Journal of Physical Education and Sport ® (JPES), Vol. 23 (issue 12), Art 399, pp. 3478- 3486, December 2023
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Strength development using functional training (FST) AMRAP and EMOM to minimum sports injury anterior cruciate ligament (ACL) & jumper knee for basketball students athlete

GIGIH SIANTORO[1], FAHD MUKHTARSYAF[2], DWI CAHYO KARTIKO[3], LUCY WIDYA FATHIR[4], DONNY SETIAWAN[5], PRISCA WIDIAWATI[6], NURHASAN[7], MUCHAMAD ARIF AL ARDHA[8], PARAMA SURYA KUSTRAPSILA[9], PRATAMA WICAKSANA WIJAYA[10]
[1.3.4.7.8,] Faculty of Sport and Health Science, Universitas Negeri Surabaya
[2]Sport Science Department, Universitas Negeri Padang
[5]Fakultas Olahraga Kesehatan, Universitas PGRI Banyuwangi
[6]Sport Coaching Department, Universitas Negeri Malang
[9]Sport Coaching Department, Training Zone INDONESIA
[10] Sport Medicine Residency Training Program, Faculty of Medicine, Universitas INDONESIA

Published online: December 31, 2023
(Accepted for publication : December 15, 2023)
DOI:10.7752/jpes.2023.12399

Abstract:
Basketball is a sport that focuses on physique, techniques, tactics, and defensive and offensive strategies with two opposing teams. A weakness often occurs in basketball athletes is a lack of strengthening training, which causes injuries to bones and ligaments such as the Anterior Cruciate Ligament (ACL) and jumper Knee. Basketball athletes really need weight training. Weight training can be done using the interval method; this study was carried out using a functional strength training program. The aims of this research were (1) to determine the effect of interval training using AMRAP and EMOM functional strength training (FST) media on increasing leg strength to minimum impacts of sports injury (ACL & Jumper knee), (2) to determine the effect of interval training using AMRAP and EMOM on increasing abdominal strength to minimum impacts of sports injury (ACL & Jumper knee), (3) determine the difference in the effect of training with the AMRAP and EMOM models on increasing leg and abdominal strength to minimum impacts of sports injury ACL & jumper knee for basketball students-athlete. The sample in this study was males aged 15-17 years, totalling 24 basketball student-athletes. Each group consisted of 12 athletes, who carried out functional strength training for 90 minutes with a training intensity of 75-85%, starting with a training volume of 30% of 1RM for sixteen weeks with a frequency of three times a week. This type of research was quantitative using an ordinal pairing technique after a leg strength test was carried out using a leg dynamometer (kg) and an abdominal strength test using a 30-second sit-up. Research results: 1) There was a significant increase in AMRAP training in the post-test results of leg strength by 9% (sign. < 0.05), and there was a significant increase in abdominal strength by 6% greater than (sign. < 0, 05), 2) There was a significant increase in EMOM training in the post-test results of leg strength by 6% (sign. < 0.05) and there was a significant increase in abdominal strength by 4% from the average pre-test results (sign. < 0.05), 3) There results stated that there was no significant difference in effect between AMRAP and EMOM due to the results of the ANOVA test at the mean difference level sig > 0.05 and the percentage increase in the variable for each group is not more than 20 % of the results of the AMRAP and EMOM groups. Conclusion: The results of this study proved that there is a significant effect on the effectiveness of strength training using the AMRAP and EMOM groups on increasing leg and abdominal strength in 16 weeks to minimize the impacts of sports injuries, such as ACL and jumper knee. The AMRAP group was more effective than EMOM in increasing leg and abdominal strength. The AMRAP and EMOM groups did not have a significant difference in effect because the results of the multivariate test analysis were at the sign. > 0.05
Key Word: **Functional strength training, AMRAP, EMOM, back strength, leg strength, abdominal strength**.

Introduction

Sports science can support physical training in long-term athlete development (LTAD). Sports science has contributed to developing optimal athlete performance. Physical training can be given to athletes to improve performance when practising techniques and tactics before the competition. The function of strength training is to improve performance and prevent injuries to the leg area, for example, ACL and jumper knee. According to the findings of Nurhasan (2021) and Wibowo (2020), a basketball athlete needs to receive strength and endurance training to support the biomotor components of speed, power and agility, as well as being given strength, agility and balance training to minimize the occurrence of injuries, especially to the lower extremities.

