INTERRELATION OF FOOTBALL PLAYERS' (13 TO 14 YEARS OLD) INDICES OF MOVEMENT IN VARIOUS DIRECTIONS

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Abstract. The aim of the work – to establish motor skills peculiarities in young football players (aged 13 to 14 years). Methods of the research: Tests for speed and velocity and Tensodynamometry (Radžiukynas 1997).

Average height of football players is 168 cm, their body mass – 55.84 kilos, BMI – 19.58. The vertical body movement speed in two foot take-off of the players is 2.49 m/sec, running results: in 10 m run – 1.88 sec (5.31 m/sec), in 20 m run – 3.31 sec (6.04 m/sec), in 30 m run – 4.68 sec (6.41 m/sec), jumping in hexagon area result – 17.16 sec, angular movement result – 2.35 m/sec. Individual movement skills are expressed by kinematic and kinetic indices of interaction with support, such as: squat time (0.348 sec), take-off duration (0.249 sec), squat speed (1.02 m/sec), squat depth (19.5 cm), reactivity of legs' muscles (22.1 Hz), jump height (31.4 cm), absolute power of take-off (1555 N), relative capacity (28.5 W). Football players do not experience fatigue performing intense two foot vertical jumps, in average 45 jumps in 30 sec.

Correlation analysis of all movement directions kinematic and kinetic indices relation significance highlighted the main indices which most objectively allow evaluation, prognosis, and correction of various directions movement level and abilities of young football players. Alteration of these indices' significance interrelation shows peculiarities of athletes' body functional systems' adaptation to training loads, also serves as an effective methodical direction in improving preparation of young football players.

Key words: young football players, vertical jumps, kinematic and kinetic indices

Introduction

Human sport movement is the main practical form of sport expression. Its content is made up and conditioned by various sports movements, teaching and training programs, while a variety of movement forms is disclosed during training sessions and competitions.

The aim of the sport movement is regular training sessions and participation in competitions, systematically aiming at optimal sport results. Human movement possessing no such features performs other social, cultural, health enhancing and remedial functions.

Possibilities to perform sport movement depend on person's body constitution, age, support and movement parts abilities, body functional systems capacities, use of accumulated energy, special training condition, etc. (Skurvydas 2010; Radžiukynas 2013).

Sport movement is particularly complex in game sports, as the athlete in his relation with support has to overcome gravity force, to move in various directions, at the same time possessing a ball.

The exceptional feature of football game is intense, short-lasting and frequently repeated locomotion movement in various directions with or without a ball, aiming to acquire space and time advantage in regard to one or several opponents. It was established that the most integral indices, indicating effectiveness of movement in various directions and competitive activity are absolute and momentum speed, absolute and momentum capacity, absolute and relative power, as well as precision of movements and actions (Gražulis 2013).

The data of the researches, carried out on athletes representing other sport games, of different age and mastership level proved that effectiveness of moving in various directions is mainly conditioned by kinematic and kinetic take-off from the support indices (Radžiukynas 1997; Radžiukynas et al. 2010). Presumably, effectiveness of young football players' moving can be recognized and evaluated according to the same kinematic and kinetic indices of relation with support. Less investigations are carried out on young (aged 13 to 14 years) football players' movement in various directions abilities. The aim of our work was to establish relation between young (aged 13 to 14 years) football players' indices of movement in various directions.

Organization and methods of the research

Young football players (aged 13 to 14 years), members of football school "Ateitis", participated in the research. Anthropometric indices: height (m), body mass (kg), BMI (body mass index, (c/u) were recorded. Applying the method of tenzodynamometry, football players' abilities of moving in vertical direction were established by performing three single jumps: 1. Standing vertical jump by both legs, with a natural squat and a hand movement. 2. Standing vertical jump by both legs without a hand movement. 3. Vertical jumps in 30 seconds by both legs with a hand movement.

The following indices were recorded and calculated: ds (sec) – squat duration, dt (sec) – take-off duration, df (sec) – flight phase duration, dj (sec) – total jump duration, Vs (m/sec) – squat speed, V (m/sec) – body movement speed, sd (m) – squat depth, h (m) – total body mass centre lifting height, h_1 (m) – jump height, Fmax (N) – greatest take-off force, Fav (N) – average take-off force, R (Hz) – muscle reactivity, A (J) – work, P (W) – power, Pr (W/kg) – relative power.

Established were such measurements: 5 m, 10 m, 20 m and 30 m running time (sec) and speed (m/sec), jumping in hexagon time (sec) and speed (m/sec) (Hexagonal Obstacle Test. Arnot and Gaines (1984)), angular body movement time (sec) and speed (m/sec) performing 7 jumps.

Mathematical statistic. Calculations were carried out to find out arithmetical mean $\overline{X}$, mean error ± $S\overline{x}$, standard deviation ± S, level of significance of difference t and p, correlation between indices – r. SPSS program (13.0 version) was used for calculation.

The results and discussion

It was established that young football players (13 to 14 years old) had reached the appropriate level of anthropometric indices. This natural process, also influenced by the training, determines the content of movement, its forms, effectiveness, as well as natural biologic maturity (Table 1).

Table 1. Biometric indices of football players aged from 13 to 14 years (n = 26)

Indices	x	±S	±Sx
Age	13.60	0.11	0.50
Height (m)	1.68	0.02	0.09
Body mass (kg)	55.85	1.98	8.88
BMI	19.58	0.41	1.85

The jump height when performing vertical jump by both legs with a hand movement is 0.307 m, while without a hand movement it is 0.268 m, the difference being 3.9 cm ($p < 0.05$). Vertical jump with a hand movement is natural action, used in games, more objectively reflecting movement abilities. No significant differences were established in other indices (Tables 2 and 3).

