Journal of Health Science 4 (2016) 45-52
doi: 10.17265/2328-7136/2016.01.006

Influence of Free Indoor Football Play (FISP) on the Circulatory System, among Overweight Young Adult Male

Ferenc Ihász[1], I. Liziczai[2], Zs. Szakály[1], I. Barthalos[1], J. Bognár[3], Zs. Nemes[1] and J. Gang[1]

1. Department of Sports Science, Széchenyi István University of Győr, Hungary

2. Centrum of Cardiology, Mosonmagyaróvár, Hungary

3. University of Physical Education, Budapest, Hungary

Abstract: For middle age individuals (male), it may be difficult to find motivation for suitable exercise training, which has similarly favorable characteristics for cardiovascular adaptations as other exercises performed by younger individuals. Fifty four (n = 54); (age = 41.57 ± 3.25) untrained, overweight (F% = 19.52 ± 5.6), range of (12.6-30.6), (visceral fat area (VFA) = 111.1 cm^{-2}) healthy male (they are managers in four different Banks) were taking part in this research program. The participants took part on preliminary cardiac examination (echocardiography, GE Vivid 9 ultrasound machine. Body composition measured with type of "InBody720" (Biospace Co. Inc., Seoul, South Korea) Bioelectrical Impedance Analyzer (BIA). The heart rate of the participants was measured continuously during all training sessions using heart rate belts (POLAR Team System, Finland). Pulmonary gas exchange "Cardiosoft", (Milwaukee, USA were measured during a standardized treadmill test. Results: In many cases of the free indoor soccer play (FISP) recorded extremely high pulse rate, which is compared with the laboratory high pulse rate (LHPR), much higher than the recommended physiological load level $HR_{(FISP)}$ > 190 beat/min; $HR_{(LHPR)}$ = 175 beat/min ; $P < 0.001$. Despite the many advantages of the Free Indoor Football Play (FISP) are hiding a lot of dangerous in the terms of circulatory adaptation.

Key words: Vigorous exercise, extreme heart rate elevation, Free Indoor Football Play (FISP), football training sessions, circulatory adaptation.

1. Introduction

Cardiovascular disease (CVD) morbidity and all-cause mortality is associated with physical inactivity [1-2]. Regular exercise has a favorable effect on many of the established risk factors for cardiovascular disease [3]. Even small increases in cardiorespiratory fitness and improvements in muscle strength have been associated with reduced CVD risk and all-cause mortality and implementation of light- or moderate-exercise training in middle aged adults [4-7].[1]

Football exhibits features of interval training, with vigorous exercise interspersed with lower exercise intensity and has a very effective influence on reducing cardiovascular risk factors: blood pressure abdominal fatness, and insulin resistance in healthy males [8] as well as in subjects with mild and moderate hypertension [9-11].

Numerous self-organized groups (mostly men) are involved in physical activity during their free time. The majority of the activities performed are usually various types of ball games (e.g. indoor football). The resulting joy of the game is a guarantee to keep up motivation. The indicated extreme heart rate elevations caused by high intensity running are suppressed by a successful trick or transfer of the ball or just the joy of the goal. While on one side this is welcomed, it represents truly dangerous consequences.

Therefore the aim of the present study was to examine and to compare measured cardiovascular effects of Free Indoor Football Play (FISP) *and*

Corresponding author: Ferenc Ihász, associate professor, research fields: human biology and applied exercise physiology.

Laboratory Test (LAB to suggest possible solutions in order to avoid situation of cardiovascular overload).

2. Patients and Methods

2.1 Participants and Settings

Fifty four (n = 54) apparently healthy middle age adult ranging from 36 to 46 years (mean age = 41.57 ± 3.25) were recruited from the same workplace (managers from four different banks).

