Cardiovascular Trainings

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Cardiovascular fitness is the most important element in the health-related fitness. It is the result of all kinds of combined physiologic performances. However, cardiovascular fitness gradually declines with increasing age which is a disputable fact. As the research finds out, the development of cardiovascular fitness begins to decline after people reach 16 years old. And after 25 years old, it declines annually by 1% in average (McArdle et al., 1991). In view of the facts that the age distribution of domestic exercise population goes towards the aging group and the high percentage of Taiwanese people who lack of the habit of regular exercise (Chin-Lung Fang, 1993 and Rui-Xia Wang, 1994), it is not difficult to imagine the health problems of Taiwanese people. Among them, the declining cardiovascular fitness is the most serious problem. Therefore, it is critical to face and solve the problem of cardiovascular fitness declination.

Overload Principle

In order to improve cardiovascular fitness, it is necessary to comply with the overload principle. The basis of applying the overload principle is to set the exercise load with formula of weight (kilogram) x distance (meter) / time span. If weight is heavier or distance is longer, the exercise load will be larger. Certainly, the required level of cardiovascular endurance shall be higher. Otherwise there will be health problems or activity efficiency issue. And this is the exact reason why cardiovascular endurance could be or must be trained.

How to carry out cardiovascular training?

a. Understanding the design concept of the training equipment:

Indoor sports auxiliary equipment: take treadmill and stationary bicycle as examples.

Treadmill or stationary bicycle is sports auxiliary equipment which is designed based on the principle of power. Treadmill allows the users to control its speed and slop level as desired, and the stationary bicycle users can also adjust speed and resistance by themselves. The most advantageous point of using these sports auxiliary equipment is that the users can make the correct adjustment according to their own physical condition or demand to apply the overload principle. The power of using a treadmill or stationary bicycle is calculated as the multiplier of the user's weight and the performed vertical distance. The calculation of vertical distance involves the inclination. Thus the basic structure of treadmill includes both speed and inclination controlling. And as to the structure of stationary bicycle, power is calculated by the distance between two pedals, and the distance is the multiplier of the wheel's circumference and turning speed.

b. Prediction of the maximum oxygen consumption (VO2max) or the maximal heart rate:

Doing long-time physical activities without fatigue is the main purpose for many people in training. The capability is called aerobic capacity and represented by oxygen consumption relative to weight and time (VO2 ml · kg-1 · min-1). While in research setting, maximum value is more often used as the indicator of cardiovascular function. The data of maximum oxygen consumption can be obtained from performing exhaustive exercises on treadmill or stationary bicycle. However for the middle-aged or aging people, it is not only dangerous but also unnecessary to carry out exhaustive exercise. Particularly for the people with cardiovascular diseases, it is far more dangerous to perform this test. Thus, the prediction methods of VO2max and the maximal heart rate are recommended.

Astrand VO2max prediction method

Due to the fact that VO2max declines with growing age, applying prediction method sometimes overestimates VO2max of middle-aged or aging people. Therefore, after obtaining the prediction value of VO2max, it is critical to make further corrections based on heart rate or age (see as Table 1 and Table 2). For example, the prediction value of VO2max of a female exerciser with body mass as 61 kg would be 2.4 liters. If she was 15 years old, her oxygen consumption shall be 2.4 liter x 1.1 = 2.64 liters. If she was 55 years old, her oxygen consumption shall be 2.4 x 0.71 = 1.704 liters. And for a female exerciser who weighs 61 kg and whose VO2max is 2.4 liters, if her maximal heart rate was 210 bpm, then her oxygen consumption shall be 2.4 liters x 1.12 = 2.688 liters. If her maximum heart rate was 170 bpm, her oxygen consumption shall be 2.4 liters x 0.75 = 1.8 liters.

