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ORIGINAL ARTICLE

COMBINED EFFECTS OF DIGITAL RESTRICTION AND SOMATOTYPE ON CARDIOVASCULAR ADJUSTMENT DURING TRAINING IN THE CONGOLESE CULTURAL FOOTBALLERS

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ABSTRACT

Background: The practice of football contributes to the training of the intelligent player who masters the football of zone by means of a well thought out planning and a good coaching. **Methods**: In order to evaluate the combined effects of numerical restriction and somatotype on cardiovascular adjustments to training among Congolese junior footballers, 10 Congolese players including 5 meso-ectomorphs and 5 meso-endomorphs were subjected to heart rate of rest (FCo) using a cardiofréquencemètre, systolic and diastolic blood pressure (PAS, PAD) using a sphygmomanometer from which the MAP and the YoYo evaluation test of the maximum aerobic speed (VMA) and maximum oxygen consumption ($\dot{V}$O2max) before and after an integrated 24-month training program. Averages were compared using the Mann-Whitney U test. **Results:** The results obtained at the end of this program showed significantly lower values for the meso-ectomorphic junior players than those recorded at the end of the training for the meso-endomorphic FCo junior footballers (64.20 ± 0.83bpm vs. 69.50 ± 0.70 bpm, $p < 0.001$), PAS (122.20 ± 0.83mmHg Vs 128.99 ± 0.60mmHg, $p < 0.001$) and MAP (90.16) ± 1.59mmHg Vs 92.93 ± 1.49 mmHg and 92.68 ± 0.94 mmHg, $p < 0.01$). However, VMA and $\dot{V}$O2max after ecto-mesomorphic training were significantly greater compared to those of meso-endomorphs (19.93 ± 1.83 km.h^{-1} Vs 15.74 ± 1.88 km.h^{-1}). 1 and 70.66 ± 0.00 ml.kg^{-1}.mn^{-1} Vs 53.61 ± 3.09 ml.kg^{-1}.mn-1, $p < 0.001$). **Conclusion**: These findings suggest cardiovascular adjustments to reduced-strength football training as a function of somatotype.

Key Words: *Football, Reduced Training, Somatotype and Cardiovascular Adjustments*.

I.INTRODUCTION

The practice of football contributes to the training of the intelligent player who masters the football of zone by means of a well thought out planning and a good coaching. The zone is a game design and has nothing to do with the game system. In the first instance, it aims at a rational use of space. A player's offensive and defensive actions are based on an intelligent positional game in the full context of the entire team [1]. These authors also pointed out that these actions favor a space occupation vis-à-vis the ball, a reduction as much as possible of the playing space of the opponent and ensuring mutual coverage. Thus, the whole team tries to open the game to the max in the direction of the opposing goal both in length and width by avoiding the positioning of all the players at the same height from each other and then creating a formation the game in triangle [1].

Zone football involves always being master in the area where the ball lies with the creation of the numerical superiority by individual actions, fast exchanges of ball contributes to the technical efficiency. The importance of technical efficiency stems from the fact that the amount of oxygen ($\dot{V}$O2) required for a given power of work can vary quite significantly from one individual to another during a cyclic exercise of the type aerobic [2].

Technical efficiency is influenced by energy cost [3] and mechanical efficiency [4]. Ibata (2013) has obtained a close correlation between the value of $\dot{V}$O2 max and the amount of travel as well as the number of sprints made in the match [2]. The performance of physical aerobic work is a function of the physical qualities needed for each job [5]. As a result, effective athletes consume less oxygen when performing exercise at work power (speed of movement).

The technical efficiency of football is translated by the physiological responses caused by the alternation of races at maximum intensity (jumps, percussion, races during counter attacks ...) and under maximal (phases of walking and trotting ...) [6] giving this activity an intermittent character. This author also pointed out that from the moderate phase of this intermittency of the maximal exercises of more than 5 minutes decreases the reaction time and puts the organism in under maximal activation state. He also noted that a physical exercise between 40% and 80% of $\dot{V}$O2max results in a higher activation level of the central system, which has a beneficial effect on the efficiency of information processing processes (especially for decisional tasks).

