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### FUNCTIONAL DIAGNOSTICS OF TOP TABLE TENNIS PLAYERS

#### Abstract

*In order to achieve top sport result multidiscipline approach is needed as well as viewing the players' ability from different aspects. Modern table tennis demands high level of functional and motor abilities in player. With functional diagnostic of athlete will be able to provide tests and programs geared to meet specific goals and to improve performance. Our sport-specific tests use the latest in technology to identify individual strengths and weaknesses in aerobic capacity, anaerobic power, speed, strength, technique, and more. The term "functional diagnostics" implies determining of the basic anthropometrical characteristics (and their analysis), evaluation of functional abilities (the battery of tests) and evaluation of functional abilities of the athlete.*

*The functional diagnostic aims to: 1) Provide and monitor highly specialist training methodologies to high performance athletes, 2) Assess and devise fitness programs for sports people, 3) Promote the importance of sports medicine including diet, nutrition and exercise.*

*The importance of the functional diagnostics of the athletes is success of the training program is largely dependent upon satisfying the performance aims associated with it.*

*Testing and measurement are the means of collecting information upon which subsequent performance evaluations and decisions are made.*

*Functional diagnostics of the table tennis players includes the following analyses: 1) BOD POD Body Composition Analysis, 2) Anthropometrics data, 3) VO<sub>2</sub> max (Maximal Oxygen Uptake), 4) Blood Lactate Analysis, 5) HR Training Zones & Training Intensities, 6) Dynamic Bike Fit & Treadmill Analysis, 7) Sub-maximal Testing, 8) Anaerobic Power and Capacity, 9) Nutritional Analysis, 10) Scientifically-Based Training Programs correction, 11) Training Log Reviews, 12) Speed of reaction and Explosive Power Analysis, 13) Bio Chemical substrate Analysis, 14) Pulmonary (Spirometry) Analysis, 15) Muscle Strength and endurance (upper & lower) Analysis.*

*Some analyses are interpreted on the basis of age-long work with the senior national team of Yugoslavia (Serbia and Montenegro). The results in certain periods of time and their consequential relation with the achieved results at big competitions (European and World championships) were analyzed.*

*Importance of recording the information: For the coach it is important to monitor the program of work, so as to maintain progression in terms of the volume of work and its intensity. Both coach and athlete must keep their own training records. A training diary can give an enormous amount of information about what has happened in the past and how training has gone in the past. When planning future training cycles, information of this kind is absolutely invaluable.*

**Key words:** *table tennis, functional diagnostics, Anthropometrics, VO<sub>2</sub>max, Anaerobic Threshold, Lactate analyses*

#### 1 Introduction

In order to achieve top sport result multidiscipline approach is needed as well as viewing the players' ability from different aspects. Modern table tennis demands high level of functional and motor abilities in player. With functional diagnostic of athlete will be able to provide tests and programs geared to meet specific goals and to improve performance. Our sport-specific tests use the latest in technology to identify individual strengths and weaknesses in aerobic capacity, anaerobic power, speed, strength, technique, and more. The term "functional diagnostics" implies determining of the basic

anthropometrical characteristics (and their analysis), evaluation of functional abilities (the battery of tests) and evaluation of functional abilities of the athlete.

## **2 Methods**

Analyses of these parameters were done in period 1997/98 to 2004/2005. We used to take these data in pre season period (before start of championships) or at the beginning of summer and winter National Team preparation.

### **2.1 Participants**

Sample of players were the National Teams (all categories) of Yugoslavia-Serbia&Montenegro – 87 players. Also, some of results were taken in season 2001/2002 with senior National Team of India – 12 players.

### **2.2 Procedure**

All results were analyzed as a group results and as individual results. Standard statistical methods were used:

- Arithmetic Middle
- Standard Deviation
- Variation (Maximum and Minimum results)
- Simple and relative Frequency

## **3 Results**

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- 2) Assess and devise fitness programs for players,
- 3) Promote the importance of sports medicine including diet, nutrition and exercise.

