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Shiv Kumar
Post-TGT (P & He) KV Vasant Kunj, New Delhi, India

Correspondence
Shiv Kumar
Post-TGT (P & He) KV Vasant Kunj, New Delhi, India

Research on table tennis players cardio-respiratory endurance

Shiv Kumar

Abstract
The circulatory organ ability of the high level is needed so that the table tennis player may play for 30 minutes or more. The evaluation of player's circulatory organ ability is possible from the measurement of the maximal oxygen consumption under the maximal effort. 5 players who belongs to the STAG – Table Tennis Academy participated in this experiment 5 players are high-ranking players who represented INDIA at international level.K4B2 which is a portable oxygen consumption measurement machine analyzes a player's exhalation, and has the function to transmit the result to a personal computer. The players hit the ball by forehand continuously for 1 minute. This experiment was done by three conditions, namely, mild hitting, topspin and smash. Additionally, between each test, they sat on the chair for 2 minutes rest. Player hit the ball until exhaustion continuously in smash condition. After this experiment, oxygen consumption was measured until the heart rate decreased to 100 beats per minute. Players showed maximal oxygen consumption (ml/min/kg) in smash condition. When a hit ball was continuously carried out until it was completely exhausted by the forehand smash, the player's maximal oxygen uptake and a maximal heart rate showed maximal.
Moreover, the analysis from the viewpoint whether the energy efficiency of moving is high becomes important as for the evaluation of ability of player. The cardio-respiratory endurance of the high level is needed so that the table tennis player may play for 30 minutes or more. The evaluation of player's cardio -respiratory endurance is possible from the measurement of the oxygen uptake. The players are evaluated from the measurement result of the oxygen uptake during the maximum effort. Subjects are five players who belong to the Stag table tennis academy, representing at international level. K4B2 which is a portable oxygen uptake measurement machine analyzes a player's expiration, and has the function to transmit the result to a personal computer. The players hit the ball by *forehand long* (L), a forehand drive (D), and the forehand smash (S) continuously for 1 minute, respectively. In addition, between each trial, it sat on the chair for 2 minutes rest (R). Only in the forehand smash, the continuation hit the ball was performed to complete exhaustion. Rest was taken from the moment of being completely exhausted, and oxygen uptake was measured until the heart rate decreased to 100 beats per minute. Under the conditions which carry out hitting the ball by forehand smash, a player's oxygen uptake (ml/min/kg) showed maximal. Under the conditions which carry out a hit ball by forehand smash, several players' oxygen uptake (ml/min/kg) showed maximal. When a hit ball was continuously carried out until it was completely exhausted by the forehand smash, the player's maximal oxygen uptake and a maximal heart rate showed maximal. Moreover, the analysis from the viewpoint whether the energy efficiency of moving is high becomes important as for the evaluation of ability of player.

Keywords: Oxygen uptake, k4b2, heart rate

1. Introduction
Mr. Ogimura commented table tennis to be "the sport which performs chess while carrying out 100m running". Although it is expressing table tennis simply, this text moves not only to front but to back or a horizontal direction in fact, chooses the optimal batting style and carries out the hit ball of the ball which comes flying at irregular timing and an irregular spin, and speed. And it is the sport as which the change of tactics is required, analyzing a partner's style. At the place of a top level's fighting, it is high-level performance. Clearly high-level physical strength exists in the background of the player to develop. The physical strength level of the top player which plays an active part in the world is very high, and digests an intense prolonged game on both sides of the recess for only 1 minute. The cardiac beats rate in the game of the case of attacked type players is in 170-180-beat the range for /, and it is reported that the degree of

burden concerning the living body in a table tennis game is quite large. Table tennis is the game which owner oxygen movement and non-oxygen movement mixed.