2.2 Echocardiography

On purpose prevention the program was preceded by a cardiological examination with the help of which we could separate our patients according to their anatomical and functional cardiac disorders. Examinations were performed by an experienced cardiologist, with subjects resting in the left lateral supine position. Offline analysis was performed using commercially available software (EchoPac BT11, GE Vingmed Ultrasound, Horten, Norway). Recordings were later analyzed by the same person in random order without knowledge of the training type of the subject. Intraobserver variability was below 5% for the included measurements. Cine-loops of parasternal long-axis and apical four-chamber, two chamber, and long-axis views were recorded. Left and right ventricular dimensions were calculated from parasternal long-axis Two-dimensional (2D) recordings at the mid-ventricular level. LV volumes and ejection fraction were calculated using Simpson's biplane method from apical two- and four-chamber views [12]. LV mass was calculated according to the American Society of Echocardiography from the formula $0.832\ [1.05\ [(LVID + IVST + PWT)^3] - (LVID)^3]$ and indexed according to body surface area. Measurements included peak transmitral flow in early diastole (E), peak transmitral flow velocity in late diastole during atrial contraction (A), and their ratio (E/A).

The results of the two-dimensional and tissue Doppler echocardiography performed before inclusion in the program are summarized in (Table 1). We could not find a critical value that would exclude candidates from the program.

2.3 Body Dimensions and Body Composition

Anthropometric measurements of body stature were recorded to the nearest 0.1 cm (Sieber-Hagner, Switzerland) based on the International Biological Program (37). For this study, the "InBody720" (Biospace Co. Inc., Seoul, South Korea) Bioelectrical Impedance Analyzer (BIA) was used to assess body mass and composition. This foot-to-foot, hand-to-hand and hand-to-foot contact device uses two stainless-steel foot pad electrodes mounted on a platform scale and two stainless-steel handles to allow for "Tetra polar" 8-point tactile electrode system. A multi-frequency (six) current is applied to determine 30 impedance measures (5 paths x 6 frequencies). These measures are integrated into the system to provide output measures of total body water, intracellular water, extracellular water, and segmental lean analysis. Body fat percentage is calculated using a summation of

Table 1 Evaluation of cardiac structure and function by two-dimensional and tissue Doppler echocardiography in healthy middle aged 36- to 46-year-old men, at baseline.

	(n = 54)	
variable	mean	min.-max.
LV diameter of end diastole (mm)	52.36 ± 6.37	(51.16-54.28)
LV diameter of end systole (mm)	32.28 ± (3.42)	(33.17-35.03)
LV ejection fraction (%)	63.02 ± (6.7)	(60.10-65.21)
LV mass (g)	216.52 ± (37.6)	(199.60-237.30)
LV mass index ($g*m^2$)	99.12 ± (17.8)	(92.20-102.10)
LA volume index (mL/m^2)	21.30 ± (0.57)	(20.00-23.30)
E/A ratio	1.38 ± (0.13)	(1.26-1.54)

segmental lean analysis to determine total lean body mass, fat mass, and ultimately the proportion of fat to total weight mass fraction. Body mass index were calculated using body mass from the platform scale and stature entered into the BIA device.

2.4 Physiological Tests

VO_2max was measured on “Marquette” 2000 treadmill (Pittsburgh, PA, USA) using the personalized submaximal exercise testing protocols, based on the expected fitness level of them. The following parameters were measured: resting heart rate (R-HR), (beat·min^{-1}), the maximal heart rate (MaxHR), (beat·min^{-1}) using the “Cardiosoft”, Cardiological System ECG, (Milwaukee, USA). The VO_2submax test was considered acceptable when respiratory exchange ratio (RQ); (~ 0.97-1.00) and when a plateau in VO_2 was observed. The test only when extreme pressure increases or the examined person’s specific request was stopped prematurely.

2.5 Blood Pressure

Blood pressure was measured with the “Tango” type automatic blood pressure monitor (SunTech® Medical Instruments Inc. Raleigh NC. USA) using the auscultator method. Systolic and diastolic pressures were recorded at the appearance and disappearance of “Korotkoff” sounds, respectively. Resting blood pressure was assessed in the left upper arm after the subject had been sitting quietly for a minimum of four minutes, repeated three times in row, with two minutes break between each measurement. The average of the three measurements was used to determine resting blood pressure. Blood pressure cuffs were used that covered at least two thirds of the upper arm with the bladder encompassing most of the circumference of the arm without overlapping. Maximum blood pressure was measured until the final stages of the maximal exercise test (LAB) and during the greatest intensity of Free Indoor Football Play (FISP).