Maximum exercises to optimize the performance during training are likely to induce cardiovascular adjustments, among others: heart rate, blood pressure, $\dot{V}$O2max in sports. Indeed, during the 2/3 of a football match, the CF is above 85% of its maximum HR (maximum heart rate) during a period of 25 ± 5min, between 90 and 95% for 17 ± 10min and 95 to 100% for 7 ± 5min [7]. Cazorla (1992) considers on the basis of personal work that more than 2/3 of the duration of a football match is made at $\dot{V}$O2max higher than 80%. This $\dot{V}$O2max would be reached several times in the course of a match (1 to 5 times depending on the quality of the game and / or against the opponent). It has usually been considered that the average power of a football match requires 75% of oxygen consumption, around 165 bpm of heart rate for all players except the goalkeeper [7]. It has also been reported that treadmill results over the last 10 years, professional players playing in major European leagues are relatively stable at around 62ml.kg-^{1}.mn-^{1} on average for a maximum aerobic speed (AMV) of 17 km / h.

However, there is considerable inter-individual variability, even among individuals of the same age and sex, with equivalent training loads and cardiovascular capacity. Significant but moderate correlation coefficients were obtained between $\dot{V}O^2$max and body composition [2]. There is an influence of body structure on intense physical effort [8]. It is estimated that 69% of individual $\dot{V}$O2max differences are dependent on differences in body mass [9]. In consideration of the above-mentioned facts, particular attention should be paid to the combined effects of numerical restriction and somatotype on cardiovascular adjustments during training for Congolese junior footballers.

2. METHODOLOGY

2.1 Participants

The study focused on 10 including 5 meso-ectomorphic junior players and 5 meso-endomorphic junior footballers from the CONGO National Football Training Center. Aged 16 to 17, they all had 3 years of continuous experience in the center, training 5 times a week, participating regularly in national and international competitions, and having a VMA of at least 13 km.h-^{1}.

2.2 Procedure

This study was carried out in two stages, namely: the preliminary investigation and the effective investigation.

2.3 Preliminary investigation

The preliminary investigation consisted in:

- identifying teams using the gaming systems according to the tactical devices mentioned previously and to collect the acceptance of participation in the study,

- to carry out anthropometric measurements before training according to the technique recommended by the KINO-QUEBEC committee: weight, height, circumference (calf, forearm, arm flexed, knees, ankle and elbow) using STANLEY brand tape measure, skin folds (tricipital, sub scapular, supra iliac, abdominal) quadricipital) using the adiposometer, Body Mass Index (BMI), fat index (IG), fat-free mass (MSG) and fat mass (MG) using Keto 7. The somatotype of each subject was determined from the calculated values corresponding to each of its components, including: C1 for endomorphism [10], C2 and C3 respectively for mesomorphism and ectomorphism [11].

2.4 Effective Investigation

The investigation was to follow the training program and collect the data.

2.5 Training

Subjects being U16s were subjected to a training program as part of the development of the international player. To this end, they have worked to gain maturity in a match situation by learning to use these skills in a variety of competitive conditions. In addition, they were exposed to a game and training environment that brought them to the limits of their psychological, physical, technical and tactical abilities. The work rested:

1) - physically on well-developed flexibility, good warm-ups and calm, address, aerobic and anaerobic endurance, strength, strength of stabilizers, balance, nutrition and nutrition plan adapted to the situations (pre-game, post-game, tournaments), injury prevention and treatment, importance of rest and recuperation,
2) - technically the refinement of specific and relative skills in post, continual development of advanced techniques and skills,
3) - tactically on tactical decision-making ability, game play, match analysis, match preparation, productivity, competitiveness,

4) - psychologically on high concentration, responsibility, discipline, accountability, goal setting, self-confidence, intrinsic motivation, desire to win, mental strength, competitive mentality in games and training, response to the athlete's desire for competitiveness, the importance of having a interested look at the televised match.

In practice, they have been subjected to a 24-month training program in the form of reduced strength play with:

-a variation in numbers and surfaces: 1) -2 Vs 2 (28mx20m) for the perception of the effort, 2) -4 Vs 4 (40m x 30m) and 5 Vs 5 (99m x 37m) for improvement of aerobic capacity; intermittent exercises with active and average duration breaks improve cardiac recovery on exertion;

- continuous exercises to reach 90 to 95% of the AMV;

- the insertion of additional players to create the temporary situations of under-loads and overloads of work for the players of the two meetings;
- Increasing keys.

2.6 Data collection technique

The study consisted of two components, namely:

- the physiological measurements made before and after training were those: FCo in beats per minute (bpm), systolic blood pressure (PAS) in millimeters of mercury (mmHg) and diastolic blood pressure (DBP) in millimeters of mercury (mmHg). From PAS and PAD, mean arterial pressure was deducted;

- the physical fitness assessment that was performed using the YOYO test [12] before and after training.

Mann-Whitney U test and analysis of variance were used to compare two mean and mean cardiovascular variables, respectively, in the subjects of the three or four different somatotype who underwent training by post.