Corresponding Author: GIGIH SIANTORO, E-mail: gigihsiantoro@unesa.ac.id

In this study, research will focus on strength training programs to improve physical condition and prevent injury. The training program is dynamic, providing weight training at a volume of 30% with heart rate training at 75-85% and using functional training media such as barbells, dumbbells, VIPR, TRX and so on. This functional training media really helps improve physical condition, especially for athletes whose movements are dynamic, such as in football, basketball, hockey, softball, baseball, karate, judo, middle-distance athletics, triathlon and swimming. Asca (2010) explains that developing training programs, especially strength training, is necessary for game sports such as basketball, football, hockey, softball, and others, where the training process is adjusted to the training periodisation to achieve optimal performance. Strength training can be supported by doing weight training. Weight training consists of 2 types, including training using external weights and training using internal weights. Exercises using external weights include conventional training, traditional training, training using machines, and functional training exercises while training using internal weights is training using the body as a lifting load (Fathir, 2021). The development of this research refers to the implementation of a strength training program using functional training and body weight training media. Functional training (FST) is an exercise carried out using functional media such as dumbbells, barbells, kettlebells, TRX, ViPR, Gymball, and Bosu, where this media can be used to train ten components of physical condition, especially strength, endurance, power, speed, agility, balance and flexibility (Exos, 2019). Functional training exercises consist of 3 parts, namely, lateral part, sagittal part and transverse part where the use of functional media can activate several muscle groups in one training model, Nurhasan (2021), Mirizo (2020), Schoenfeld (2019) explains several advantages This exercise can improve biomotor strength, endurance, power and in each exercise it can simultaneously activate 3-5 muscle groups in one movement so that the time spent is more effective and efficient, and most importantly it supports improving physical performance, especially in sports. Dynamic ones such as games, basketball, football, softball, hockey, and measurable sports such as marathon running, athletics, swimming, shooting, etc.

Training using functional training that is Tabata, Every minute on the minute (EMOM), As many rounds as possible (AMRAP), For time, which can be done in addition to the weight of the body, but also with additional functional equipment that not only uses weight but maximizes joint motion space and motoric skills by doing a sagittal anatomy movement, frontal and transverse where the movement is yet involving muscles groups in performing elongated movements and shortening muscles than minimum sports injuries like anterior cruciate ligament (ACL) and minimum overuse in ligament or lower body sprain. The reps and sets can be determined by taking the maximum load as much as possible and then adjusting the intensity and percentage of the load to be done in six weeks of research with Amrap and Emom models. The development of the exercise in this study focuses on the ratio of functional exercise models between Amrap and Emom as an effort to increase the muscle strength of the limb. The muscle strength of the arm and the muscles of the stomach of the basketball student.

Previous research explains that athletes who compete competitively will be at great risk of injury if they do not do strength training, especially leg muscle and core strength training (Pancheva, 2021). The return to sport phase for an athlete after injury also requires strength training, which can be done using external or internal loads. The strength training program using internal weights can increase leg muscle strength by 18% with a training frequency of three times a week for twelve weeks at an intensity of 30% and a training heart rate of 75%. Staude (2023) also proves that there is a significant improvement in athletes after a jumper knee injury by carrying out weight training for eight weeks of physiological adaptation using external loads such as deadlifts, back squats and dynamic exercises for core stability. Avramora (2023) reveals that athletes, after injuries such as ACL surgery, can restore ligament strength with a minimum of strengthening exercises for up to twenty-four weeks after a six-month post-operative recovery period by doing strength training on the lower extremities using external weights with movements such as leg presses, dumbell lunges, hip abductor and hip adductor using machines as well as exercises using functional training equipment such as dumbbell lunges, Bosu squats and ViPR lateral lunges. Several previous research results encourage researchers to conduct research by applying strength training to male student basketball athletes to achieve optimal performance and minimize the occurrence of injuries to the lower extremities, such as ACL and jumper knee, where movements in basketball games are carried out dynamically, quickly, and move in all directions in a short time and high body contact. The strength training program carried out in this research was training using functional training for sixteen weeks for male student basketball athletes with a training program in the first group using the as many rounds as possible (AMRAP) method or what is meant is that an athlete can complete repetitions of lifting weights. At each station with limited time as long as possible, adjusted to individual abilities, namely training intensity and maximum load and increased by 10% every two weeks from the initial test results. Then, in group two, a weight training program was given using every minute on the minute (EMOM) method, which means that each athlete must complete one or more movements with a time limit of one minute at each station; if the athlete can complete the training movements according to the repetition range. Before one minute, the remaining time is used for a break before entering the next set at each station. This research applies interval training methods using functional media such as Dumbells, Barbells, VIPR, Kettlebells, Bosu, Gymball and TRX with training intensity of 75-85%, volume of 30% of 1 RM for male student basketball athletes in the age range 15-17 years in the city of Surabaya.

