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Influence of 12 weeks of basketball training on college students' heart function

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Abstract. – OBJECTIVE: This study aims to investigate the influence of 12 weeks of basketball training on college students' heart function.

SUBJECTS AND METHODS: The subjects were 30 college male basketball players. Carry out 8-week interval training, monitor the training load and interval time of athletes, and strictly control the heart rate during the interval. Before and after training, we used safe and effective experimental instruments – without any damage to the athletes – to detect the relevant indicators of the athletes' physiological functions; hence we compared and analyzed the various indicators before and after training.

RESULTS: The time domain indexes Roo[illegible] Square of Successive Differences (RMSS[illegible] tistically Determined Spatial Drift (SDSD) [illegible]centage of NN50 in the total number of NN [illegible]vals (PNN50), and Standard Deviation of all NN [illegible]tervals for all 5-min segment (SDNN) after traini[illegible] were significantly higher than [illegible]ore training, and the differences wer[illegible] significant ($p<0.05$). Average ([illegible]) and [illegible]tistically Determined Allocatio[illegible]ghts ([illegible] training were significantly [illegible] fore training, the diff[illegible]ce [illegible]stically significant ($p<0.05$); A[illegible]metry (A[illegible]nd Tension index (TI) were si[illegible]antly lower [illegible]hose before training, th[illegible]ce was stat[illegible]ally significant ($p<0$[illegible] Ap[illegible]n Information Index (ApInf) ha[illegible] no significa[illegible]fference ($p>0.05$). There wa[illegible] significant [illegible]ce in shooting hit rate [illegible]0.05). The speed [illegible] the 8-character dribb[illegible] the w[illegible] field after training was signifi[illegible]y low[illegible]an that before training, and the diffe[illegible] statis[illegible]y significant ($p<0.05$). There [illegible] signif[illegible] difference in average [illegible] heig[illegible] maxi[illegible] jump height, average time [illegible]ir, an[illegible]p time in the air after training [illegible]0.05). F[illegible]e test of athletes' explosive po[illegible] five vertical jumps in situ were selected f[illegible] the jump height and time in the [illegible] of each vertical jump were counted to calcu[illegible] the maximum and average values of five ver[illegible]umps. The results showed that there was no si[illegible]ant change in the explosive force of the athle[illegible]s' lower limbs after training. The reason may be that strength training needs to follow the principles of he[illegible]oad, [illegible]lizati[illegible]xercise sequence and [illegible]sonable i[illegible] intermittent trainin[illegible]d used du[illegible]ning is not specialize[illegible] s[illegible]h training, a[illegible] the reasonable inte[illegible] of st[illegible] training was not considered in the training p[illegible].

C[illegible]SIONS: Inte[illegible]nt training can inc[illegible] the tension of the cardiac vagus nerve [illegible]ollege basketball players, increase the car[illegible] reserve fu[illegible]n and the load that the heart [illegible]bear, so tha[illegible] cardiac function can be imp[illegible] well. It c[illegible]mprove the cardiopulmonary fu[illegible] and [illegible]ic work ability of college basketba[illegible] It can improve the adjustment ability of the heart, lungs, liver, and other organs [illegible] college basketball players. It also can increase [illegible]tensity that the central nerve can bear [illegible]ove the function of the central nerve and autonomic nerve. The anti-fatigue ability of athletes can be improved. It can improve the speed quality of college basketball players.

Key Words:
College student, Basketball, Interval training, Physiological function index.

Introduction

With the development of basketball, the action's rhythm in basketball matches is accelerating, and the confrontation degree is also constantly strengthening, which has a higher requirement for the physical quality of athletes[1,2]. Basketball is a combination of aerobic and anaerobic sports[3]. Therefore, it is particularly important to improve the physiological function level and competitive ability of basketball players by deeply understanding their metabolic characteristics and physiological function status[4-7]. This research aims to improve the physical function level of college basketball players in an all-around way. During the winter vacation, the college basketball players were trained for 8 weeks by using the intermittent

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training method, and the impact of the intermittent training method on the physical function level of basketball players was analyzed.