3. RESULTS

Age, height, weight, body mass index (BMI), fat index (IG), fat-free mass (MSG), fat mass (MG) and (inverted weight index (IPI) of meso-ectomorphic and meso junior footballers -endomorphs were presented in Table 1 as an average plus or minus standard deviation ($x \pm \delta$).

Table 1: The table presents the values mean plus or minus standard deviation ($\bar{x} \pm \delta$) of the anthropometric characteristics of meso junior footballers -ectomorphic and meso-endomorphous Meso-ectomorphs.

	Meso-ectomorphs (n=5)	Meso-endomorphs (n=5)	P
Age (years)	16.20 ± 0.83	16.52 ± 0.90	NS
Hight (cm)	172.80 ± 2.58	172.00 ± 4.24	NS
Weight (kg)	64.40 ± 2.21	68.95 ± 2.61 **	<0.01
BMI (kg.m²)	22.32 ± 0.30	23.30 ± 0.28 ***	<0.001
IG (%)	20.38 ± 0.66	21.55 ± 1.05 *	<0.05
MSG (kg)	56.22 ± 1.44*	54.80 ± 0.70	<0.05
MG (kg)	13.20 ± 0.03	14.55 ± 0.90 **	<0.01
IPI (cm.kg-1/3)	42.57 ± 0.41**	41.99 ± 0.23	<0.01

NS: difference not significant; *****: significant difference (P<0.05); ******: significant difference (P<0.01); *******: significant difference (P<0.001); **IG**: fat index; **MSG**: fat-free mass; **MG**: fat mass; **IPI**: inverted weight index.

The analysis in Table 1 show no significant difference did not appear between the ages and the Hight of the meso-ectomorphic and meso-endomorphic junior footballers. However, meso-endomorphic junior players had significantly higher values compared to their meso-ectomorphic counterparts in terms of weight ($p < 0.01$), BMI ($p < 0.001$). and IG ($p < 0.05$). Conversely, MSG was significantly greater among meso-ectomorphic junior footballers than that of meso-endomorphic junior footballers ($p < 0.05$). However, these meso-endomorphic junior players showed a significantly higher MG compared to their meso-ectomorphic counterparts while the opposite was observed for the IPI ($p < 0.05$).

Table 2 contains the mean and standard deviation ($x \pm \delta$) of resting heart rate (FCo), systolic arterial pressure (PAS), diastolic arterial pressure (PAD), mean arterial pressure (MAP), aerobic maximum velocity (VMA) and maximum oxygen consumption ($\dot{V}O2max$)

Table 2: The table presents the resting heart rate (FCo), systolic arterial pressure (PAS), diastolic arterial pressure (PAD), mean arterial pressure (MAP), aerobic maximum velocity (VMA) and maximum oxygen consumption (V̇O2max) pre and post reduced strength football training as an average and less deviation -type ($\bar{x} \pm \delta$).

	Meso-ectomorphic (n=5)	Meso-endomorphic (n=5)	p
	Pre Training		
FCo (bpm)	72.14 ± 1.57	73.50 ± 3.53	NS
PAS (mmHg)	128.40 ± 3.43	130.50 ± 0.00	NS
PAD (mmHg)	75.80 ± 0.44	76.50 ± 3.53	NS
PAM (mmHg)	92.93 ± 1.49	93.66 ± 4.48	NS
VMA ($km.h^{-1}$)	15.74 ± 1.88	15.28 ± 0.04	NS
$\dot{V}O_2max$ ($ml.kg.^{-1}.mn^{-1}$)	53.61 ± 3.09	54.56 ± 0.05	NS
	Post Training		
FCo (bpm)	64.20 ± 0.83 ***.†††	69.50 ± 0.70 †	<0.001
PAS (mmHg)	122.20 ± 0.83 ***.†††	128.99 ± 0.60 †††	<0.001
PAD (mmHg)	74.00 ± 2.34	75.08 ± 2.44	NS
PAM (mmHg)	90.16 ± 1.59 ***.††	92.68 ± 0.94	<0.01
VMA (km^{-1})	19.93 ± 1.83 ***.††	16.00 ± 1.87	<0.001
$\dot{V}O_2max$ ($ml.kg^{-1}.mn^{-1}$)	70.66 ± 0.00 ***.†††	55.80 ± 1.03 †††	<0.001

NS : non-significant difference ; ** : very significant difference (P<0.01) ; *** : highly significant difference (P<0.001); **†** : significant difference pre and post (P<0.05) ; **††** : very significant difference pre and post (P<0.01) ; **†††** : highly significant difference pre and post (P<0.001).