2.6 Pulse Rate Measurement

The football training sessions were performed indoor (sport hall) one times per week for 4 months. Each training session lasted 1 h, and sessions were supervised by one of the investigators. The football sessions consisted on a 20-wide and 45-long, plastic covered place. Each training session started with a 5-min low-intensity warm-up period, and thereafter the participants completed four football playing periods each lasting 12 min separated by 2-min recovery periods. The heart rate of the participants was measured continuously during all training sessions using heart rate belts (POLAR Team System, Polar Electro Oy, Kempele, Finland) (Figs. 1-2).

2.7 Statistical Process

Statistical analysis of the data was used “Statistica for Windows” program package (version 12.1, Stat. Soft Inc. Tulsa, OK 74104, USA, 2006). One-way analysis of variance (ANOVA) statistics were applied to differences between in Free Indoor Football Play (FISP), resting pulse (RPo), maximal pulse (MP), maximal systolic (Max. sys.) and maximal diastolic (Max. dias) blood pressure and Laboratory Test (LAB) of the random error $P < 0.05$ level.

2.8 The Following Questions were Raised

Several investigators have proven that changing intensity free games (f. example indoor football) have beneficial effects on the cardiovascular system.

Despite of this, based on the preliminary studies the question arises whether the recorded high elevated pulse rate responses go along with a similarly high increased systolic blood pressure?

If this is true, then what other dangers may be the two multiplied factors hold in the myocardial oxygen consumption?

3. Results

Our results are presented with the help of table and diagrams. The examinees were males, aged (41.57 ±

3.25). Based on the ratio of the body substance (F%-M%), [(19.52 ± (5.6)-39.0 ± (3.8)] the examines can be included into overweight category. Subjects are abdominal obese according to the amount of the visceral fat and age classification category [13]. The muscle mass percentage and the free fat mass are suggested that their do not have enough muscle strength due to they are not suitable for competing or exercising on very high physical activity level. (As regards the fat free mass (FFM); 68.50 ± (6.2), the investigated group is slightly affected). On the submaximal level measured aerobe capacity (VO_2 submax) is suitable for an actual Hungarian standard among middle age males (Table 2). Average of the anaerobic threshold (RQsubmax), [0.97 ± (0.38)] is confirmed that the subjects were performed at submaximal zone.

Averages of the circulatory system values which were measured during resting and at peak performance are varied within physiological limits (Table 3). There are no significant differences between the measured resting pulse in Free Indoor Football Play (FISP) and Laboratory environment (LAB). However the differences between the measured maximal pulse rate averages during the load were significant [$MP_{(FISP)}$ = 184.85 ± (8.98)-$MP_{(LAB)}$ = 176.42 ± (7.09)]; $P < 0.05$.

We have found similar results in comparison of the recorded averages of systolic and diastolic blood pressures at maximum load [Max. sys. (FISP) = 184.85 ± (8.98)-Max. sys. (LAB) = 168.28 ± (11.84)]; [Max. dias. (FISP) = 92.40 ± (8.87)-Max. sys. (LAB) = 75.40 ± (10.59)]; $P < 0.000$.

The subject's typical cardiac responses can be seen in the (Figs. 1-2). The recorded heart rate averages are similar to result of laboratory test but the maximal pulses are on critical levels. The blue line represents the pulse responses of the laboratory test, while the red line represents the average pulse during Free Indoor Football Play (FISP) (Fig. 3). The black line represents the anaerobic threshold. During the Free

Table 2 Baseline characteristics of age (years), height (cm), body mass (kg), body mass index (BMI), relative body fat (F%), relative muscle mass (M%), VFA (cm^2), FFM (kg), submaximum oxygen uptake (VO2submax $ml*kg^{-1}*min^{-1}$), aerobic threshold (RQ) in middle aged untrained healthy 36- to 46-year-old men, at baseline.

