A Study on the Intensity and Volume of Training in Achievement Sports : Narrative Literature Review

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Abstract: The importance of volume and intensity regulation in achievement sports needs to be studied in depth, although reviews related to this study already exist, but additional information is needed to provide knowledge updates. The purpose of this study is to provide comprehensive information about the literature review of intensity and volume in exercise. The research method is literature review research with the type of narrative. Data collection through secondary documents, namely articles, books and relevant documents. The results of the literature review provide information that the intensity and volume settings must be adjusted to the type of exercise, then the implementation of volume and intensity in the periodization of the exercise is also adjusted at the preparation stage such as general, special and pre-competition preparations have their own characteristics. The author's hope is that this article can provide information and reference in the preparation of the training program. Although this writing has been compiled, there are limitations such as the study written is still a narrative review, not specific to martial arts or games. It is hoped that the authors of the study can further improve this research.

Keywords: Narrative study, exercise intensity, exercise volume, achievement sport

INTRODUCTION

The process of becoming a champion is not as easy as turning the palm of your hand. Discussing sports achievements, many factors must be analyzed, such as internal and external factors (Bompa O. Tudor, 2019). Internal factors such as intrinsic motivation from the athletes themselves to strive to train so that they become true champions. In addition, external factors are influenced by human resources such as coaches and management who synergize in the organization or club (Yudhistira & Tomoliyus, 2020). Qualified human resources will produce quality champion products. Other external factors such as adequate facilities and infrastructure, this of course needs to be considered to achieve optimal achievement (Yudhistira & Tomoliyus, 2020).

Discuss more deeply that athletes' achievements cannot be separated from the core skills of a coach. Coaches play an important role in guiding athletes to the

center podium. The core skills that coaches need to have are skill analysis, teaching skills, leadership skills and management skills (Hidayah & Akhiruyanto, 2023; Martens, 2012). One of the applications of the core competencies is that the coach is able to develop periodizations and training programs as well as adjust the training dose.

Adjusting the training dose is an absolute thing for the coach to master. The dosage of this exercise includes intensity and volume. Intensity is related to the quality of a performance, the volume of exercise is related to the quantity in a sports performance (Hartono et al., 2024; Yudhistira, Siswantoyo, et al., 2021; Yudhistira, Kurnianto, Ariestika, et al., 2023). It is impossible for an athlete to be able to win without the appropriate intensity and volume settings from the coach. We analogize the intensity and volume as the administration of medicine for patients. When the patient is given a low dose of medicine, of course, it will not have any effect, while when the patient is given an overdose of medicine, it will give an overdose effect. This is certainly the same as the athlete phenomenon, when given a low dose of training, there will be no adaptation, while if the dose of training exceeds its capacity and is not given a good recovery, it will cause overtraining and burn out (Yudhistira, 2023).

The dilemma is that there are still some coaches who do not understand the regulation of training doses. As is the case with the regulation of training intensity related to endurance and speed training, of course, it will be different from the intensity setting of strength training with weight training. Furthermore, the volume settings for each item and training model in a session sometimes do not match the training objectives. For example, pure speed training related to running speed, of course, the intensity carried out is maximum with a short distance and a long recovery setting so that athletes can run at maximum speed. But the fact is that pure speed training is still with long distances and volume settings that are not adjusted so that the training goal is not pure speed training, but endurance or stamina speed training. This is what needs to be considered so that the training is in accordance with the training goals, the hope is to provide optimal performance

Some of these problems are based on field phenomena. This means that understanding and downstream are needed to provide this understanding. In addition, studies from several existing literature and books have certainly discussed intensity and volume. However, it is possible that existing studies cannot be resurfaced or used as research, of course it is very possible to deepen and sharpen such as giving examples of intensity settings based on speed training goals, endurance, weight training in detail, and discussing in depth the volume of absolute volume and relative volume.

Therefore, it is one of the bases and references for the author to write this research in the form of a narrative literature review to sharpen the previously inadequate study to be better. It is hoped that it will provide practical knowledge

so that it can be interpreted by academics and practitioners who are engaged in the field of achievement sports coaching. Based on several gaps in the research, the purpose of this study is to explore information with a narrative literature review study about the intensity and volume of exercise in performance sports.

