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Analysis Of Energy Expenditure, Energy Consumption, And Training Load Of Sepaktakraw Athletes

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***Abstract*--This study aims to assess the load exercise of sepaktakraw athletes based on the heart rate of athletes. This survey research uses a quantitative approach. The subjects were 20 sepaktakraw athletes. The initial stage was to take athlete heartbeat data before and after exercise. The next process were calculating energy expenditure, energy consumption, and cardiovascular load (% CVL) for the exercise load assessment process. The resulting output was a classification of the exercise load of sepaktakraw athlete and recommendations for sepaktakraw athletes. The result of CVL% calculation shows that 20 sepaktakraw athletes are in the range 30% up to 60% CVL so that classification needs improvement.**

Keywords—energy expenditure, energy consumption, cardiovascular load, and sepaktakraw.

I. INTRODUCTION

Sepaktakraw is one of the sports that requires great energy and is done with high intensity while playing. Sepaktakraw is a fast and action-packed sport, especially when doing smash, block and service techniques and observed for no more than 1-5 seconds, so sepaktakraw requires excellent physical conditions for supporting athlete performance in the field [1].

The physical condition of an athlete is strongly influenced by physiological needs, as the physiological needs are intended to be able to release energy in a short time when athletes perform physical activities in sports [2]. By doing sports activities regularly, there will be changes in the body according to type, duration, and intensity of exercise performed [3].

A well planned and programmed exercise program will have a better impact on the performance of athletes [4]. Regular exercise with adequate doses will cause changes in the heart, blood vessels, lungs, muscles, bones, ligaments and tendons, joints and cartilage, and acclimatization to heat [5]. During physical exercise, the amount of oxygen that enters the bloodstream in the lungs increases as the amount of oxygen added in each unit of blood and lung blood flow per minute increases [6].

One indicator to see the intensity of the sport being done is the pulse. The pulse can provide an overview of the general physical condition and especially describes the ability of the cardiovascular system. For that pulse measurement correctly will be able to provide a picture of the real conditions [7].

Routinely pulse measurements are used to assess the heart's response to exercise, or recovery after exercise, and to determine the intensity of exercise [8]. The pulse is a flow of heart rate calculated per minute with repetition (times/min), with a normal pulse of 60-100 times/min. The pulse is the frequency of rhythm pulse/palpable pulse on the skin surface at certain places. Pulse frequency is generally the same as the beat / heart rate.

Knowing the pulse of an athlete can predict the amount of energy required to perform physiological functions and physical activity performed (energy expenditure), then can be used as a benchmark determining the weight or light of a physical activity (energy consumption) and to determine the classification of the load exercises based on an increase in the working pulse compared to the maximum pulse rate (cardiovascular load).

Based on the theoretical statements, physiological measurements closely affect the ability of an athlete's physical condition, so it is important to know the athlete's physiological condition specially in sepaktakraw, then this research will analyze the physiological condition sepaktakraw athlete based on athlete’s heart beat.

II. METHOD

This research was conducted at Faculty of Sport Science Universitas Negeri Makassar. Subjects in this study were FIK UNM 2018 sepaktakraw athletes inhabit 20 male athletes. This study began by taking restriction pulse data of sepaktakraw athlete (DN0) taken at the time of before training or under normal condition and after 4 hours of training, work pulse data (DN1) was taken. The pulse measurement process is performed on the upper front arm wrist of the base of the thumb (radial artery). After measuring the pulse, the next step was to calculate the energy expenditure, energy consumption, and training load by calculating the cardiovascular load (% CVL). To calculate energy expenditure a form of energy relation with pulse rate was used as a formula as follows.

A. Energy Consumption

After doing the above calculation, we can calculate the energy consumption by using this equation:

$$KE = Et - Ei$$

Annotation:
KE: Energy consumption (kilocalorie/min)
Et : Expenditure of energy after training (kilocalorie/min)
Ei : Energy expenditure at rest (kilocalorie/min)

B. Cardiovasculair Load

To determine the classification of workloads based on the increase in work-rate compared with the maximum pulse rate due to cardiovascular burden (*cardiovasculair load* = % CVL) can be calculated by the following formula.

$$\% \text{ CVL} = \frac{100x\,(DNK - DNI)}{DN\ Max - DNI}$$

Annotation:
CVL : *Cardiovasculair load*
DNK : Working pulse
DNI : Resting Pulse
DNmax : Maximum pulse rate

III. RESULTS

A. Sepaktakraw Athletes Pulse Data

Measurement results of resting pulse rate (DNI) and working pulse rate (DNK) sepaktakraw athletes in full results can be seen in Table 1 as follows.

TABLE I. MEASUREMENT RESULTS OF RESTING PULSE OF SEPAKTAKRAW ATHLETES.

No.	Subjects	Heart Rate	
		DNI	DNK
1.	Subjects 1	65	115
2.	Subjects 2	68	104
Table 1. cont.			
3.	Subjects 3	62	99
4.	Subjects 4	70	112
5.	Subjects 5	64	100
6.	Subjects 6	76	115
7.	Subjects 7	68	113
8.	Subjects 8	63	99
9.	Subjects 9	65	101
10.	Subjects 10	62	102
11.	Subjects 11	70	114
12.	Subjects 12	63	98
13.	Subjects 13	60	99
14.	Subjects 14	65	112
15.	Subjects 15	70	108
16.	Subjects 16	77	116
17.	Subjects 17	60	99
18.	Subjects 18	65	100
19.	Subjects 19	60	98
20.	Subjects 20	68	113

Calculation of energy consumption using the above formula, the calculation results can be seen in Table 2 as follows.