	(n = 54)	
variable	mean	min.-max.
Age (years)	41.57 ± (3.25)	(36.00-46.00)
BH (cm)	179.28 ± (4.42)	(174.00-188.00)
BW (kg)	88.02 ± (9.7)	(76.10-101.90)
BMI	27.43 ± (2.76)	(23.83-31.44)
F%	19.52 ± (5.6)	(12. 60-30.30)
M%	39.00 ± (3.8)	(33.20-43.10)
VFA (cm^2)	111.31 ± (29.57)	(79.70-158.00)
FFM (kg)	68.50 ± (6.2)	(59.10-75.30)
VO2submax ($ml*kg^{-1}*min^{-1}$)	42.38 ± (6.9)	(37.73-51.41)
RQsubmax	0.97 ± (0.38)	(0.96-1.02)

Table 3 Baseline characteristics of resting pulse (RPo, min/beat), maximum pulse (MP min/beat) Maximum systolic blood pressure (MBP; mmHg), Maximum diastolic blood pressure in middle aged untrained healthy 36- to 46-year-old men, at baseline.

	(n = 54)		
variable	$mean_{(Lab)}$	$mean_{(FISP)}$	P
RPo ($min*beat^{-1}$)	69.85 ± (12.10)	67.49 ± (14.06)	NS
Max. Po ($min*beat^{-1}$)	176.42 ± (7.09)	184.85 ± (8.98)	$P < 0.001$
Max. sys. (Hgmm)	168.28 ± (11.84)	180.28 ± (14.80)	$P < 0.000$
Max. dias. (Hgmm)	75.40 ± (10.59)	92.40 ± (8.87)	$P < 0.000$

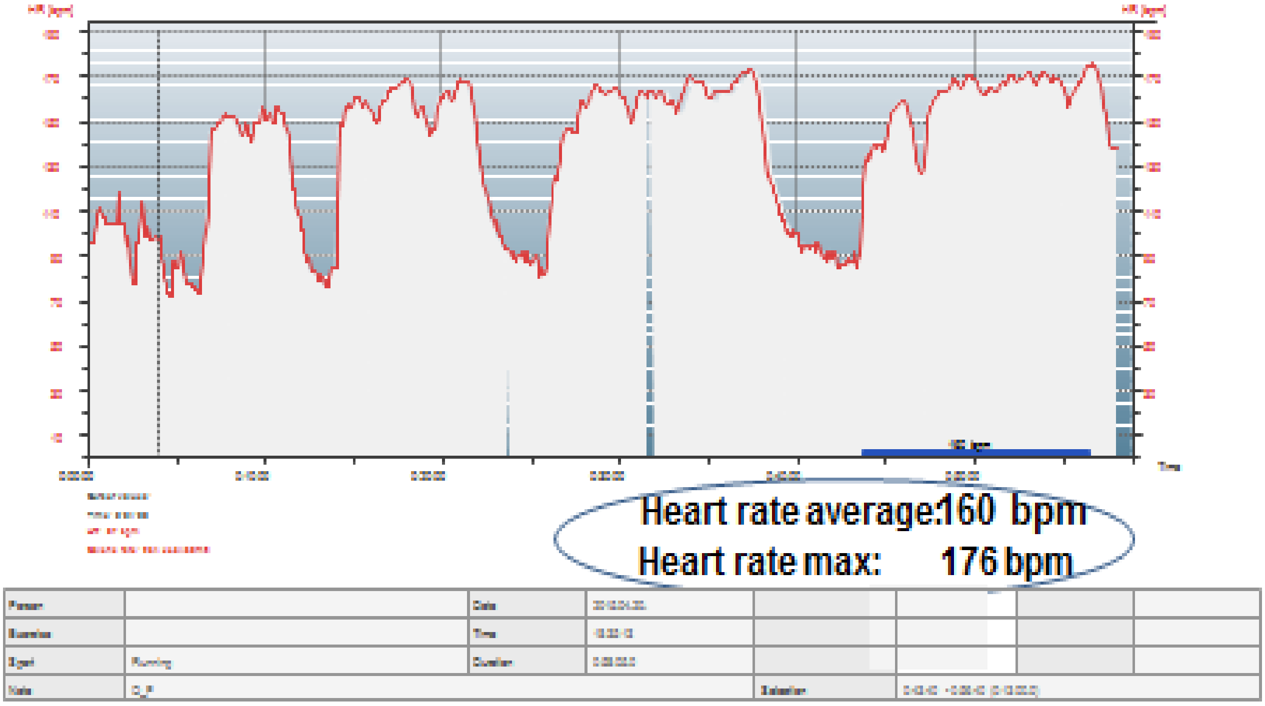

Fig. 1 Recorded heart rate during Free Indoor Football Play (FISP) by (1) test person.

