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The research about the evaluation index on cardiac reserve of female athletes

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Objective How well the heart and cardiovascular system operate will directly influence the ability that female athletes bear the training and competition load. The accurate evaluation of heart and cardiovascular system is the important part of female athletes training processes monitor and medical supervision. Nowadays, there are many evaluation index to assess the condition of the heart and cardiovascular system. Due to the differences of tested mechanisms, there are huge differences lay between the focus of index to show the cardiac function of female athletes. As a result, to clarify the significance of different evaluation index will be benefit to accurately evaluate the cardiac function of female athletes. This research clarifies different significance of different index to evaluate female athletes' cardiac function by comparing two indexes (CRI, HRr) to evaluate the cardiac contractility of female athletes in different programs, and also offers grounds for accurately applying these two indexes to evaluate female athletes' cardiac function.

Methods The study subjects of this research are the female athletes from sports team in Hubei province. We select 63 female athletes whose ages are between 14 and 18 and average age is 17 ± 1.6 . They have been trained to play basketball game, soccer, badminton or table tennis for more than four years. This research applies quantitative exercise experiment to get the cardiac index -- CI_2 ($CI = CO/BSA$) after the female athletes' doing sports. We can compare the difference between the cardiac indexes during the female athletes doing sports and they becoming calm and the work done by exercise load (PP) to get the cardiac reserve index (CRI). The formula of this process is $CRI = PP / (CI_2 - CI_1) / 10$. We can also dividing CRI by cardiac function index to get heart recovery rate (HRr). We divide CRI by CFI to get the value of HRr. $CFI = (HR_1 + HR_2 + HR_3 - 200) / 10$. Thereinto, HR_1 、 HR_2 、 HR_3 respectively mean the athletes' heart rates when they are calm, when they just finish doing sports and when they are in restoration stage. Data assessment and statistical analysis was performed in this research, using the value of female athletes' CRI and HRr in different programs.

Results There are huge differences between the average CRI values of female athletes in different programs. Among them, the highest value is 11.13 ± 1.1 , which is the average CRI values of female athletes who play soccer. And the lowest one is 7.56 ± 0.7 , which is the average CRI values of female athletes who play table tennis. The values of CRI of female athletes in basketball group and badminton group are 10.07 ± 0.9 and 7.82 ± 0.8 respectively. However, there is no significant difference between the values of female athletes' HRr in different groups. The values are 0.94 ± 0.05 (women's basketball), 0.97 ± 0.06 (women's football), 0.93 ± 0.04 (women's table tennis), 0.97 ± 0.08 (women's badminton) respectively.

Conclusions The phrase "cardiac reserve" means the ability that cardiac output can increase according to the need of the body's metabolism. When people do some vigorous exercise, sympathetic will be active, and adrenalin production will increase. At the same time, cardiac output will increase because of the increasing of heart rate reserve and mental efforts. The cardiac storage function can be more comprehensive reflected by the indexes such as heart rate and SV during people doing

sports and being calm .Cardiac reserve includes heart rate reserve and cardiac contractile capacity reserve. This research shows the condition of female athletes' cardiac reserve by using ultrasonic cardiography to directly test the change of cardiac output before and after people doing sports .Using this method ,we can get more straightforward results .Considering the big change of female athletes' height and weight during puberty ,we use the change of cardiac index to replace it of cardiac output .In this way ,we can make the assessment index more unique .When people do the same amounts of exercise ,the ones whose heart rate and cardiac output increase less have greater heart reserve .Therefore ,we can compare the work done by the exercise (PP) and the difference of cardiac index CI_1 and CI_2 to get cardiac reserve index (CRI) .

The research result shows that there are significant differences between the average value of female athletes' CRI in different programs .We can get the conclusion that the CRI has the typical item features .So we can apply CRI to be the assessment index which reflects the item features of female athletes .We can also apply CRI in selecting youth athletes of different programs .We can divide CRI by heart functional index to get HRr . Heart functional index can be figured out by calculating the HR_1 , HR_2 , HR_3 .It can reflect the heart health status of athletes .This research also shows that there is no significantly difference between female athletes' HRr in different programs .But this research do not include the data of normal women .As a result ,we still need to compare the test result of female athletes and that of normal women in the further research .According to the result of this research ,it is more reasonable and accurate to apply HRr to be the health assessment index of female athletes' cardiac function .