Table 1 Oxygen consumption index table corrected based on age

Age	Index
15	1.10
25	1.00
35	0.87
40	0.83
45	0.78
50	0.75
55	0.71
60	0.68
65	0.65

Table 2 Oxygen consumption index table corrected based heart rate

Heart Rate	Index
210	1.12
200	1.00
190	0.93
180	0.83
170	0.75
160	0.69
150	0.64
140	0.68
130	0.65

1-mile walking prediction method

Walking for 1 mile (1.6 kilometers) as fast as possible and the heart rate should be elevated above 120 per minute. Taking consumed time, heart rate right after testing, and basic information into the formula, and calculate the prediction value of maximal oxygen consumption. The method is described as followed (Kline et al., 1987)

- Key-in basic information

  W: Weight, in pound unit. Convert kilograms into pounds (1 kilogram equals to 2.2 pounds)

  A: Age: Count the factual years.

  G: Gender. Mark male as 1; female as 0.

- Testing information

  T: Time span for completing 1-mile walking is recorded in minute unit to the hundredth. For example, 15 minutes and 25 seconds should be recorded as 15 + (25 / 60) = 15.42

  H: After completing exercise, record heart rate for 15 seconds, multiply four, and convert into heartbeat number for 1 minute.

- Put into the prediction formula of maximal oxygen consumption

  VO2max (ml · kg-1 · min-1) = 132.853 − (0.0769×W) − (0.3877×A) ＋ (6.315×G) − (3.2649×T) − (0.1565×H)

1.5-mile running and walking prediction method

1.5-mile (about 2.4 kilometers) running and walking is a simpler prediction method of VO2max (Brooks and Fahey, 1987). Time span (T) for completing 1.5-mile running or walking is recorded in minute unit to the hundredth. For example, 15 minutes and 25 seconds should be recorded as 15 + (25 / 60) = 15.42, and put into the prediction equation VO2max (ml. kg-1. min-1) = (483÷ T) + 3.5.

3-min step test

Use wooden box or stairway with 16.25-inche (41.3-centimeter) height to carry out the testing. Thy stepping rhythm for males is 96 bpm, and the participants should complete stepping cycles for 24 times. While in females, the rhythm is 88 bpm, and the 22 stepping cycles should be completed. After keeping stepping for 3 minutes, participants are required to rest in standing position. The heartbeat number from the 5th to 20th seconds after one minute rest after the end of stepping is recorded, and is multiplied by 4 to convert into the heart rate for 1 minute. Then the heart rate will be put into the prediction equation to gain maximal oxygen consumption. The formulas are presented below:

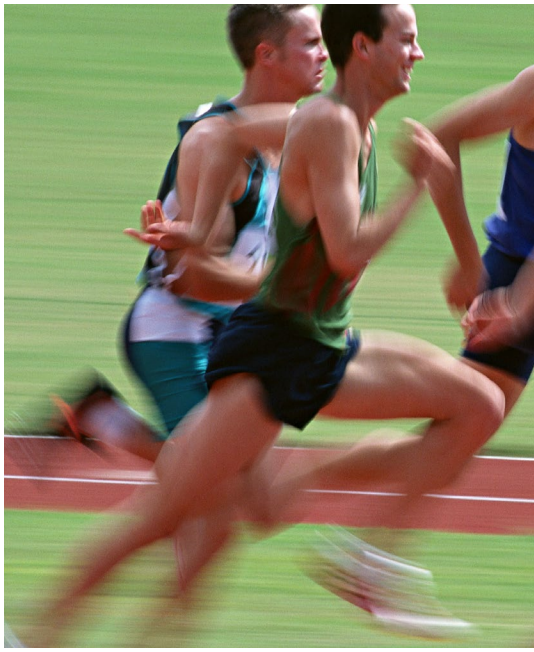
Male VO2max（ml · kg-1 · min-1）= 111.33 -（0.42×H）

Female VO2max（ml ·kg-1 ·min-1）= 65.81 – (0.1847×H）

Maximal heart rate prediction method

The data of heart rate should be gained via graded exhaustive exercise testing. The heart rate while reaching maximal oxygen consumption is recorded to represent the maximal heart rate. As mentioned previously, performing exhaustive exercise testing not only has potential danger, but also is not necessary indeed. Maximal heart rate can be gained via maximal heart rate prediction method which is commonly adopted by healthy people (ACSM, 1995). The equation is: maximal heart rate = 220 – age.