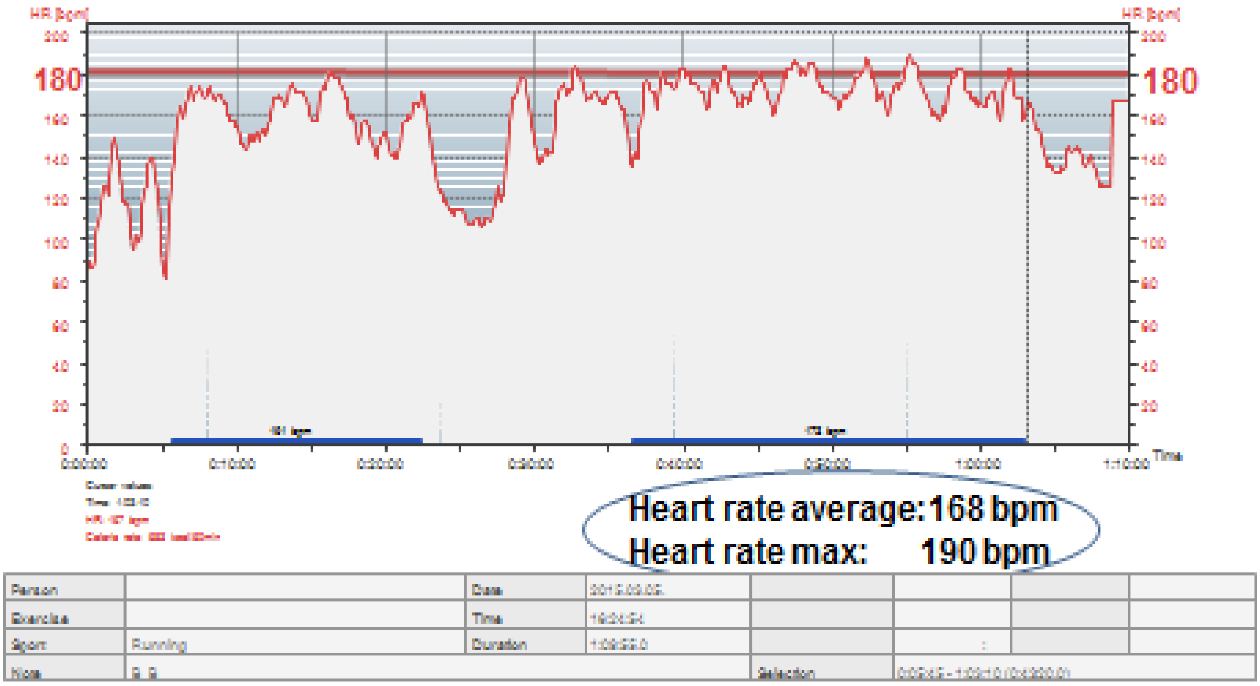

Fig. 2 Recorded heart rate during Free Indoor Football Play (FISP) by (2) test person.

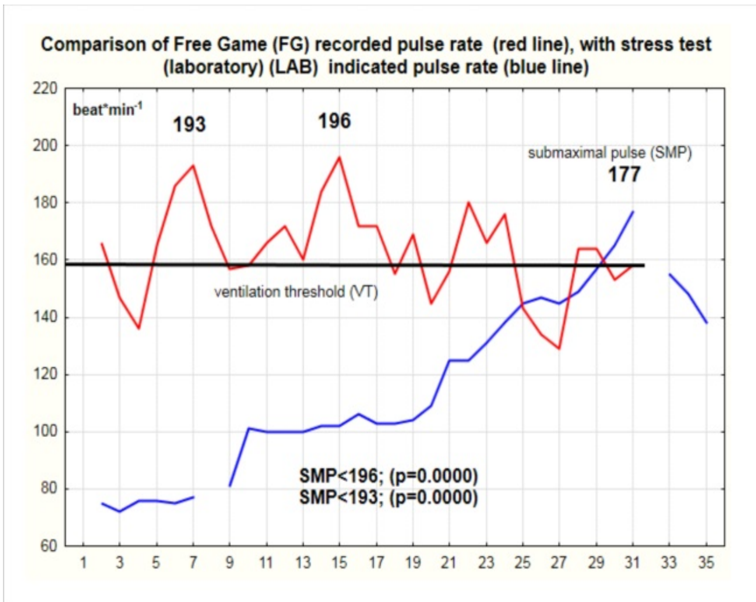

Fig. 3 Comparison of recorded heart rate in Free Indoor Football Play (FISP) with the Laboratory stress test (LAB) values.