This study is not only for professional athlete basketball training programs but also for both student-athletes and amateur athletes. Scanlan (2018) states that practising using functional training equipment to improve high performance will affect the improvement in fitness, especially in cardiovascular resilience. So, this research could be re-developed for the development model exercise to increase cardiovascular endurance, agility, and power to the next research.

Material & methods

Study Design

This research was quantitative research using a quasi-experimental two-sample group pre-post test design method. The research sample was selected using a purposive sampling method, namely basketball student-athletes who were currently in training camp at the Training Zone for the Detection Basketball League (DBL) provincial student championship.

Research Sample

The sample in this study was 24 student-athletes, where in every group, 12 people did functional strength training exercises. Group One used the AMRAP method, and Group Two used the EMOM method. For the group sample method, this research used ordinal pairing. After carrying out the pre-test stage for the leg and abdominal strength test it was continued by sorting the test results from the largest to the smallest test results and then grouped following the pattern of the letter "S" starting from rank 1 to 24, then rank 1 goes into group 1 and rank 2 enter group 2 then rank 3 enters group 2, rank 4 enters group 1, rank 5 enters group 1 and so on until rank 24. Based on the technique of obtaining 2 groups (N=12) and then proceeding with training treatment, group 1 with the AMRAP training model and group 2 with the EMOM training model for 16 weeks with a training frequency of three times a week, then a post-test was carried out, namely a leg strength test using the leg dynamometer (kg) and an abdominal strength using the 30 seconds sit-up test.

Table 1. *Baseline characteristics of participants.* *

	FST (n = 12)	BWT (n= 12)
Age (y)	16.14 0.95	16.50 0.98
Height (cm	175.71 7.03	174.36 7.20
Weight (kg)	75. 51 7.62	74.81 9.12
Body mass index (kg. m^{-2})	21,42 3.35	23, 65 4.15
Visceral Fat	3 5.31	4 5.16

Procedure

The treatment in the form of functional strength training was carried out in 64 training sessions over 16 weeks, with a training duration of 90 minutes in each session. During the pre-test and post-test, each athlete had the opportunity to carry out a leg dynamometer (kg) and an abdominal strength test with 30 seconds sit-ups. The measurement data was then tested for normality using Kolmogorv-Smirnov to determine the different test methods that will be carried out.

Figure 1. Leg strength test using leg dynamometer (kg)

Figure 2. Sit up test (repetition)

Training Program

a. Functional Strength Training (FST)

The functional training program in this research included; Barbell Back Squat, Barbell deadlift, Barbell Clean and press, Barbell High pull, Dumbell Thruster, Dumbell Plank Drag, TRX Pike push up, TRX Hamstring curl, ViPR Lunges, Bosu V-sit up and Gymball total abdominal. The training program using functional media starts from a training intensity of 75%, with a load percentage of 30% of 1 RM, and every 2 weeks increases by 10% with a repetition range of 5-8 and 3-5 sets until week 16.

The program implemented in this research used a scientific method approach where the intensity of the training program was differentiated according to the athlete's initial abilities. The preparation of this training program involved experts from the field of strength and conditioning from the Indonesian Trainingzone sports development team (Parama Surya Kustrapsila).

In general, the training program consists of three stages, namely warming up (10 minutes), resistance training (90 minutes), and cooling down (10 minutes). Each training program had the same duration, but the target heart rate (THR), repetitions, sets, and duration were adjusted according to the athlete's increasing ability.

Table 2. *Functional Strength Training AMRAP Program*

No	Stage	Activities	Duration
1	Warming up	Phase 1. Neural Activation	10 minutes
2	Pillar Preparation:	Phase 2. Muscle Activation	
3		Phase 3. Dynamic Stretch	
4		Phase 4. Plyometric	
5	Functional Strength Training	Back Squat	45 Minutes
6		Clean and Press	
7		Deadlift	
8		High Pull	
9		Thruster	
10		Plank Drag	
11		TRX Pike Push-up	
12		TRX Hamstring curl	
13		ViPR Lunges	
14		Gymball total abdominal	
15		Bosu V sit up	
16	Cooling Down Soft Tissue using Roller Foam	Lower Body	10 Minutes
17		Upper Body	
18		SMR	

b. *Functional Strength Training EMOM Program*

A model of exercise that is carried out using one's body weight as a weight support with the body position and palms touching the floor (prone position) and the form of movement carried out is following the human body movement system (human movement), namely by flexing the knee and elbow joints 90^0 then hold the body position in a standing position (sagittal, frontal and transverse) or pronation.

