort test for elite men's volleyball. *Int J Sports Phys Perf* 2: 292-304, 2007.

Silva, M., Lacerda, D., & João, P. V. (2014). Game-related volleyball skills that influence victory. *Journal of Human Kinetics*, *41*(1), 173–179. https://doi.org/10.2478/HUKIN-2014-0045

Strength can be defined as the ability to overcome resistance or to act against | Course Hero. (n.d.). Retrieved August 9, 2022, from https://www.coursehero.com/file/p65rcla2/Strength-can-be-defined-as-the-ability-to-overcome-resistance-or-to-act-against/

Szabó, P. (2016). *Szabo 2014 Biological Reviews*. https://www.researchgate.net/publication/308889827_Szabo_2014_Biological_Reviews

Taro Yamane. (1967). *HOW TO CALCULATE A RELAIBLE SAMPLE SIZE USING TARO YAMANE METHOD | UniProjectMaterials Blog*. https://uniprojectmaterials.com/view-blog/how-to-calculate-a-relaible-sample-size-using-taro-yamane-method

Zhang, T. (2010). Volleyball forehand stroke and double handed backhand technique. *Journal of Chinese Sports Medicine*, *29*((1)).