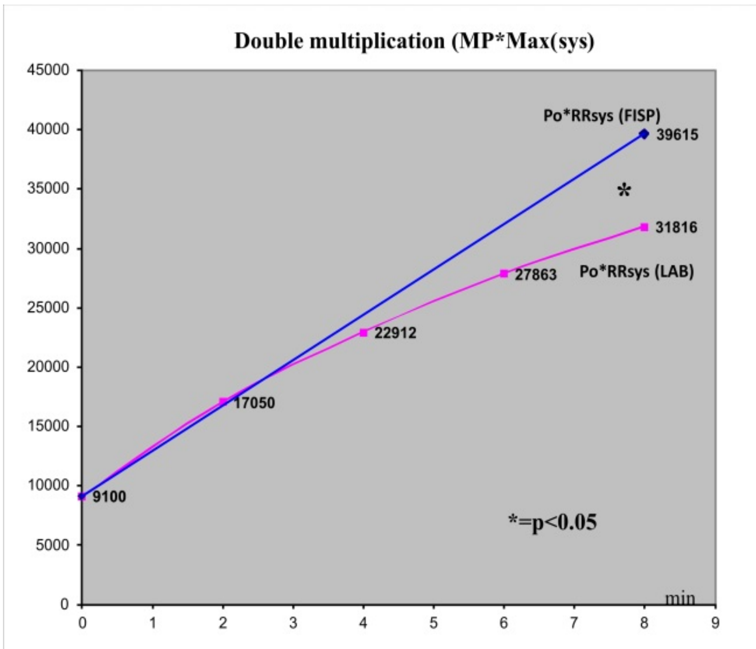

Fig. 4 Camparison of the oxygen demand of the myocardium values (Po*RRsys) during Free Indoor Football Play (FISP) with the Laboratory stress test (LAB).

Indoor Football Play (FISP) the pulse average values repeatedly crosses the anaerobic threshold. Also on two occasions they significantly exceed the maximum pulse which was recorded during the laboratory tests (LAB). We have found significant difference between the measured maximum pulse during the Free Indoor Football Play (FISP) (black colored exclamation mark) and the submaximal pulse measured by Laboratory test (LAB). [$MP_{(FISP)}$ (177 beat/min) < 193)]; P = 0.0000, [$MP_{(FISP)}$ (177 beat/min) < 196)]; P = 0.0000.

The (Fig. 4) represents the oxygen demand of the myocardium (Po*RRsys.), where MPo is multiple of the pulse rate measured at maximum load and (RRsys.) the maximal systolic blood pressure. The difference between the two values is significant. [$RRsys._{(FISP)}$ = 39,615-$RRsys._{(LAB)}$ = 31,316]; P < 0.000.

4. Conclusions

Our subjects have a sedentary work but they have a regular extra psychical load during their work. According to body composition analysis, our managers are overweight and they do not have a healthy amount of muscle mass. Despite of this the intensive physical activities like Free Indoor Football (FISP) are preferred by them. The problem is that the ball games can be strongly controlled. Sometimes the motivation forces the player into such different intensity levels which can be dangerous for the unprepared. It can cause not only a cardiac overload but a negative effect of the bones and muscles as well [14-17].

As a result of research it has been clearly established, that Free Indoor Football Play (FISP) (in our case indoor football) induces a significant pulse-increasing effect. The cause for concern is the value of the multiple of the maximal pulse (MP) and the maximal systolic pulse (Max.sys.) as well as the significant increase thereof. The degree of the increase in pulse rate exceeds the degree measured during the laboratory test on multiple occasions. We know that the load work performed under laboratory conditions offers a lower level of motivation for the examinee. In contrast, the ball games can be a cause of joy, surprise and excitement at any point during the game. These combined and alone can both result in a significant and fast rise in pulse. As we are familiar with the structure of the indoor football, we know that the intensity of the movement of the players is determined by the speed of the ball. This means that the examinees have to perform on 80-100% of the performance and in during some periods even above that (please see the sections indicated with the black exclamation mark).