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Functional diagnostics of the table tennis players includes the following analyses:

1) BOD POD Body Composition Analysis , 2) Anthropometrics data, 3) VO<sub>2</sub> max (Maximal Oxygen Uptake), 4) Blood Lactate Analysis, 5) HR Training Zones & Training Intensities, 6) Dynamic Bike Fit & Treadmill Analysis, 7) Sub-maximal Testing, 8) Anaerobic Power and Capacity, 9) Nutritional Analysis, 10) Scientifically-Based Training Programs correction, 11) Training Log Reviews, 12) Speed of reaction and Explosive Power Analysis, 13) Bio Chemical substrate Analysis, 14) Pulmonary (Spirometry) Analysis, 15) Muscle Strength and endurance (upper & lower) Analysis.

Just some of them, most important will be interpreted in this work.

### **3.1 Body Composition Analysis**

For measurement of body fat we used two methods. Previously, we used Durnin&Womersley method (the percent of body fat was determined from the sum of four skin folds) and later we used Body fat analyses with BIA method (Bioelectrical Impedance Analysis) because is considered as one of the most exact and accessible methods of screening body fat. Also, for all players we calculate and following parameters:

- Body Mass Index (BMI = Body mass in kilograms ÷ (Height x Height in meters))
- Ideal weight

Here are some results of measurements of man senior Team of Yugoslavia and India, and junior and cadet Teams.

**Table 1** Average value of Body fat and Body Mass index of Teams

Teams	Year	Age	Body Fat (%)	BMI
Men senior Team (YUG)	2000	27.0	15.3	24.2
Men senior Team (IND)	2001	19.0	15.5	21.7
Junior boys (YUG)	2001/2002	15.6	11.9	21.1
Cadet boys (YUG)	2001/2002	13.6	11.2	17.7
Junior girls (YUG)	2001/2002	16.5	14.2	21.5
Cadet girls (YUG)	2001/2002	14.0	15.0	21.9

It is interesting that players with high percentage of body fat make very good results at European Championship in Bremen (2000). Lupulesku I. won silver medal in double (Body fat was 22.5%) and Karakasevic A. won gold medal in mix double (Body fat was 20.1%).

Body composition measurement is important specially in pre season period, because considering this data training program (and supplement or dietary program if it's necessary) can be much more quality and with high efficacy. Body fat percentage is related with very important functional and motoric abilities as aerobic and anaerobic capacity, explosive strength, speed and agility.

### 3.2 Anthropometrics data

Anthropometry (def.): The field that deals with the physical dimensions, proportions, and composition of the human body, as well as the study of related variables that affects them.

Basic Anthropometrical measures in this program include:

- Height
- Weight
- Body circumference

Measurement of the anthropometrical characteristics is done by standardized methodology of International biological program.

**Table 2** Average value of Height and Weight of Teams

Teams	Year	Age	Height (cm)	Weight (kg)
Men senior Team (YUG)	1998-2004	25.5	176.3	73.7
Men senior Team (IND)	2001	19.0	171.4	63.8
Junior boys (YUG)	1998-2004	15.6	176.1	65.7
Cadet boys (YUG)	1998-2004	13.6	167.1	50.6
Junior girls (YUG)	1998-2004	16.5	165.6	59.1
Cadet girls (YUG)	1998-2004	14.0	161.0	65.7

Body circumference is very important because table tennis is unilateral sport. From experience, these data can show a lot about work at physical prepare of players and their work in this field. During work with National Teams, I had some cases (mostly in female teams) that values of difference in Biceps circumference (extended and flexed) were about 0 in non playing arm. Also, there are evident differences in circumference of legs after surgeon of knees, which must be equalized soon as possible, because this problem can spread in back pain or more injuries.

### 3.3 VO<sub>2</sub> max (Maximal Oxygen Uptake)

VO<sub>2</sub> is the rate of oxygen uptake, or consumption, measured during exercise. The maximum rate of oxygen uptake is called the VO<sub>2</sub>max or maximum VO<sub>2</sub>. VO<sub>2</sub> is the ultimate measure of fitness and is reported in milliliters of oxygen per kilogram of body weight per minute or ml/Kg/min.