METHOD

The research method is a literature review with a narrative type. The purpose of narrative literature review is to provide information and transfer knowledge by summarizing several relevant literature as a basis for the preparation of the synthesis of results (Hidayah et al., 2024; Yudhistira, Kurnianto, Candra, et al., 2023). Data collection techniques with document analysis in the form of books, ebooks, original articles and conferences that are in accordance with the topic of intensity and volume in sports. Database to search for articles as a reference using scopus.com, willey.com, web of sience,

RESULTS AND DISCUSSION

Intensitas Latihan

The intensity of training is often defined by the quality of the exercise. Intensity in sports performance is a very important study. In every aspect of strength, speed, endurance training, of course, you need intensity parameters to adjust the right training dose. If you look more deeply, the intensity settings related to speed, endurance and strength training are certainly different. In addition, the determination of training intensity is adjusted to the characteristics of the sport being pursued. As with training that involves speed or endurance, it is determined by the unit of meters/second, pulses/minute or it can be from power/watts. In addition, when training is related to resistance or weight training, the intensity is measured in kilograms.

The concept of the exercise program is inseparable from the setting of intensity variations. For example, the weekly (micro) training program, of course, there are appropriate intensity settings. Weekly training programs, such as strength and speed training, so the determination of the intensity of the training is different. The intensity of the exercise can be measured as the best percentage, so the best percentage can be said to be the maximum intensity.

Intensity is the stimulation or weight of training. Training loads can be classified into two, namely outside loads and inside loads. Training load is characterized by the presence of volume, intensity, duration, frequency, rhythm and density (Budiwanto, 2012). Another study states that intensity is a function of nerve stimulation to cope with the weight of training (Sidik, 2019). In addition, intensity is often referred to as the size and small amount of effort spent in an exercise (Sidik, 2019). In addition, coaches need to know how to manage and develop strategies to increase intensity, namely: (1) athletes increase the tempo of

movements such as running or other movements, (2) when it comes to weight training can increase the kilogram weight, (3) shorten the interval or recovery of training so that progressive overload occurs so that the intensity is expected to increase. Below are the intensity zones and strategies for measuring intensity as follows:

Table 2. Speed and strength training intensity zones

Non-intense	Percentage	Intense
1	30-50%	Low
2	50-70%	Intermediate
3	70-80%	Medium
4	80-90%	Submaximum
5	90-100%	Maximum
6	100-105%	Supermaximum

Source : (Bompa O. Tudor, 2019)

Table 3. Endurance Training Intensity Zone

Best Percentage (% Vo2max)	Workout Quality	Pulse/min
1	Low	130-140
2	Easy	140-150
3	Keep	150-165
4	Submaximal	165-180
5	Maximum	180 keatas

Source : (Bompa O. Tudor, 2019)

Table 4. Workout intensity zones with usability descriptions

Intense	% 1 RM	Uses
Super maximal	>100	Maximum power
Very heavy	95-100	Maximum power, hypertrophy, unit motor recruitment
Heavy	90-95	Maximum power, hypertrophy, unit motor recruitment
Medium weight	80-90	Maximum power. Power, hypertrophy
Menengah	70-80	Strength, power, hypertrophy, and muscle endurance
Light	60-70	Power, muscle endurance, hypertrophy
Very light	<60	Heating, hypertrophy, high durability

Source : (Bafirman & Wahyu, Sujana, 2018)

Table 5. Training intensity zones with classification of energy systems

Zone	Duration	Intense	Energy system	Anaerobik	Aerobics
1	<6 seconds	Maximum	ATP-PC	95-100	0-5
2	6-30 seconds	Tall	ATP-PC & Rapid Glycolysis	80-95	5-20
3	30" – 2'	Moderate – high	Fast & slow glycolysis	50-80	20-50
4	2-3'	Moderate	Slow & oxidative glycolysis	40-50	50-60
5	3-30'	Moderate-low	Oksidatif	5-40	60-95
6	>30	Low	Oksidatif	2-5	95-98

Source : (Bompa O. Tudor, 2019)

a. Tanaka Formula (208 – 0.7 x age)

Example: a 20-year-old athlete will do endurance training with the continuous run method with an intensity of 80%, so the training zone is: 208 – 0.7 x 20 = 194 maximal heart rate (MHR), so 80% x 194 = 155.2. Therefore the pulse of the training zone is 155.2 bpm. (Lach et al., 2022)

b. Jacek Lach Formula (202.5 – 0.53 x age)

Example: a 25-year-old athlete will do endurance training with the continuous run method with an intensity of 75%, so the training zone is 202.5 – 0.53 x 25 = 189.25 maximal heart rate (MHR), so 75% x 189.25 = 141. Therefore the pulse of the training zone is 141 bpm. (Lach et al., 2022)

c. Formula 1 of the maximum rep (RM) is: percentage (%) x maximum rep (kg).