This training program using bodyweight training started from a training intensity of 75%, with a load percentage of 40% of the maximum repetition, and every 2 weeks increases by 10% with a repetition range of 10-12 and 3-5 sets up to week 16. The program was implemented.

This research used a scientific method approach where the training program's intensity was differentiated according to the athlete's initial abilities. The preparation of this training program involved experts from the field of strength and conditioning from the Indonesian

Trainingzone sports development team (Parama Surya Kustrapsila). In general, the training program consists of three stages, namely, warming up (10 minutes), resistance training (90 minutes), and cooling down (10 minutes).

Each training program has the same duration, but the target heart rate (THR), repetitions, sets, and duration are adjusted according to the athlete's increasing ability.

Table 3. *Functional Strength Training EMOM Program*

No	Stage	Activities	Duration
1	Warming up	Phase 1. Neural Activation	10 minutes
2	Pillar Preparation:	Phase 2. Muscle Activation	
3		Phase 3. Dynamic Stretch	
4		Phase 4. Plyometric	
5	Body Weight Training	Barbell Thruster	65 Minutes
6		TRX Push up	
7		Barbell Good morning	
8		Pull up	
9		TRX Triceps Dips	
10		Gymball Plank Saw	
11		Kettlebell Cossack Squat	
12		RFE Split Squat	
13		Flutter kick	
14		Barbell Hip Bridge	
15		Dumbell Sit up to press	
16	Cooling Down Soft Tissue using Roller Foam	Lower Body	10 Minutes
17		Upper Body	
18		SMR	

Statistical Analysis

Data from lower strength, back strength, and core strength measurements were recorded during the pre-test and post-test in Microsoft Excel. The statistical analysis software used in this research is IBM SPSS Statistics 25. Descriptive analysis and normality tests were carried out to determine differences in pre-test and post-test results and Anova.

Results

The research results were analyzed and explained according to a predetermined hypothesis explaining the effect of functional load training (FST) AMRAP and EMOM models on increasing leg and abdominal muscle strength. The data obtained through the research results will be described, namely from the initial data results or pre-test and the data results after the research or post-test. Descriptive data analysis used the SPSS 20 application program. The research results in each treatment group are described in detail. Separately in tables 4, 5, 6, 7, and 8, as follows

a. Kolmogorov-Smirnov Test (FST AMRAP)

The results of the Kolmogorov-Smirnov Test normality test showed that all variables have a normal data distribution (sign. > 0.05). The Dependent T-Test parametric test can be continued to test hypotheses related to the impact of functional strength training as many rounds as possible (AMRAP).

Table 4. Normality Test and Descriptive Analysis Result

Variables	n	Mean	Std. Deviation	Sign.
Leg strength Pre-test	10	72.65	27.374	.076*
Leg strength Post-test	10	80.75	26.126	.200*
Abdominal strength Pre-test	10	16,21	15.762	.162*
Abdominal strength Post-test	10	22,35	17.594	.075*

* Normal Distribution

b. Kolmogorov-Smirnov Test (FST EMOM)

The results of the Kolmogorov-Smirnov Test normality test showed that all variables have a normal data distribution (sign. > 0.05). The Dependent T-Test parametric test can be continued to test hypotheses related to the impact of functional strength training every minute on the minute (EMOM).

Table 5. Normality Test and Descriptive Analysis Result

Variables	n	Mean	Std. Deviation	Sign.
Leg strength Pre-test	10	72.37	26.571	.054*
Leg strength Post-test	10	79.81	25.539	.200*
Abdominal strength Pre-test	10	15.63	14.742	.143*
Abdominal strength Post-test	10	15.78	15.165	.068*

* Normal Distribution

Dependent T-Test

a. Functional Strength Training (FST AMRAP)

The results of the dependent T-test can be divided into three parts. In the first part, the test results between the pre-test and post-test results on back muscle strength showed a significant difference (sign. <05). In this part, significant differences were also found from the difference test results between pre-test and post-test data on leg strength (sign. 0.05). The average leg strength during the post-test reached 80.75 ± 26,126 kg. In the last part, the results of abdominal strength showed a significant difference between the pre-test and post-test (sign. < 0.05). The results of abdominal strength using the 30 seconds sit-up test reached an average of 22.35 ± 17,594 reps.