Subjects and Methods

Research Object

The subjects were 30 male college basketball players. Basic information on the subjects is shown in Table I.

Experimental Methods

Eight weeks of interval training are required, and athletes' training load and interval time are monitored. During intervals, it is necessary to strictly control the heart rate. Before and after training, we used safe and effective experimental instruments – without any damage to the athletes – to detect the relevant indicators of the athletes' physiological functions and afterward, we compared and analyzed the various indicators before and after training.

Training Methods

Interval training method was adopted. [illegible] the training process, the heart rate during [illegible]n-terval was strictly controlled to ensure that [illegible] interval could make the athlete's heart rate re[illegible]ver to 120-130 times/min, and th[illegible]t group [illegible] training was carried out. Duri[illegible]rval, the enthusiasm recovery metho[illegible]dopte[illegible]he training content was divided[illegible] two pa[illegible] first part included a basic tra[illegible]an[illegible] training, the second [illegible] inc[illegible]hysical quality, technical and [illegible]cal coope[illegible][8-9]. During training, the athlete's heart rate was monitored according to the heart rate value displayed on the polar table[10]. Rest when the heart rate [illegible] training and technical and tactical [illegible] training reaches 160-170 times/min[illegible] rest when the heart rate of resistance trai[illegible]nd physical fitness training reaches 180-190 ti[illegible]n.

A one-week test was con[illegible]ted be[illegible] training, including relevant in[illegible]ors of Ome[illegible] physiological function te[illegible]stem, c[illegible]diopulm[illegible] function test system a[illegible]asketb[illegible]pecific ability. After the test, the trai[illegible]te[illegible]12 wee[illegible]After the training, the [illegible]ant[illegible]s of O[illegible] Wave physiological [illegible]ion test [illegible]opulmonary functi[illegible]system and [illegible]all specific physical f[illegible]s w[illegible]sted repeated[illegible]y.

Stati[illegible] Analysis

[illegible]ftware shall b[illegible]ed to input and sort [illegible]he data, and the data shall be processed and [illegible]yzed throu[illegible]SPSS 25.0 (IBM Corp., Ar[illegible]k, NY, USA[illegible]he paired sample *t*-test was c[illegible]ted for t[illegible]est data before and after the exp[illegible]e significance level was set as $p<0.05$. [illegible]hi-square test was conducted for [illegible]he number (%) of the central nervous system and [illegible]dicators at different levels. All data are [illegible]pr[illegible]d as mean ± standard deviation.

Results

Heart Rate Variability

The analysis of heart rate variability (HRV) can be divided into time-domain analysis and frequency-domain analysis. The frequency-domain

Table I. Basic in[illegible]mation o[illegible]bjects.

Sample [illegible] (person)	[illegible]	Weight (kg)	Height (cm)	Athlete Grade
30	20.55±1.55	83.52±12.06	187.82±7.63	Second-grade Athlete

[illegible] II. C[illegible]f ti[illegible]main indexes of heart rate variability before and after training.

In[illegible]	[illegible]efore training	After training	*t*-value	*p*-value	Effect amount d
S[illegible]	62.23±25.06	71.04±20.45	-2.247	0.040	0.39
[illegible]SSD ([illegible]	58.42±27.28	75.49±24.81	-4.125	0.000	0.66
[illegible]DSD (ms)	75.15±25.13	98.53±30.47	-4.273	0.000	0.80
[illegible]N50 (ms)	17.55±9.76	24.45±7.40	-4.187	0.000	0.81

Sta[illegible] Deviation NN intervals for all 5-min segment (SDNN); Root Mean Square of Successive Differences (RMSSD) reflects the regulatory capacity level of vagus nerve; Statistically Determined Spatial Drift (SDSD); NN50 in the total number of NN intervals (PNN50).

analysis can make up for the deficiency of time-domain analysis. Based on the time-domain analysis, further analysis of HRV is carried out. In the time domain indicators, Standard Deviation of all NN intervals for all 5-min segment (SDNN) reflects the overall activity level of sympathetic nerve and vagus nerve, which is used to evaluate the overall regulatory capacity of the cardiac autonomic nervous system. Root Mean Square of Successive Differences (RMSSD) reflects the regulatory capacity level of vagus nerve, as well as the Statistically Determined Spatial Drift (SDSD). The percentage of NN50 in the total number of NN intervals (PNN50) also measures the regulatory capacity of vagus nerve on cardiac rate variability.