Example: karate athletes will do strength training with squats that have 1 maximum rep of 120kg, so they will train at 60%, so that the intensity of the weight needed is 60%x120 – 72 kg. But coaches can also use other formulas to determine the intensity of training, sometimes the 1RM formula requires strict supervision and is at risk of injury. Another formula to measure the intensity of exercise is as follows:

d. Epley's formula is: weight of the load (1 + (0.0333 x number of reps))

Example: an athlete doing a bench press with a weight of 30kg is able to lift 10 reps, meaning it is too light, so the coach adds a bench press weight to 40kg and starts to feel heavy and can lift 8 reps. Then the formula is applied, namely = 40 (1 + (0.033x8) = 50.656 prediction of 1 maximum rep (RM).

Exercise Volume

The volume of training is often interpreted as the amount of work or quantity of an athlete carrying out movements related to the physical. The elements of the training volume are: (1) the duration and time of the exercise, (2) the weight and distance of the training volume using resistance parameters

(volume = set x rep x load/kg), (3) the number of reps from the exercise or technical elements (Bompa O. Tudor, 2019). The determination of the volume of training adjusts to the sports being engaged in such as athletics, games, martial arts, weighlifting. Like athletics, of course, the appropriate training volume is using distance, while in sports such as weighlifting, the appropriate volume parameter uses kilograms (volume = set x rep x weight in kg). Furthermore, in other cases such as plyometric exercises, throwing medicine balls, or throwing discs, the number of repetitions is a parameter for determining the volume of exercise. In depth, there are two types of exercise volumes, namely relative volume and absolute volume.

Relative volume is the total number of exercises of a team or group in a single unit of practice, while absolute volume is the total number of individual exercises per unit of practice. In this case, for detailed mentoring of athlete performance, it is better to use absolute volume because it can be detailed well. The periodization of training will not be separated from the setting of the intensity and volume of the exercise. The periodization of the exercise is divided into general, special, pre-competition, main competition and transition. In fact, in the general preparation the volume of training is relatively high, the peak is in the final general preparation. The increase in volume in general preparation is not without reason. The increase in volume aims to boost the physical aspects that are still being fostered in general preparation. Like endurance training in general preparation, of course, it will be given with a long duration, and the frequency of training is not only twice a week. In addition, such as strength training, of course, you will be given high repetitions and sets, and a large number of technical exercises. It is very natural when the volume of general preparation is very high, because it is to prepare for more specific exercises and high intensity to prepare further. But of course, volume and intensity must be inversely proportional, if the volume is high, the intensity will be low, the intensity will be low. Then how to develop a strategy to increase volume, namely increasing sets, repetitions and training duration. The strategy for calculating the volume of training is as follows:

a. **Flexibility training** can be measured by the number of reps, with times such as minutes and seconds when performing flexibility movements.
b. **Speed training** can be measured by reps and distance traveled when running. Example of a sprint of 20 meters x 20 times = 400 meters, then a shuttle run of 6 meters x 6 reversals x 10 repetitions = 360
c. **Plyometrics exercises** can be measured by the number of contacts downwards. 10 reps, 8 sets, i.e. 10 x 8 contacts = 80 jumps in a training session.
d. **Strength training** can be measured by the number of repetitions of sets, reps, kg, tons. Example of a 90 kg weight squat exercise; 6 reps; 6 sets; Rest between sets for 2 minutes. That is 90 kg x 6 reps x 6 sets = 3,240 kg.

e. **Endurance training** can be measured in kilometers/meters or hours and minutes.