Table 6. Dependent T-Test Analysis Result (FST AMRAP)

Variables	n	Mean	Std. Deviation	t	df	Sign.
Leg strength Pre-test	10	72.65	27.374	-4.243	11	0.001
Leg strength Post-test	10	80.75	26.126			
Abdominal strength Pre-test	10	16,21	15.762	-4.816	11	.001
Abdominal strength Post-test	10	16,35	17.594			

b. Functional Strength Training (FST EMOM)

The results of the dependent T-test were divided into three parts. In the first part, the test results between the pre-test and post-test results on leg strength showed a significant difference (sign. <05). Table 7 shows that the strength at post-test significant differences in abdominal strength (sign. < 0.05). The average of leg strength during the post-test reached 79.81 ± 25,539 kg. In the last part, the results of abdominal strength showed a significant difference between pre-test and post-test (sign. < 0.05). The results of abdominal strength using 30 seconds sit-up test reached an average of 15.78 ± 15,165 reps.

Table 7. Dependent T-Test Analysis Result (FST EMOM)

Variables	n	Mean	Std. Deviation	t	df	Sign.
Leg strength Pre-test	10	72.37	26.571	-4.325	11	0.001
Leg strength Post-test	10	79.81	25.539			
Abdominal strength Pre-test	10	15.63	14.742	-4.754	11	.001
Abdominal strength Post-test	10	15.78	15.165			

Multiple comparison analysis (Post Hoc Test) aimed to find out further which groups have different averages if the Anova test produces significant differences (Ho is rejected). Next, we explained the differences in data for each group with the variables used as follows;

Table 8. Post Hoc Test Summary

No	Variable	Difference	*p*
1.	Leg Strength	*AMRAP>< EMOM*	0,662
2.	Abdominal Strength	*AMRAP>< EMOM*	0,417

Discussion

Functional strength training significantly increases dynamic strength (Bashir, 2022). It also increases muscle strength and size (Binet, 2023). Furthermore, strength training using external weights such as dumbbells and barbells can stimulate the growth of soft muscle tissue in an athlete so that the athlete's muscle strength increases, and if muscle strength increases, there will be growth in actin and myosin muscle fibres so that with lots of muscle fibres there will be oxygen reserves. There is also more and more ATP in the muscles, which has an impact on the quality of athletes' movements, such as jumping, running and moving in all directions (Dauty, 2019). Athletes who can move in all directions, such as basketball athletes, must have optimal and dynamic muscle strength so that it will have little impact on sports injuries, especially in the lower extremities like Patellar Tendinopathy (Dauty, 2021), jumper knee (Santana, 2023) and anterior cruciate ligament (Chantrelle, 2023). The risk of injury is very detrimental to athletes, especially during the competition season, therefore it is necessary to provide strength training. In this study, the results obtained were a significant increase in muscle strength by providing functional training. In group one with the AMRAP model treatment, athletes carried out a training program for sixteen weeks, with a training frequency of three times a week, using functional media such as dumbbells, barbells, TRX, ViPR, and kettlebells as in Table 2. The program in the second group also used functional media with the model EMOM where an athlete will complete each movement for approximately one minute, and if the athlete can complete the repetition of each exercise model before one minute, then the remaining time can be used for rest breaks between the next sets. This was a sixteen-week experimental intervention study of two groups with different treatments. This research only applied to whether physical activity using functional training has an effect on the leg and abdominal strength of male basketball student-athletes. Based on the results of experimental research, programmatic administration for 16 weeks will produce optimal athlete performance and greatly support the improvement of the performance of student basketball athletes. This exercise certainly aimed to