Table 2 shows that pre-training values of FCo, PAS, PAD, WFP, VMA and V̇O2max of meso-ectomorphic and meso-endomorphic junior footballers have been identical from a statistical point of view. On the other hand, post-training FCo was significantly reduced compared to pre-training FCo, especially among junior meso-ectomorphic footballers compared to junior ecto-endomorphic footballers (p <0.001 and p <0.05; respectively). In addition, post-training FCo was significantly lower among meso-ectomorphic junior footballers than that recorded at the end of training for meso-endomorphic junior footballers (p <0.001). The pre- and post-training PASs were significantly different for both meso-ectomorphic junior footballers and meso-endomorphic junior footballers (p <0.001).

The values recorded in this Table 1ndicate that at the end of the training, the PAD of the meso-ectomorphic and meso-endomorphic junior players were not significantly different. However, post-training WFP for junior meso-ectomorphic footballers was significantly lower compared to their baseline value and that of their meso-endomorphic counterparts at the end of training (p <0.01). With respect to VMA and V̇O2max, we observed significantly higher post-exercise values than pre-training values for junior meso-Ectomorph foot-pedalists (p <0.001).

4. DISCUSSION

The purpose of this study was to analyze the combined effects of numerical restriction and somatotype on cardiovascular adjustments during training for Congolese junior footballers. To this end, we conducted a cross-sectional study using anthropomorphic measurements, hemodynamic variables and the evaluation of physical fitness using the Yo Yo test. The measurements and the test being valid means in physiology, the results obtained are of considerable interest.

The practice of football is determined by the body composition. The results showed that there is no significant difference between the ages and the Hight of the meso-ectomorphic and meso-endomorphic junior footballers. However, the meso-endomorphic junior players have significantly higher values compared to their meso-ectomorphic counterparts in terms of weight (68.95 ± 2.61 kg Vs 64.40 ± 2.21 kg; 0.01), BMI (23.30 ± 0.28 $kg.m^{-2}$ Vs 22.32 ± 0.30 $kg.m^{-2}$, p <0.001) and IG (21.55 ± 1, 05% Vs 20.38 ± 0.66%, p <0.05) (Table 1). These results are explained by the two components of the somatotype of the first ones, including the meso morphy which is characterized by: a square statue and a predominance of the muscles, a massive framework of the legs, the trunk and the arms, the large forearms, the wrists, hands and fingers, a relatively small Hight [13, 14] and especially the endomorphy characterized by: the predominance of fat from the abdomen to the thorax and the predominance of bone, the equality of anteroposterior diameters and lateral to the head, neck, trunk and limbs, the presence of rounded curves in the body [13]. Conversely, the MSG is significantly greater among the meso-ectomorphic junior footballers than that of the meso-endomorphic junior footballers (56.22 ± 1.44 kg Vs 54.80 ± 0.70 kg, p <0.05) (Table 1). This larger MSG of meso-ectomorphic junior footballers is related to the musculoskeletal component in relation to the mass of water in intracellular and interstitial cells of muscles [15], with bone mass accounting for 8% of body weight Body [9] (Table 1).

However, the MG of the meso-endomorphic junior players is significantly greater than that of their meso-ectomorphic counterparts (14.55 ± 0.90 kg vs. 13, 20 ± 0.03 kg) while the opposite is noted in the IPI (42.57 ± 0.41 cm.kg-1/3 Vs 41.99 ± 0.23 cm.kg-1/3; <0.01) (Table 1). These results are dependent on the large adipose mass in meso-endomorphs and the corpulence in meso-ectomorphs. However, the mesomorphic component gives the subjects of the two somatotypes an intermediate center of gravity between the two trains (carrying and worn), powerful muscles, flexible, balance, considerable amplitude and predisposition to practice all Physical and Sports Activities Kaprovich and Sinning (1983) including football [11].

The practice of football induces cardiovascular adjustments. The results obtained indicate that the pre-training values of the FCo, the PAS, the PAD, the WFP, the VMA and the $\dot{V}$O2max of the meso-ectomorphic and meso-endomorphic junior footballers are identical from a statistical point of view (Table 2). On the other hand, the post-training FCo is significantly reduced compared to pre-training FCo, especially for younger meso-ectomorphic footballers compared to junior omega-endomorphic footballers (64.20 ± 0.83 bpm Vs 72, 14 ± 1.57 bpm, p <0.001 and 69.50 ± 0.70 bpm vs. 73.50 ± 3.53 bpm, p <0.05, respectively) (Table 2). This reduction in FCo is related to training that induces a predominance of the parasympathetic system that has a bradycardic (brake) effect [16]. The reduction in FCo is due to the technical efficiency and physical performance of the integrated workout made from aerobic exercise with long passes, placements and diagonal shifts repeated during situations of at least 2 min 30 sec. Indeed, the efficiency of the motor tasks and the determining actions of the meeting increase the dynamic component which is inevitably presented on the post-training presentation, especially aerobic, through the reduction of the heart rate [15].