According to the results in Table II, the time domain indexes RMSSD, SDSD, PNN50, SDNN after training were significantly higher than those before training, and the differences were statistically significant (p<0.05). It shows that the vagus nerve regulation ability of basketball players is enhanced after training. SDNN represents the overall regulatory capacity of sympathetic nerve and vagus nerve; RMSSD, SDSD and P[illegible]50 all reflect the vagus nerve tension. The [illegible] of SDNN does not fully represent the [illegible]ncement of sympathetic nerve regulation a[illegible] of athletes, so it needs to be further discus[illegible] with frequency domain indicato[illegible]he effect [illegible] RMSSD is 0.66, showing a [illegible]fect; the effect amount of SDSD=0.8[illegible]owing [illegible]medium effect; the effect of PN[illegible]s 0.81[illegible] high effect. It can be co[illegible] indicators are greatly[illegible]cted [illegible] independent variable interval t[illegible]g metho[illegible]

Changes in [illegible]di[illegible]nction

Accordi[illegible] the resu[illegible]wn in Table III, the average a[illegible]tandard devia[illegible]fter training were signi[illegible]ntly higher than th[illegible] before training and [illegible] differe[illegible] was statistically significant (p<0.05). Asym and TI were significantly lower than those before training, and the difference was statistically significant (p<0.05), A[illegible] no significant difference (p>0.05). I[illegible] after training, the regulation deg[illegible] of central nervous system on heart activi[illegible]reases and the training effect is significantly[illegible]thened. It can also be seen that t[illegible] fatigu[illegible]e is significantly reduced, a[illegible]e stress [illegible] has no significant cha[illegible] The c[illegible]diac fu[illegible] reserve is significant[illegible]crease[illegible]nd the vagus nerve influence facto[illegible]d. The [illegible]mpathetic nerve inf[illegible]e [illegible]s weak[illegible]d, and the athletes' c[illegible]c functio[illegible]la[illegible]ability is significantly[illegible]ved after t[illegible] The effect amount of [illegible]N[illegible]55, which sh[illegible]ws a medium effect. Th[illegible] effect a[illegible]t of Statistically Determined [illegible]cation Wei[illegible]DAW) is 0.48, close to [illegible]ium effect. It [illegible] be considered that t[illegible]bove indicators are greatly affected by the [illegible]ependent va[illegible]e interval training method.

[illegible]verage (Ava[illegible]flects the stress level of card[illegible]nction s[illegible] asymmetry (Asym) reflects whe[illegible]ac function regulation mechanism is [illegible]ized, Tension Index (TI) reflects the tension index, Application Information Index [illegible]reflects the strength of stress response, [illegible]d [illegible]W reflects the level of functional reserve. The TI is jointly determined by Avag, Asym, ApInf and SDAW. It reflects whether the regulatory mechanism of cardiac function is mobilized. When the index is lower than Qiao, it indicates that the vagus nerve is stronger, the sympathetic nerve is weaker, and the regulatory mechanism of cardiac function has been mobilized. When the index is higher than 180, it indicates that the sympathetic nerve is stronger, and the vagus nerve is weaker in the process of cardiac function regulation. In the process of respiration, it will also have a corresponding impact on heart rate. SDAW index mainly reflects the tension of cardiac vagus nerve, which is the index of the impact on heart

[illegible]e III. [illegible] of c[illegible] function indexes before and after training.