prevent and slow down the fatigue experienced during competition and minimize the occurrence of lower extremity injuries in athletes (Wibowo, 2021). Time limitations and the tight schedule of trial matches carried out by basketball athletes make physical trainers and technical trainers carry out training manipulations safely, effectively, and efficiently and minimize sports injuries. Apart from that, functional strength training also has a positive impact on strength not only in certain genders but in all genders (Brito, 2023). Functional strength training has been proven to significantly influence the effectiveness of increasing back and leg strength and abdominal muscle strength (Nurhasan, 2022). In this study, basketball athletes needed an anaerobic energy source with weight training 3 times a week, moderate to high intensity from 50% to 100% of maximum heart rate, 1RM/maximum repetition (kg) ranging from 30% to 70%, progressive overload 10 The % is increased every 2 weeks so that the results of 16 weeks of weight training can produce maximum muscle strength effects in supporting lower extremity forces such as running, jumping and turning in all directions. Further research could include treatment with the AMRAP and EMOM functional training models to support cardiovascular endurance, agility, speed and power in male student basketball athletes. This is very important not only to increase strength and minimize the occurrence of injuries to the lower extremities, such as ACL and Jumper knee, but also to be able to significantly increase the VO2 max of basketball athletes so they do not get tired quickly by recommending a training program at an intensity of 80%-95% three times a week. With a duration of each session of 60-90 minutes.

Conclusions

The functional strength training program was carried out in 64 training sessions over 16 weeks, with a training duration of 90 minutes in each session. It was proven to effectively increase leg muscle strength and abdominal muscle strength in male basketball student-athletes to minimum sports injury (ACL & jumper knee). Functional strength training with the AMRAP model had a better increase in leg strength compared to the EMOM model. There was no significant difference between the AMRAP and EMOM models in improving leg and abdominal strength, so these findings were analyzed because the intensity of the training for 16 weeks was classified in the moderate to high-intensity category between 75%-85%. As in previous research (Fathir, 2021), strength training on the leg muscles does not significantly impact the difference in results with the ascending interval and constant load training methods in the AMRAP model training approach due to the light intensity -medium for 6 weeks. Similar training programs (Clark, 2019), (Ratamess, 2016) and (Brooks, 2015) also found that there was no significant difference in training using the interval method on abdominal muscle strength because the range of repetitions performed was the same, the muscle groups involved the same even though using functional training media such as Bosu, TRX and resistance bands. The findings of this study concluded that the AMRAP and EMOM as functional training programs had more impact on strengthening in lower extremity function and minimum impact from sports injuries like ACL and jumper knee for 16 weeks training program on strength (leg and abdominal muscle) except there are the AMRAP model was more efficient and effective in improving leg muscle strength than the EMOM model. The average pre-test AMRAP increased leg strength by 9% (sign. < 0.05), and there was a significant increase in abdominal strength by 6% greater than (sign. < 0, 05). EMOM training in the post-test results of leg strength increased by 6% (sign. < 0.05), and there was a significant increase in abdominal strength by 4% from the average pre-test results (sign. < 0.05). The results of this study proved that there was a significant effect on the effectiveness of strength training using the AMRAP and EMOM groups on increasing leg and abdominal strength in 16 weeks to minimize the impacts of sports injury, such as ACL and jumper knee. The AMRAP group was more effective than EMOM in increasing leg and abdominal strength. The AMRAP and EMOM groups did not have a significant difference in effect because the results of the multivariate test analysis for 16 weeks were signed. Level ($p > 0.05$).

References

Angel, Pedro Latorre., Campos, Maria Aparecida Santos E., Pinillos, Felipe Garcia. (2015). "Effects Of Functional Training On Pain, Leg Strength, And Balance In Women With Fibromyalgia". Pubmed. 2015;25 (6): 934-7. Epub 2015 May 28. Doi: 10.3109/14397595.2015.1040614

Asca (Australian Strength & Conditioning Association). 2010. International Conference On Applied Strength And Conditioning. Australia: Asca.

Avramova, Margarita., Mitova, Stamenka., Georgieva, Dilyana., Kalpachki, Blagoy. 2023. Clinical Effect Of Combined Therapy With Capacitive And Resistive Electric Transfer In Athletes After Anterior Cruciate Ligament Reconstruction. Journal Of Physical Education And Sport (Jpes), Vol 23 (Issue 9), Published Online: September 30, 2023 (Accepted For Publication September 15, 2023). Doi:10.7752/Jpes.2023.09275

Bashir, Marriium., Soh, Kim Geok., Samsudin, Shamsuariffin., Akbar, Saddam., Luo, Shengyao., Sunardi, Jaka. 2022. Effects Of Functional Training On Sprinting, Jumping, And Functional Movement In Athletes: A Systematic Review. Https://Doi.Org/10.3389/Fphys.2022.1045870

Beattie, Kris., Kenny, Ian C., Lyons, Mark., Carson, Brian P. (2021).“The Effect Of Strength Training On Performance In Endurance Athletes”.Sport Med. 2014 Jun; 44 (6): 845-65.Pmid: 24532151.Doi: 10.1007/S40279-014-0157-Y