Table 6. Correlation of Exercise intensity and volume

Exercise components	Intense	Volume
Speed	- Contact points - Training speed	Set x foot contact
Strength	- Maximum reps - 1 maximum rep	Set x rep x load
Endurance	- Heart rate target	Set x distance x time
Kelentukan	- Low and high - Static to PNF	Set x stretch time

Source : Sidik (2019:77)

Implementation of Intensity and Volume on Exercise Periodization

The periodization of training is built on the basis of the characteristics of the sport, the needs of the dominant biomotor components, the level of athlete training, the level of athletes and the set match calendar. But before talking about it, tests and measurements are an absolute requirement to arrange a good periodization, so that you can know the physical condition, technique, health and mental condition of athletes. Periodization is important. Periodization as a whole can be divided into periodization of physical exercise, technique, psychology and nutrition. This means that not only physical periodization, but all of these periodizations need to be prepared with the skills and expertise of coaches and sports consultants.

Periodization can be defined as macro management as a whole to divide the segments of the exercise program into more detailed (Kataoka et al., 2021). The periodization of the exercises is divided into general, special, pre-competition, main competition and transitional. The general characteristic of preparation is that it has a longer preparation time than others, but it also adjusts the competition and the level of the athlete being trained, another characteristic is the high volume of training and the relatively low intensity. The goal is to develop technique, endurance, strength, flexibility and speed as best as possible (Yudhistira, 2023).

The special characteristic preparation is that the intensity is already classified as moderate to high and gradually the volume of exercise will decrease progressively. Another feature is that the training method is in accordance with the characteristics of movement in the match and adjusts to the needs of the dominant biomotor (Yudhistira, Suherman, et al., 2021). Then the pre-competition preparation emphasizes more on the match strategy with mature techniques and maintaining physical condition so that it remains in excellent condition. The main match is ready to show optimal performance by strengthening motivation and

confidence to compete. While the transition is the time for athletes to rest after the main match, usually the transition stage can be used to maintain performance with other fun sports so that when entering the initial preparation, their physical condition is maintained (Yudhistira, 2023).

Then what does the periodization of exercise have to do with intensity and volume. In the periodization of exercises and training programs that are prepared with intensity and volume so that the training dose is in accordance with the training goals. To make it clearer, the illustration table is presented as follows:

Table 2. Illustration of exercise periodization

Training periodization																								
Phase	preparation																competition							Transition
Sub phase	General preparation								specific preparation								Pre competition						Main	
Micro	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Meso	1								2								3							

The author presents a simple illustration of the periodization of the exercise for six months. The author gives an example of the implementation of periodization of martial arts training to develop strength and power training.

1. The athlete's data recap is that he has been training for 2 years at the age of 18 years, weighing 70kg
2. Tests and measurements of 1 maximum rep were found to be 140kg
3. The application to general preparation is to develop a strength training program consisting of exercise items, exercise volume and intensity.
4. The intensity of strength training is 60% x 140 = 84. The athlete exercises squats with a weight of 84 x 8 reps x 4 sets = 2,688. The athlete performed squat exercises in one session, the total volume was 2,688.
5. The intensity and volume are carried out from micro 1 to 4, then the volume is increased by increasing the reps, loads or sets from micro to 5 to 8.
6. Then enter the special preparation will be given power training with the plyometrics method with hurdles. Athletes jump with a hurdle 20 times x 5 sets = 100 contacts. This means that the volume of practice in one session is 100. If you want to increase the intensity, you can shorten the recovery time, if you want to increase the volume by increasing the reps and or sets
7. In pre-competition preparation, athletes can maintain increased training intensity but relatively low volume. The strategy is that athletes can do the maximum number of punches or kicks as much as possible, but the sets and reps are reduced so that there is no excessive fatigue but the performance is maintained.

CONCLUSION

Based on the description above, the author concludes that the exercise program cannot be separated from the intensity and volume. Intensity and volume are like the heart of the training program, when the type and model of training have been arranged but the volume and intensity settings have not been compiled cannot be called an exercise program. It should be noted that the training intensity setting is adjusted to what type of exercise is used, if the exercise is related to the respiratory system, the intensity of the exercise can be measured by pulse, while the intensity setting of strength training can be measured by the weight of the weight in kilograms, while the volume of the exercise consists of sets, reps, distance, time so it is necessary to pay attention to what type of exercise is used. The author's hope is that this article can provide information and reference in the preparation of the training program. Although this writing has been compiled, there are limitations such as the study written is still a narrative review, not specific to martial arts or games. It is hoped that the authors of the study can further improve this research.