I[illegible] influe[illegible]tor	Before training	After training	*t*-value	*p*-value	Effect amount d
A[illegible]	0.16±0.08	0.21±0.08	-2.853	0.005	0.55
[illegible]m	35.35±11.23	30.52±7.48	2.795	0.011	0.53
[illegible]	86.20±62.21	57.78±34.62	2.817	0.011	0.54
[illegible]Inf	1.60±0.27	1.52±0.16	1.03	0.255	0.24
[illegible]V	0.015±0.011	0.020±0.007	-2.970	0.004	0.48

Average (Avag); Asymmetry (Asym); Tension Index (TI); Application Information Index (ApInf); Statistically Determined Allocation Weights (SDAW).

rate variability caused by faster heart rate due to inspiration and slower heart rate due to expiration. Avag and Asym indicators mainly reflect the training effect and fatigue level of athletes.

Intermittent training can effectively improve the vagus nerve tension of athletes. The increase of vagus nerve can effectively inhibit the excitability of the heart, reduce the number of heart beats, and reduce the heart rate. The acceleration of heart rate will lead to insufficient ventricular filling, which will affect the blood pumping function of the heart. At the same time, it will increase the energy consumption of the heart muscle, which can easily lead to myocardial fatigue. Therefore, the increase of vagus nerve excitability after training can better inhibit the beating of the heart, reduce the occurrence of myocardial fatigue, reduce the fatigue index and tension index, and play a good role in the functional reserve of the heart.

Discussion

According to the results in Table IV, there is no significant difference in shooting hit rate (p>0.05). The speed of the 8-character dribble in the whole field after training is significantly lower than that before training, and the differences are statistically significant (p<0.05). It shows that the movement speed of basketball players has been significantly improved after training, and the shooting percentage has not changed significantly. And the effect amount of the whole field eight-character dribble [illegible] d=0.64, [illegible] a medium effect. It can be considered that the above indicators are greatly affected by the independent variable interval training, and the change in shooting hit rate is related to multiple factors. It is a long-term accumulation process, which requires targeted training. The intermittent training method adopted during this training mainly aims at improving the athletes' physical fitness and the stable use of skills and tactics. The shooting hit rate has not been significantly improved, but its stable play is maintained. The increase of movement speed is consistent with several research results. Interval training can enhance the movement speed of athletes.

Speed quality is very important in basketball. It is essential in the fast break, forward court promotion, offensive and defensive conversion, rebounding, and dribbling. The intermittent training method adopts active rest during intervals. The respiratory system and central nervous system are still in an excited state, which is of great significance for the improvement of athletes' speed quality.

According to the results in Table V, there is no significant difference in average jump height, maximum jump height, average time in the air, and best jump time in the air after training (p>0.05). In the test of athletes' explosive power, five vertical jumps in situ were selected for testing, and the jump height and time in the air of each vertical jump were counted to calculate the maximum and average values of five vertical jumps. After each vertical jump, there is enough time to rest, which can ensure that each jump has sufficient preparation and power accumulation time and ensure that each vertical jump athlete can exert maximum strength.

The results show that there is no significant change in the explosive force of the athletes' lower limbs after training. The reason may be that strength training needs to follow the principles of heavy load, specialization, exercise sequence, and reasonable interval. The intermittent

Table IV. Changes in specific abilities before and after training.

Index	Before training	After training	*t*-value	*p*-value	Effect amount d
One-minute shooting hits ([illegible])	9.22±3.34	10.29±4.18	-1.334	0.150	0.32
Eight-character dribble time (sec)	41.82±3.72	39.13±4.02	5.03	0.000	0.64

Table V. The changes of five vertical jump indexes before and after training.

Index	Before training	After training	*t*-value	*p*-value	Effect amount d
Average jumping height (cm)	42.06±6.68	42.01±4.04	0.060	0.833	0.01
Maximum jumping height (cm)	44.40±6.07	44.23±5.27	0.176	0.742	0.02
Average dead time (ms)	590.40±44.67	590.34±33.86	0.001	0.881	0.00
The best jump time (ms)	606.30±45.44	605.52±35.01	0.134	0.775	0.03

training method used during training is not specialized in strength training, and the reasonable interval of strength training is not considered in the training process.