Binet, E. R., Mckenna, C. F., Salvador, A. F., Martinez, I. G., Alamilla, R. A., Collao, N., Bodnariuc, G., Khan, N. A., Paluska, S. A., Burd, N. A., & De Lisio, M. (2023). Sex-Based Comparisons Of Muscle Cellular Adaptations After 10 Weeks Of Progressive Resistance Training In Middle-Aged Adults. *Journal Of Applied Physiology (Bethesda, Md.: 1985)*, *134*(1), 116–129. Https://Doi.Org/10.1152/Japplphysiol.00274.2022/Asset/Images/Medium/Jappl-00274-2022r01.Png

Brito, Andrade Michele., Fernandes, José Raimundo., Carvalho, Pedro Henrique Berbert De, Brito, Ciro José., Muñoz, Esteban Aedo., Soto, Dany., Miarka,Alexis Sobarzo Bianca. 2023. Acute Effect Of High-Intensity Functional Training (Hift) Using A Benchmark On Cognition And Physiological Parameters According To The Competitive Level. Journal Of Physical Education And Sport (Jpes), Vol. 23 (Issue 6), Art 175, Pp. 1432 - 1440, June 2023 Online Issn: 2247 - 806x; P-Issn: 2247 – 8051; Issn - L = 2247 - 8051 Jpes. Doi:10.7752/Jpes.2023.06175

Brooks, Douglas, M.S., Brooks, Copeland Candice. (2015). Bosu Balance Trainer Integrated Balance Training. United States.

Cassemiro, Bruna Montechieze., Lemes, Italo Ribeiro, Figueiredo, Maria Paula Ferreira De., Vanderlei, Franciele Marques., Pastre, Carlos Marcelo., Junior, Jayme Netto. (2017). “Effects Of Functional Resistance Training On Muscle Strength And Musculoskeletal Discomfort”. Fisioterapia Em Movimento. Issn 0103-5150 Fisioter. Mov., Curitiba, V. 30, N. 2, P. 347-356, Apr./June 2017 Licenciado Sob Uma Licença Creative Commons Doi: Http://Dx.Doi.Org/10.1590/1980-5918.030.002.Ao15.

Chantrelle M, Menu P, Crenn V, Grondin J, Daley P, Louguet B, Fouasson-Chailloux A, Dauty M. 2023. Consequences Of Anterior Knee Pain After Anterior Cruciate Ligament Reconstruction: A 2015-2020 Cohort Study. Plos One. 2023 Jan 5;18(1):E0280146. Doi: 10.1371/Journal.Pone.0280146. Pmid: 36603016; Pmcid: Pmc9815630.

Clark, Michael A., Lucett, Scott., Corn, Rodney., Cappuccio, Robert., Humphrey, Reed., Kraus, J. S., Titchenal, Alam., Robbins, Paul. 2018. *Optimum Performance Training For The Health And Fitness Professional (*Nasm’s *Course Manual)*. Usa.

Dauty M, Menu P, Garraud T, Mesland O, Berlivet T, Metayer B, Fouasson-Chailloux A. 2019. Jumper's Knee Mechanical Consequences In Professional Basketball Players: The "Camel's Back Curve". Eur J Appl Physiol. 2019 Mar;119(3):735-742. Doi: 10.1007/S00421-018-04064-8. Epub 2019 Jan 4. Pmid: 30610445.

Dauty M, Menu P, Mesland O, Louguet B, Fouasson-Chailloux A. Impact Of Patellar Tendinopathy On Isokinetic Knee Strength And Jumps In Professional Basketball Players. Sensors (Basel). 2021 Jun 22;21(13):4259. Doi: 10.3390/S21134259. Pmid: 34206269; Pmcid: Pmc8271954.

Exos. (2019). Performance Specialist. United States.

Fathir, L. W., Hartanto, S., Kusnanik, N. W. (2021). Strength, Endurance, And Speed Development Using Functional Strength Training (Fst) Program For Recreational Runners Performance. Journal Of Physical Education And Sport (Jpes), Vol 21 (Suppl. Issue 4), Art 330 Pp 2453 – 2457, Aug. 2021 Online Issn: 2247 - 806x; P-Issn: 2247 – 8051; Issn - L = 2247 – 8051. Doi:10.7752/Jpes.2021.S4330

Feito, Yuri. Et Al. 2018. High-Intensity Functional Training (Hift): Definition And Research Implications For Improved Fitness. Pubmed: Doi 10.3390/Sports6030076

Ratamess, Nicholas. 2016. *Strength Training And Conditioning (Acsm’s Foundations)*. Usa: Indianapolis.