TABLE II. ENERGY CONSUMPTION CALCULATION

No.	Subjects	Heart Rate		*Et*	*Et*	*KE*
		DNI	DNK			
1.	Subjects 1	65	115	5,409	2,308	3,101
2.	Subjects 2	68	104	4,524	2,427	2,096
3.	Subjects 3	62	99	4,160	2,197	1,963
4.	Subjects 4	70	112	5,156	2,512	2,643
5.	Subjects 5	64	100	4,231	2,270	1.961
6.	Subjects 6	76	115	5,409	2,788	2,620
7.	Subjects 7	68	113	5,309	2,512	2,897
8.	Subjects 8	63	99	4,160	2,233	1,927
9.	Subjects 9	65	101	4,303	2,308	1,995
10.	Subjects 10	62	102	4,376	2,197	2,178
11.	Subjects 11	70	114	5,323	2,512	2,811
12.	Subjects 12	63	98	4,090	2,233	1,857
13.	Subjects 13	60	99	4,161	2,128	2,032
14.	Subjects 14	65	112	5,156	2,308	2,848
15.	Subjects 15	70	108	4,832	2,512	2,320
16.	Subjects 16	77	116	5,495	2,837	2,657
17.	Subjects 17	60	99	4,160	2,128	2,032
18.	Subjects 18	65	100	4,231	2,308	1,923
19.	Subjects 19	60	98	4,090	2,128	1,962
20.	Subjects 20	68	113	5,239	2,428	2,812
	$\sum x$	1321	2117	93,814	47,274	44,676
	$\bar{x}$	66,05	105,85	4,691	2,363	2,233

Cardiovascular load calculation results can be seen in Table 3 as follows.

TABLE III. CARDIOVASKULER LOAD CALCULATION RESULTS.

No.	Subjects	DN Kerja	DN Istirahat	DN Maximal	CVL
1.	Subjects 1	115	65	169	48,0769
2.	Subjects 2	104	68	165	37,1134
3.	Subjects 3	99	62	160	37,7551
4.	Subjects 4	112	70	173	40,7767
5.	Subjects 5	100	64	168	34,6153
6.	Subjects 6	115	76	172	40,6250
7.	Subjects 7	113	68	170	44,1176
8.	Subjects 8	99	63	172	33,0275
9.	Subjects 9	101	65	180	31,3043
10.	Subjects 10	102	62	166	38,4615
11.	Subjects 11	114	70	175	41,9047
12.	Subjects 12	98	63	164	34,6534

Table III. Cont.					
13.	Subjects 13	99	60	165	37,1428
14.	Subjects 14	112	65	173	43,5185
15.	Subjects 15	108	70	166	39,5833
16.	Subjects 16	116	77	170	41,9354
17.	Subjects 17	99	60	170	35,4545
18.	Subjects 18	100	65	170	33,3333
19.	Subjects 19	98	60	175	33,0434
20.	Subjects 20	113	68	174	42,4528

The results of cardiovascular load calculations are then compared with the classification that has been set as follows.

TABLE IV. CLASSIFICATION OF EXERCISE LOADS BASED ON INCREASE OF HEART RATE.

% CVL	Clacification % CVL
< 30%	No fatigue
30% – 60%	Repair requires
60% – <80%	Working in short time
80% – <100%	Immediate action is required
> 100 %	Activities are prohibited

Source: Manuaba & Vanwonteerghem, 1996.

The results of pulse measurement and athlete oxygen consumption of 20 subjects in the study showed a difference, this is influenced by several factors, namely: age, weight, gender, health, and the person's activities. The pulse is a simple and informative parameter to measure the height of one's body activity [9].

The results showed that the cardiovascular load of 20 subjects of sepaktakraw athlete in the range% CVL of 30% to 60%, so the recommendation given is that improvement is needed. The suggested improvement may be an evaluation of the exercise program on the physical exercise load (dose) consisting the athlete's intensity of exercise, the frequency of the exercise, the duration of the exercise, and the type of exercise.

By doing a regular dose of exercise, there will be changes in the body according to type, duration, and intensity of exercise performed [3]. Dose is a measurable physical exercise load containing elements: intensity, frequency, duration, and type of exercise. The dose of exercise is a systematic attempt to prepare an athlete with the goal of achieving excellence and being ready to compete. Exercising one's physical condition is a planned effort to improve the functional body in physical aspect and is a very important factor for an athlete [10].

IV. CONCLUSION

Based on the results of this study, the conclusions in this study are:

- The results is cardiovascular load calculation of 20 athletes subjects in the range% CVL 30% to 60% so that the recommendation given is the need for improvement.
- The suggested improvement is that the evaluation of the exercise program can be done on the physical exercise load (dose) by increasing the intensity of the exercise, the frequency of exercise, the duration of exercise, and the type of exercise.

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