In addition, post-training FCo was significantly lower among meso-ectomorphic junior footballers than that recorded at the end of training for meso-endomorphic junior footballers (64.20 ± 0.83 bpm Vs 69.50 ± 0.70 bpm; p <0.001) (Table 2). This significantly lower FCo for meso-ectomorphic junior footballers is explained by their dynamism in relation to the marked component of ectomorphy which gives them great amplitude and makes them endurance efforts on the one hand and the component dominant namely the mesomorphism that gives them the ability to speed execution of movements and exceptional endurance [17]. These two components allowed these footballers to maintain the dynamic component of the aerobic effort with the increase in space and strength, the insertion of additional players, intermittent exercises with active recoveries and average duration during the integrated training.

The pre- and post-training PAS are significantly different for younger meso-ectomorphic footballers (122.20 ± 0.83 mmHg Vs 128.40 ± 3.43 mmHg) than for the junior meso-footballers endomorphs (128.99 ± 0.60 mmHg Vs 130.50 ± 0.00 mmHg) (p <0.001) (Table 2). This decrease in blood pressure is a function of sub maximal intensity [18]. Aerobic training causes an increase in the number of capillaries and their calibers, a reduction in blood flow and consequently that of blood pressure [19].

The post-workout PAS meso-ectomorphic junior footballers was significantly lower compared to meso-endomorphic junior footballers (122.20 ± 0.83 mmHg Vs 128.99 ± 0.60 mmHg, p <0.001) (Table 2). These results indicate a much greater decline in PAS in meso-ectomorphic junior footballers can be explained by their active recovery capacity during integrated training that reduces the static component to the dynamic component and affects the cardiovascular functions [20]. In addition, active recovery induces muscle activity to reduce lactate and H + concentrations, which cause damage to the circulation and transport of O_2 [21]. This much more marked decrease in PAS among junior meso-ectomorphic footballers is also related to the somatotype favorable to aerobic exercises.

The values recorded in this table indicate that after the training, the PAD of the junior footballer's meso-ectomorphs and meso-endomorphs were not significantly different. However, the post-training WFP of the meso-ectomorphic junior footballers was significantly weak compared to their initial value and that obtained in their meso-endomorphic counterparts at the end of training (90.16 ± 1.59 mmHg Vs 92.93 ± 1.49 mmHg and 92.68 ± 0.94 mmHg, p <0.01) (Table 2). These results are attributable to integrated training and somatotype. In effect, integrated training requires aerobic exercises that increase the number of capillaries and cause peripheral vasodilatation, thereby reducing vascular resistance and blood pressure [22]. These aerobic exercises which are endowed with the ecto mesomorphs are probably responsible for the reduction of MAP to integrated football training in these meso-ectomorphic junior footballers.

With the VMA and VO_2max, we observed post-workout values significantly higher than pre-training levels for junior meso-ectomorphic footballers (19.93 ± 1.83 $km.h^{-1}$ Vs 15.74 ± 1.88 $km.h^{-1}$ and 70.66 ± 0.00 $ml.kg^{-1}.mn^{-1}$ Vs 53.61 ± 3.09 $ml.kg^{-1}.mn^{-1}$, p <0.001) (Table 2). This increase in VMA and VO2max is also dependent on tactics and game strategies and the collective intelligence used during integrated training. It has been reported in this regard that tactics, game strategies and collective intelligence during football-integrated coaching are characterized by the fairly varied and fluctuating positioning of players relative to each other, synchronization and consistency of their actions in offensive and defensive animations even in ball conservation increases the quality and quantity requirements of the players' technical background and fitness [6]. El Ouirghioui et al., (2018) have obtained results showing an increase in VMA of VO2max (0.68 $km.m^{-1}$ and 4.05 $ml.kg^{-1}.min^{-1}$) during an integrated protocol. Six months of football training [1]. It is highly likely that this improvement in aerobic performance is related to the somatotype in that the marked ectomorphic and dominant mesomorphic components confer on subjects increased chondrioma, aerobic metabolism, aerobic performance, and cardiovascular capacity.

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