It is thought that exercise intensity also become high as the average heart rate under game of table tennis is in 110-170 b/min the range. The play domain of table tennis must be the narrowest of games, the speed of the ball in which the partner player moreover did the hit ball within about 0.50 - 1.75 seconds, a spin, and the direction of a hit ball must be predicted, and the optimal hit ball position and hit ball posture for the hit ball must be taken. Most rallies of top-class players end the number of hit balls within 5 including service less than 4 seconds. That is, it is the game which sandwiches for 10-15 seconds (time until one of both issues service after the one-point end), and repeats non-oxygen movement for about 4 seconds for 20 minutes.

This research aims to an improvement of the con-tents of physical workouts and technical training. The oxygen uptake used as the index of the respiratory circulatory system under movement.

The continuation hit ball of the same subject was performed by the multi-practice method on training and oxygen uptake, heart rate were measured by k4b2.

2. Experimental Method

Subjects are five male players from STAG table tennis Academy. They took rest sufficient after the end of warming-up, equipped with telemetry k4b2 at the time of quiet, and measured oxygen uptake, heart rate, an amount of ventilation, etc.

It carried out to the beginning in order of the forehand for 1 minute (FH), the drive for 1 minute (DR), the smash for 1 minute (SM), the continuation forehand (FH+FW) ac-companied by footwork for 1 minute, the drive (DR+FW) accompanied by footwork for 1 minute, and the smash stroke (SM+ FW) accompanied by footwork for 1 minute. The interval for 1 minute was taken and was made to rest between the subjects of each. The time which an experiment takes were for 14 minutes in total.

The pitching timing of a ball was set as per minute 60 times, and the ball was sent alternately with right and left only at the time of a footwork experiment. Moreover, footwork put the mark on the position of about 2/3 on a table tennis table (seeing from the course of a dominant hand), and the player moved to right and left regularly, and did the hit ball of it to them.

The feature of telemetry k4b2 was described. It is portable respiratory metabolism measurement equipment which can be measured on the field.

It has the oxygen sensor and oxygen uptake on dioxide sensor of high speed, high precision, and quantity stability. An original highly efficient digital turbines sensor corresponds to.

3. Experimental Result and Discussion

Table 1. Physical characteristic of the 5 subjects

Table 1: Shows physical characteristics of the subjects.

Sub.	Age	H(cm)	W(kg)
A	19	175	63
B	19	159	58
C	20	177	67
D	20	174	68
E	21	170	64

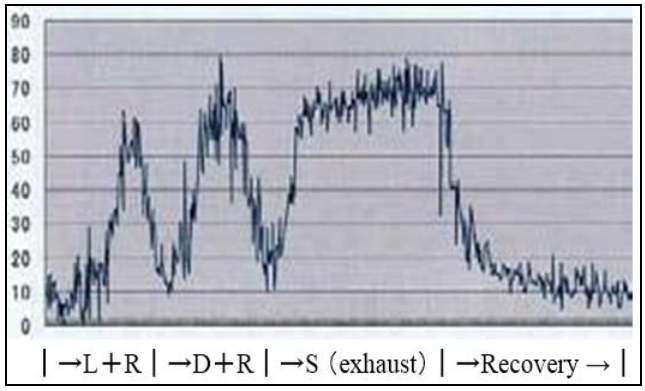

Fig 1: Oxygen uptake during each strokes of player

After performing the drive for 2 minutes at 60 times of a rate in 1 minute with long and inserting a break for 2 minutes in between, change of the oxygen uptake when going a smash by the same timing to complete exhaustion was shown in Fig. 1.

They are each values at the time of an end of oxygen uptake at the smash accompanied by footwork. The oxygen uptake, heart rate, ventilation, and exercise intensity,

Moreover, exercise intensity had reached to about 100% with regular movement on either side in man at the conditions of a continuous hit the ball.

In addition, when every person's data was analyzed in detail, maximal and the minimum of the heart rate in each style were seen at the last, heart rate increased gradually and maximum and the minimum became of the smash accompanied by footwork as the experiment was conducted on the hit ball conditions of each style.

From this result, it became clear that it was the practice for which the smash style accompanied by footwork strengthens the heart rate most in a table tennis.

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