In National Teams during summer and winter prepare we used mostly Astrand Cycle Ergometer Test for evaluation of maximal oxygen uptake. Also, if there was not condition for doing this test we used to do Cooper test (which have some benefits with younger categories in way of motivation in equalized groups).

**Table 3** Results (average) of absolute and relative values of VO<sub>2</sub>max of Teams

Teams	Year	Age	VO <sub>2</sub> max (l/min)	VO <sub>2</sub> max (ml/kg)
Men senior Team (YUG)	2001	26.5	3.94	55.88
Men senior Team (IND)	2002	19.0	3.73	57.13
Junior boys (YUG)	2003	15.6	3.24	49.06
Cadet boys (YUG)	2003	13.6	2.55	52.58
Junior girls (YUG)	2003	16.5	2.46	41.76
Cadet girls (YUG)	2003	14.0	2.91	51.46

In Yugoslav National Teams we start with systematic work from season 1997/98 with all categories. What we notice, that in pre season there is a space for development of aerobic capacity, and also in winter break period. Start of prepare for big championships (senior WC, EC, Olympics and Youth Championships) should start with practice in aerobic regimes. It helps recovery of players after league competitions, and development is successful in periods of only 10-14 days, for continue of prepare and competition.

**Table 4** Results (average) of VO<sub>2</sub>max in period 1998-2003

Teams (YUG)	VO <sub>2</sub> max (ml/kg)					
	1998	1999	2000	2001	2002	2003
Men Senior Team	57.75	58.21	54.05	55.88	56.73	53.48
Junior boys	48.24	59.75	62.63	55.36	52.54	49.06
Cadet boys	42.67	47.77	49.04	48.92	47.90	49.06
Junior girls	36.00	49.86	42.08	44.12	43.41	41.76
Cadet girls	34.49	46.76	44.55	41.03	47.04	51.46

### 3.4 Blood Lactate Analysis

Lactate measurement we used to accurately determine Heart Rate training zones, recovery and much more. The blood lactate level increases with exercise intensity and shows clearly the transition from aerobic to anaerobic activity. Since the measurement is completely individual it gives a precise method for testing and monitoring training intensity and recovery.

We use Lactate Scout (EKF diagnostics). Also, we used and POLAR heart rate monitor during practice, to know exactly HR in moment of taking sample of blood.

We made our own test protocol during the table tennis exercise. In this protocol intensity and quality of sparing during test is very important.

Measured values during table tennis practice show that younger players have less resistance in anaerobic work.

**Table 5** Average values of Lactate of Teams

Teams (YUG)	Age	Lactate mmol/l	bp/min
Men Senior Team	26.5	6.1	176.0
Junior boys	15.6	4.2	172.0
Cadet boys	13.6	3.1	173.3
Junior girls	16.5	3.7	177.1
Cadet girls	14.0	3.5	176.2

### 3.5 HR Training Zones & Training Intensities

Lactate measurement is far more precise than the outdated and inaccurate method of using percentages of maximum heart rate to set training zones. Heart rate is an individual response; heart rate training zones need to be determined by measurement of physiological variables not set by mathematical formulas. Lactate measurement differs from, and is complimentary to VO<sub>2</sub>max testing. VO<sub>2</sub>max is a great tool for identifying anaerobic threshold and calculating training zones. The training zones are then used to determine training intensity from recovery to max effort intervals.

From experience, at the beginning we use heart rate monitors on players, to get used to practice in adequate training zones. After two weeks, well trained players, are able to practice in adequate intensity without heart monitor.

### 3.6 LT – Lactate Threshold

In National Team we used Conconi-Test to define Lactate Threshold LT (as Heart Rate or Power Level at the anaerobic/aerobic threshold) under realistic circumstances to then be used to define your Training Zones.

We used protocol in POLAR PRECISION PERFORMANCE SW 4.0 SOFTWARE. Now, we are going to put in procedure new test with table tennis robot in stead of individual concept of play. About this, will be in some next presentation.