Therefore significant pulse rate swings can occur any time during the game. It is possible that behind the pulse-swings there is a fairly rapid change in the energy providing service (aerob-anaerobe threshold). It is important to again emphasize that behind the double multiple characterizing the oxygen supply of the heart muscle (MP*Max.sys.) there is a significant strain of the coronary wall, which can directly result in the probable premature ventricular contractions (PVCs). These together can result in a perfusion confusion of the coronary artery [18].

In order to decrease the extremities of these processes we have to advise the examinees to perform personally planned low intensity physical activity on other say of the week [19]. Thereby we can improve aerobic capacity and so there will a longer time available to reach aerobic capacity. Also the personally tailored periodical low-intensity physical activities improve blood pressure responses in both the active and “passive”-relaxing-stage of the heart.

On the other hand, a recent study in middle aged subjects with controlled hypertension did find changes in LV diastolic function after 6 months of combined aerobic and strength training consisting of 30 min of walking at an intensity of 60-75% of maximum heart rate plus three series of resistance exercises with 8-12 repetitions for each muscle group and three sessions per week [20].

Acknowledgments

The authors would like to acknowledge the contribution of the patients (the Managers of “Danube Cooperative Savings”) who participated in the present study. This work was supported by the “Center of Cardimed” (Cardiological Center, Mosonmagyarovar, Hungary).

Perspectives

Mainly in Hungary the Free Indoor Football Play (FISP) is a popular team sport that also involves positive motivational and social factors. Future studies should look into the long-term effects of football on blood pressure regulation, cardiac function, and clinical end points in patients who live a sedentary life. Between occasional games personally tailored periodical low-intensity physical activities are recommended.

References

[1] Paffenbarger, R. S. Jr., Hyde, R. T., Wing, A. L., and Hsieh, C. C. 1986. "Physical Activity, All-cause Mortality, and Longevity of College Alumni." *N. Engl. J. Med.* 314: 605-13.

[2] Blair, S. N., Kohl, H. W. III., Paffenbarger, R. S. Jr., Clark, D. G., Cooper, K. H., and Gibbons, L. W. 1989. "Physical Fitness and All-cause Mortality. A Prospective Study of Healthy Men and Women." *JAMA*.

[3] Myers, J., Prakash, M., and Froelicher. V., et al. 2002. "Exercise Capacity and Mortality among Men Referred for Exercise Testing." *N. Engl. J. Med*. 346: 793-801.

[4] Erikssen, G., Liestol, K., Bjornholt, J., Thaulow, E., Sandvik, L., and Erikssen, J. 1998. "Changes in Physical Fitness and Changes in Mortality." *Lancet* 352: 759-62.

[5] Wannamethee, S. G., Shaper, A. G., and Walker, M. 1998. "Changes in Physical Activity, Mortality, and Incidence of Coronary Heart Disease in Older Men." *Lancet* 351: 1603-8.

[6] Kodama, S., Saito, K., Tanaka, S., Maki, M., Yachi, Y., Asumi, M., Sugawara, A., Totsuka, K., Shimano, H., Ohashi, Y., Yamada, N., and Sone, H. 2009. "Cardiorespiratory Fitness as a Quantitative Predictor of All-cause Mortality and Cardiovascular Events in Healthy Men and Women: a Meta-analysis." *JAMA* 301: 2024-35.

[7] Artero, E. G., Lee, D. C., Lavie, C. J., Espana-Romero, V., Sui, X., Church, T. S., and Blair, S. N. "Effects of Muscular Strength on Cardiovascular Risk Factors and Prognosis." *J. Cardiopulm Rehabil Prev.*

[8] Krustrup, P., Aagaard, P., Nybo, L., Petersen, J., Mohr, M., and Bangsbo, J. 2010. "Recreational Football as a Health Promoting Activity: a Topical Review." *Scand. J. Med. Sci. Sports* 20 (1): 1-13.