Conflict of Interest

All authors declare no conflict of interest

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REFERENCES

Bafirman, & Wahyu, Sujana, A. (2018). *Pembentukan kondisi fisik*.

Bompa O. Tudor, B. A. C. (2019). *Periodization theory and methodology of training*. Human Kinetics, Inc. https://doi.org/https://doi.org/10.5040/9781718225435

Budiwanto, S. (2012). *Metodologi Latihan Olahraga*.

Epley, B. (1985). Poundage chart. Lincoln. *Boyd Epley Workout. Lincoln, NE: University of Nebraska*.

Hartono, M., Akhiruyanto, A., & Yudhistira, D. (2024). *Massed and Distributed Practice : What is the Best Method to Improve Young Dribbling Skills of Football Players ? 12*(1), 18–25. https://doi.org/10.13189/saj.2024.120103

Hidayah, T., & Akhiruyanto, A. (2023). *The effect of LTAD-based programming on fundamental skills and physical abilities of basketball players aged 11-12 years*. *7989*, 909–917. https://doi.org/10.17309/tmfv.2023.6.13

Hidayah, T., Akhiruyanto, A., & Yudhistira, D. (2024). Critical Systematic Review : Linear and Nonlinear What Is A Training Periodization Model ? *Proceedings of*

International Conference on Physical Education, Health, and Sports, *2016*, 417–426.

Kataoka, R., Vasenina, E., Loenneke, J., & Buckner, S. L. (2021). Periodization: Variation in the Definition and Discrepancies in Study Design. *Sports Medicine*, *51*(4), 625–651. https://doi.org/10.1007/s40279-020-01414-5

Lach, J., Śliż, D., Wiecha, S., Price, S., Brzozowski, A., & Mamcarz, A. (2022). How to calculate a maximum heart rate correctly ? *Folia Cardiologica*, *17*(4), 289–292. https://doi.org/10.5603/FC.2022.0057

Martens, R. (2012). Successful Coaching. In *The Coaching Process*. https://doi.org/10.4324/9780203857427-10

Sidik Z. Dikdik. (2019). Pelatihan kondisi fisik. Bandung: Remaja Rosdakarya.

Yudhistira, D. (2023). Development of a special preparation period physical training model to improve power, agility and endurance in senior kumite karateka (Doctor Disertation). In *Program Doktor Fakultas Ilmu Keolahragaan dan Kesehatan, Universitas Negeri Yogyakarta* (Vol. 4, Issue 1).

Yudhistira, D., Kurnianto, H., Ariestika, E., Ikhsan Rizkyanto, W., & Ramadhan, K. (2023). Enthusiastic Students of Poltekkes Semarang Participated in Self-Body Weight Training in the Covid-19 Era: A Survey Study Enthusiastic Students of Poltekkes Semarang Participated in Self-Body Weight Training in the COVID-19 Era: A Survey Study. *Gandrung*, *4*(1), 754–762. https://doi.org/https://doi.org/10.36526/gandrung.v4i1.2399

Yudhistira, D., Kurnianto, H., Candra, A., Ulinnuha, R., & Wicaksono, A. (2023). Tapering in the Sport of Karate: Narrative Review. *Proceeding ISPHE*. https://doi.org/10.4108/eai.29-6-2022.2326103

Yudhistira, D., Siswantoyo, Tomoliyus, Sumaryanti, Tirtawirya, D., Paryadi, Virama, L. O. A., Naviri, S., & Noralisa. (2021). Development of agility test construction: Validity and reliability of karate agility test construction in kata category. *International Journal of Human Movement and Sports Sciences*, *9*(4), 697–703. https://doi.org/10.13189/saj.2021.090413

Yudhistira, D., Suherman, W. S., Wiratama, A., Wijaya, U. K., Paryadi, P., Faruk, M., Hadi, H., Siregar, S., Jufrianis, J., & Pratama, K. W. (2021). Content Validity of the HIIT Training Program in Special Preparations to Improve the Dominant Biomotor Components of Kumite Athletes. *International Journal of Human Movement and Sports Sciences*, *9*(5), 1051–1057. https://doi.org/10.13189/saj.2021.090527

Yudhistira, D., & Tomoliyus. (2020). Content validity of agility test in karate kumite category. *International Journal of Human Movement and Sports Sciences*, *8*(5), 211–216. https://doi.org/10.13189/saj.2020.080508