**Table 6** Average values of Lactate Threshold of Teams

Teams (YUG)	% of HR max	bp/min
Men Senior Team	87%	168.2
Junior boys	82%	157.0
Cadet boys	80%	156.0
Junior girls	75%	148.8
Cadet girls	77%	150.0

### 3.7 Resting Metabolic Rate Testing (RMR)

Metabolic rate, or metabolism, is the rate at which the body expends energy. This is also referred to as the "caloric burn rate". Energy expenditure can be divided into three groups of calories:

1) Resting Calories – Calories that are burned while the body is at rest. These calories are needed just to maintain life. The majority of all calories burned (about 70-80%) are burned at the resting level.

2) Activity Calories – Calories that are burned because of normal daily activities are "Activity Calories". Normal daily activities such as walking, eating (digesting food), typing, etc. are included in activity calories.

3) Exercise Calories – These calories are burned because of exercise.

The sum of all of these groups of calories is the total metabolic rate. Evaluation of these parameters is done with 10 minute breath test

### 3.8 Pulmonary (Spirometry) Analysis

Spirometry (Collins Cybermedic Classic TLi Total Lung Analyzer)

- Measurements of lung volumes and capacities
- Helium-dilution method for measurement of functional residual capacity.

The measurements which are usually made are:

1. VC (vital capacity) - maximum volume of air which can be exhaled or inspired during either a forced (FVC) or a slow (VC) manoeuvre.
2. FEV<sub>1</sub> (forced expired volume in one second) - volume expired in the first second of maximal expiration after a maximal inspiration and is a useful measure of how quickly full lungs can be emptied.
3. FEV<sub>1</sub>/VC - FEV<sub>1</sub> expressed as a percentage of the VC or FVC (whichever volume is larger) and gives a clinically useful index of airflow limitation.
4. FEF<sub>25-75%</sub> - average expired flow over the middle half of the FVC manoeuvre and is regarded as a more sensitive measure of small airways narrowing than FEV<sub>1</sub>.
5. PEF (peak expiratory flow) - maximal expiratory flow rate achieved and this occurs very early in the forced expiratory manoeuvre
6. FEF<sub>50%</sub> and FEF<sub>75%</sub> (forced expiratory flow at 50% or 75% FVC) - maximal expiratory flow measured at the point where 50% of the FVC has been expired (FEF<sub>50%</sub>) and after 75% has been expired (FEF<sub>75%</sub>). Both indices have a wide range of normality but are usually reproducible in a given subject provided the FVC is reproducible.

**Table 6** Results of Vital capacity of senior players

Teams	age	height	weight	VC (ccm)
Men Senior Team (YUG)	23.89	174.53 $\pm$ 0.64	62.90 $\pm$ 1.00	4623 $\pm$ 40.94

### 3.9 Strength assessment via dynamometry and one-repetition max tests

We use following equipments for measuring strength of upper and lower extremities.

- Takei Digital Hand Grip Dynamometer Model 884150
- Lafayette Hand Dynamometer Model 78010
- Takei Back-Leg Dynamometer TKK-5002
- Apollo 4 Multi-station Gym

## 4 Discussion/Conclusion

Testing and measurement are the means of collecting information upon which subsequent performance evaluations and decisions are made.

Importance of recording the information: For the coach it is important to monitor the program of work, so as to maintain progression in terms of the volume of work and its intensity. Both coach and athlete must keep their own training records. A training diary can give an enormous amount of information about what has happened in the past and how training has gone in the past. When planning future training cycles, information of this kind is absolutely invaluable.

Also for National Teams is important timing of tests. So it should be at least two or three time per season. At the beginning of season, in winter break (half season) and at the end of the season.

At the beginning it should give the clear picture of the players, and guide for creating of training program. At the half season, we can check efficacy of training program and make plans for the next period, and at the end of season, we can see complete season and analyze it. Also, with these data, we can start planning new season and new goals.

Creating data base, we have more data to compare, and some of taken data can be important, because they may give us information about some factors which can cause

achieving results in competition. Unfortunately, we didn't have in past abilities to do these tests when we wanted, but we were finding best solutions. With portable laboratory for functional diagnostics of athletes, which is my next project, I believe that this job will be done with much more efficacies, because it will be done in less time period and precise in time point when it should be done. Practically, for one Team (8-10 players) all this measurements can be done in two days.

All of this information should be in service of practice work in training with players, and integral part of training process and activities of National Teams.

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