[9] Andersen, L. J., Randers, M. B., Westh, K., Martone, D., Hansen, P. R., Junge, A., Dvorak, J., Bangsbo, J., and Krustrup, P. 2010a. "Soccer as a Treatment for Hypertension in Untrained 30-55-year-old Men: a Prospective Randomized Study." *Scand. J. Med. Sci. Sports* 20 (1): 98-102.

[10] Knoepfli-Lenzin, C., Sennhauser, C., Toigo, M., Boutellier, U., Bangsbo, J., Krustrup, P., Junge, A., and Dvorak, J. 2010. "Effects of a 12-week Intervention Period with Soccer and Running for Habitually Active Men with Mild Hypertension." *Scand. J. Med. Sci. Sports* 20 (1): 72-9.

[11] Krustrup, P., Randers, M. B., Andersen, L. J., Jackman, S. R., Bangsbo, J., and Hansen, P. R. 2013. "Soccer Improves Fitness and Attenuates Cardiovascular Risk Factors in Hypertensive Men." *Med. Sci. Sports. Exerc.* 45: 553-60.

[12] Schiller, N. B., Shah, P. M., Crawford, M., DeMaria, A., Devereux, R., Feigenbaum, H., Gutgesell, H., Reichek, N., Sahn, D., and Schnittger, I., et al. 1989. "Recommendations for Quantitation of the Left Ventricle by Two-dimensional Echocardiography. American Society of Echocardiography Committee on Standards, Subcommittee on Quantitation of Two-Dimensional Echocardiograms." *J. Am. Soc. Echocardiogr.* 2: 358-67.

[13] Ihász Ferenc, Liziczai Imre, Raffai András Terheléses EKG prediktív szerepe a középkorú hobbisportolók körében *MAGYAR SPORTTUDOMÁNYI SZEMLE* 16 (2): 37. (2015) XII. Országos Sporttudományi Kongresszus. Eger, Magyarország: 2015.06.04-2015.06.06.

[14] Gardner, M. M., Robertson, M. C., and Campbell, A. J. 2000. "Exercise in Preventing Falls and Fall Related Injuries in Older People: a Review of Randomised Controlled Trials." *Br. J. Sports. Med.* 34 (1): 7-17.

[15] Mussolino, M. E., Looker, A. C., and Orwoll, E. S. 2001. "Jogging and Bone Mineral Density in Men: Results from NHANES III." *Am. J. Public Health* 91 (7): 1056-9.

[16] Beck, B. R. 2009. "Muscle Forces or Gravity—what Predominates Mechanical Loading on Bone?" Introduction. *Med. Sci. Sports Exerc.* 41 (11): 2033-6.

[17] Judex, S., and Carlson, K. J. 2009. "Is Bone's Response to Mechanical Signals Dominated by Gravitational Loading?" *Med. Sci. Sports Exerc.* 41: 2037-43.

[18] Jelinek, M. V., and Lown, B. 1974. "Exercise Stress Testing for Exposure of Cardiac Arrhythmias." *Prog. Cardiovasc. Dis.* 16: 497-522.

[19] Cocco, G., and Pandolfi, S. 2011. "Physical Exercise with Weight Reduction Lowers Blood Pressure and Improves Abnormal LV Relaxation in Pharmacologically Treated Hypertensive Patients." *J. Clin. Hypertens. (Greenwich)* 13 (1): 23-9.

[20] Zheng, H., Luo, M., Shen, Y., and Fang, H. 2011. "Improved LV Diastolic Function with Exercise Training in Hypertension: a Doppler Imaging Study." *Rehabil. Res. Pract.* 2011: 1-6.

[21] Guirado, G. N., Damatto, R. L., Matsubara, B. B., Roscani, M. G., Fusco, D. R., Cicchetto, L. A., Seki, M. M., Teixeira, A. S., Valle, A. P., Okoshi, K., and Okoshi, M. P. 2012. "Combined Exercise Training in Asymptomatic Elderly with Controlled Hypertension: Effects on Functional Capacity and Cardiac Diastolic Function." *Med. Sci. Monit.* 18 (7): CR461-5.