Rossi, M. K., Pasanen, K., Heinonen, A., Äyrämö, S., Leppänen, M., Myklebust, G., Vasankari, T., Kannus, P., & Parkkari, J. (2021). The Standing Knee Lift Test Is Not A Useful Screening Tool For Time Loss From Low Back Pain In Youth Basketball And Floorball Players. *Physical Therapy In Sport*, *49*, 141–148. Https://Doi.Org/10.1016/J.Ptsp.2021.01.017

Mirizo, Gerardo Gabriel., Et Al. 2019. Time Of Day Effects On Short Duration Maximal Exercise Performance. Scientific Reports. Www. Nature. Com/ Scientificreports.

Nurhasan, Fathir, Lucy Widya., Nur Hayati, Faridha., Wibowo, Sapto., Kartiko, Dwi Cahyo., Muhammad, Heyanto Nur., Hafidz, Abdul., Al Ardha, Muchamad Arif. 2021. The Effects Of Functional Strength Training (Fst) Using Dumbell And Kettlebell To Improves Core Strength And Reduce Abdominal Fat. Proceedings The 5th Ismina International Conference On Sports, Health, And Physical Education. Isbn: 978-623-7123-73-6

Santana Ja, Mabrouk A, Sherman Al. Jumpers Knee. 2023 Apr 22. In: Statpearls [Internet]. Treasure Island (Fl): Statpearls Publishing; 2023 Jan–. Pmid: 30422564. “Transformation On Sports, Health And Physical Education Facing The Global Pa

Oxfeldt, M., Overgaard, K., Hvid, L. G., & Dalgas, U. (2019). Effects Of Plyometric Training On Jumping, Sprint Performance, And Lower Body Muscle Strength In Healthy Adults: A Systematic Review

And Meta-Analyses. Scandinavian Journal Of Medicine & Science In Sports, 29(10), 1453-1465. Https://Doi.Org/10.1111/Sms.13487

Scanlan, A. T., Fox, J. L., Borges, N. R., Tucker, P. S., & Dalbo, V.J. (2018). Temporal Changes In Physiological And Performance Responses Across Game-Specific Simulated Basketball Activity. Journal Of Sport And Health Science, 7(2), 176-182. Https://Doi.Org/10.1016/J.Jshs.2016.05.002

Staude, Volodymyr., Prozorovsky, Dmytro., Radzyshevska, Yevhenia. 2023. Rehabilitation Therapy For Athletes After Orthopedic Surgery Procedures On The Forefoot . Journal Of Physical Education And Sport (Jpes), Vol. 23 Issue 6 June 2023 (Accepted For Publication June 15, 2023). Doi:10.7752/Jpes.2023.06179

Schoenfeld, B. J., Contreras, B., Krieger, J., Grgic, J., Delcastillo, K., Belliard, R., & Alto, A. (2019). Resistance Training Volume Enhances Muscle Hypertrophy But Not Strength In Trained Men. *Medicine And Science In Sports And Exercise*, *51*(1), 94. Https://Doi.Org/10.1249/Mss.0000000000001764

Wibowo, S., Nurhasan., Fathir, L. W., Ashadi, K., Hartoto, S., Ardha, M. A. A., Kartiko, D. C. (2021). The Effect Of A Short-Term High-Intensity Functional Strength Training On Strength And Endurance In Recreational Runners. Journal Of Physical Education And Sport (Jpes), Vol 21 (Suppl. Issue 4), Art 312 Pp 2332 – 2336, Aug. 2021 Online Issn: 2247 - 806x; P-Issn: 2247 – 8051; Issn - L = 2247 – 8051. Doi:10.7752/Jpes.2021.S4312

Wibowo, S., Hidayat, T., Muhammad, N. H., Fathir, L. W., Nurhasan., Hartoto, S., Kartiko, D. C., Wiriawan, O., Setijono, H., Kusnanik, N. W., Kustrapsila., P. S. (2022). Endurance Cardiovascular, Core, And Leg Strength Development Using Amrap, Emom, And For Time Training Program. Journal Of Physical Education And Sport (Jpes), Vol. 22 (Issue 12), Art 402, Pp. 3168-3176, December 2022 Online Issn: 2247 - 806x; Issn - L = 2247 – 8051. Doi:10.7752/Jpes.2022.12402