Setting exercise intensity



The improvement of cardiovascular fitness occurs under the condition that optimal exercise intensity continuously stimulates to improve the physical functions, such as efficiency of vascular circulating, neuromuscular coordination, energy metabolism and ventilation. It is the adaptive effect from long-term regulation to create a new homeostasis status (Astrand and Rodahl,1986; McArdle et al., 1994). As recommended by American College of Sports Medicine, the exercise intensity in an exercise prescription of aerobic exercise training for improving cardiovascular fitness should be set within the range of 50%-85% maximal oxygen uptake or 55%-90% maximal heart rate. It is also suggested that within the effective exercise intensity range, people could select lower exercise intensity to promote health and select higher exercise intensity to improve cardiovascular fitness (ACSM, 1995). Other relevant studies also indicate that the exercise intensity required to improve cardiovascular fitness should be at least above 40% maximal oxygen uptake. (Pollock et al., 1971; Wenger and Macnab,1975; Klinzing and Hazelton, 1982; Jette et al., 1988; ACSM, 1995; Wilmoreand Costill, 1994).

Another calculation method to decide exercise intensity is based on the training heart rate (THR). THR is built upon Karvonen's calculating method. The concept is based on the maximal heart rate reserve which refers to the difference between the maximal heart rate and the resting heart rate. And THR is a certain-percentage heart rate within the reserve range of the maximal heart rate plus the resting heart rate. The study shows that the training heart rate of exercise intensity which is calculated by Karvonen's method would correspond to the exercise intensity represented in percentage of maximal oxygen consumption (Davis and Convertino, 1975; Fahey et al., 1994). Suppose a person whose resting heart rate is 70 bpm and his maximal heart rate is 190 bpm, then 60%THR = 70 + 60% (190-70) =142 bpm.

The condition of establishing exercise intensity in previous statement is mostly based on running. For the middle-aged or the aging people, running might be an exhaustive exercise or having potential dangers. Thus, another issue which we shall not ignore is the choice of exercise modes.

Exercise mode

For the middle-aged or aging people who want to train cardiovascular fitness via stationary treadmill or bicycle, although having basic understanding about training methods and theories, it's still not convenient in daily life application. Thus, simple and effective training methods are worth promoting. The followings are three easy to learn training methods:

a. 12-minute running / walking training

The longest distance completed by running or walking for 12 minutes is taken as the standard of cardiovascular fitness. According to the research, cardiovascular function shows significant improvement after 8-week training, and three times per week.

b. 1.5-mile or 2-mile jogging

The required time to complete a given distance is taken as the standard of cardiovascular fitness. This distance-oriented way of training is more flexible for the middle-aged or aging people to make adjustment according to their physical condition so as to avoid accidents. After having training for 3 or 4 times a week, they will progress significantly after 10 weeks.

c. PWC150 (power work capacity) training

The work capability while heart rate is around 150 beats per minute is taken as a criterion. The unit is represented in Kg, m/min. PWC150 is a progressive loading cardiovascular training which is suitable for the middle-aged and the aging people. If they receive training for 3 times a week and 5 minutes per session, their cardiovascular fitness will improve after 6 weeks.

In addition to the 3 simple training methods mentioned earlier, there are still many other training modes suitable for the middle-aged and the aging people, such as 15-minutes running, step test, hiking and swimming, etc. While Cooper's study (1970) indicated that 12-minute running and walking is more related to maximal oxygen consumption, and recognized as a more effective measure to improve cardiovascular fitness compared to the 15-minute walking training or step test. However, no matter choosing which training measure, it is essential to avoid sport injuries, and the preparatory activities before every training should be taken seriously.