The explosive power is mainly provided by anaerobic metabolism, which is composed of phosphate energy supply system and glycolysis energy supply system. It reflects the ability of human muscle to provide energy through anaerobic metabolism. The improvement of glycolysis energy supply system is mainly carried out through maximum lactic acid training and lactic acid tolerance training. The training is generally required to be more than 30 seconds, and 1-2 minutes is the most appropriate to maintain a certain functional state, stimulate the blood lactic acid level of the body, and improve the buffer capacity and the activity of lactate dehydrogenase in the muscle. The results of interval training show that it has a significant effect on the improvement of aerobic metabolism but has no significant effect on the improvement of anaerobic metabolism.

Conclusions

According to the experimental analysis, the following conclusions are drawn: (1) intermittent training can improve the tension of the cardiac vagus nerve of college basketball players, increase the cardiac reserve fu[illegible] the load that the heart can bear, and improve [illegible] cardiac function. (2) Intermittent training c[illegible] improve the cardiopulmonary function and [illegible]king ability of college basketball players. (3) Intermittent training can improve [illegible] adjustment ability of the he[illegible]s, liver, and [illegible] organs of college basketball players, increase the load intensity that the central [illegible] can bear, improve the function of the central [illegible] and autonomic nerve, [illegible] improve the anti-fatigue ability of athletes. [illegible] interval training can improve the speed qu[illegible] of college basketball players.

At [illegible] time, [illegible] paper also has some suggestions: [illegible] According to the physical quality [illegible] college [illegible] players, formulate corresponding scientific training programs, strictly mo[illegible] the training heart rate to better improve th[illegible]rts ability of athletes, and reasonably arrange the number, time, and intensity [illegible]raining. (2) Reinforce the strength quality a[illegible]ility training of college basketball players. (3) Increase the richness of training content and strengthen the subjectivity of athletes' training. (4) Intermittent training can be combined with other training methods to train athletes more comprehensively.

Conflict of Interest

The Authors declare that they have no co[illegible] interests.

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Informed Co[illegible]t

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Ava[illegible] of Date an[illegible]terials

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References

1) Pondeljak N, Lugović-Mihić L. Stress-induced Interaction of Skin Immune Cells, Hormones, and Neurotransmitters. Clin Ther 2020; 42: 757-770.
2) Kannan S, Shaik SA, Sheeza A. Monkeypox: epidemiology, mode of transmission, clinical features, genetic clades and molecular properties. Eur Rev Med Pharmacol Sci 2022; 26: 5983-5990.
3) Rinaldi VE, Alonzo RD, Di CG, Verrotti A. COVID-19 and abdominal pain: a pediatric case report and a point of view in pediatric emergency medicine. Eur Rev Med Pharmacol Sci 2021; 25: 7115-7126.
4) Alemdar M. Abdominal epilepsia partialis continua in a patient with astrocytoma treated with Lacosamide - value of repetitive EEG recordings. Eur Rev Med Pharmacol Sci 2021; 25: 6277-6282.
5) Chen F, Zhao X. Systematic family therapy for the psychological support of the public under the COVID-19 epidemic. Int J Psychiat 2020; 47: 4-11.
6) Mukdes H, Cheng J, Zhang L. Effects of intensive psychological support intervention on adverse reactions, psychological resilience and quality of life of patients with

ovarian cancer undergoing chemotherapy. Cancer Prog 2020; 18: 4-9.

7) Zhang B, Dong Y. Analysis of the value of language communication combined with psychological support in urodynamic examination of patients with BPH. Basic Med Forum 2020; 24: 3488-3489.

8) Li Z, Zhang Z. Research on psychological support and counseling model under COVID-19. Health Med Res Pract 2020; 17: 5-16.

9) Brasil DL, Montagna E, Trevisan CM, La Rosa VL, Laganà AS, Barbosa CP, Bianco B, Zaia V. Psychological stress levels in women with endo[illegible]sis: systematic review and meta-analy[illegible] vational studies. Minerva Med 2020[illegible]

10) Yan S, Xu R, Stratton TD, Kavcic [illegible] D, Hou F, Bi[illegible] F, Jiao R, Song K, Jiang Y. Sex [illegible]ces and psychological stress: responses to th[illegible]D-19 pandemic in China. BMC Publi[illegible]ealth 2[illegible]79-89.