Table 2. Vertical jump by both legs with a hand movement

Indices	x	±Sx	±S
ds (sec)	0.353	0.058	0.011
dt (sec)	0.245	0.041	0.008
df (sec)	0.496	0.043	0.008
dj (sec)	0.850	0.094	0.018
Vs (m/sec)	–1.005	0.200	0.038
V (m/sec)	2.426	0.274	0.053
sd (m)	–0.191	0.050	0.010
h (m)	0.499	0.102	0.020
h1 (m)*	0.307	0.053	0.010
Fmax	1,529.130	380.472	73.222
Fav	1,136.103	238.653	45.929
R (Hz)	21.620	7.671	1.476
A (J)	375.801	90.347	17.387
P (W)	1,545.624	416.786	80.210
Pr (W/kg)	27.684	4.783	0.921

Higher vertical jump with a hand movement results are achieved due to the fact that this movement creates additional kinetic energy, which influences prolongation of flight phase duration (ds) and altogether increases body movement speed (V) and jump height (h1). Other indices did not possess significant differences.

Table 3. Vertical jump by both legs without a hand movement

Indices	x	±Sx	±x
ds (s)	0.323	0.056	0.011
dt (s)	0.226	0.030	0.006
df (s)	0.464	0.038	0.007
dj (s)	0.785	0.084	0.016
Vs (m/sec)	–0.986	0.194	0.037
V (m/sec)	2.301	0.290	0.055
sd (m)	–0.174	0.044	0.008
h (m)	0.464	0.118	0.022
h1 (m)	0.268	0.044	0.008
Fmax	1,664.823	425.866	80.481
Fav	1,174.031	247.212	46.719
R (Hz)	25.099	10.942	2.068
A (J)	349.841	95.862	18.116
P (W)	1,557.304	440.831	83.309
Pr (W/kg)	27.671	5.123	0.968

Table 4. Vertical jump by both legs after 30 sec. load

Indices	x	±Sx	±S
ds (sec)	0.365	0.099	0.019
dt (sec)	0.248	0.046	0.009
df (sec)	0.495	0.038	0.007
dj (sec)	0.865	0.124	0.024
Vs (m/sec)	–1.030	0.239	0.047
V (m/sec)	2.430	0.328	0.064
sd (m)	–0.192	0.053	0.010
h (m)	0.512	0.158	0.031
h1 (m)	0.305	0.046	0.009
Fmax	1544.126	424.889	83.328
Fav	1139.728	253.217	49.660
R (Hz)	20.027	6.324	1.240
A (J)	383.602	105.899	20.768
P (W)	1563.013	451.265	88.500
Pr (W/kg)	27.888	5.261	1.032

During 30 seconds, the young football players, aged from 13–14 years, performed in average 45 jumps. Such load was not of remarkable influence on change of indices (Tables 3 and 4). Duration of squat (sec) prior the load was 0.353 sec, after it – 0.365 sec ($p > 0.005$). Take-off duration was 0.245 sec and 0.248 sec ($p > 0.005$), flight phase duration – 0.496 sec and 0.495 sec ($p > 0.005$), body movement speed in take-off phase was 2.42 m/sec and 2.43 m/sec; jump duration – 0.850 sec and 0.865 sec, squat speed – 1.005 m/sec and 1.030 m/sec, squat depth – 0.191 m and 0.192 m did not experience change, too. Jump height was 0.307 m and 0.305 m, absolute force of take-off – 1529 N and 1544 N, average force – 1136 N and 1139 N, muscle reactivity – 21.626 Hz and 20.027 N

($p > 0.005$). Similar results were of the performed work, absolute and relative power; this shows that football players are able to carry out training loads of similar character, lasting up to 30 sec, without experiencing fatigue. It is purposeful to carry out future investigations, exploring the fatigue of one legs muscles performing same number of jumps in the same time, establishing the muscle working recovery. This would be of use aiming at more precise modeling of similar trend training loads.

Football players of 13 to 14 years, moving in horizontal direction, reach the speed of 6.41 m/sec, while their speed moving in various directions fluctuates from 1.38 m/sec to 2.43 m/sec (Figure 1).

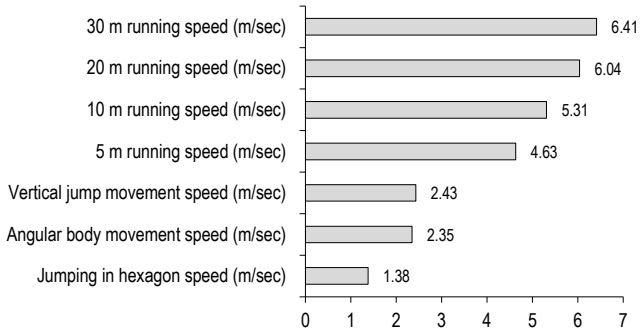

Figure 1. Speed of football players' movement in various directions (m/sec)

The least body movement speed is achieved when the athlete, moving horizontally, changes the direction of movement.

Football players', aged from 13 to 14 years, kinematic and kinetic indices of locomotion movement in various directions, as well as their anthropometric indices possess significant inter-correlation. This demonstrates the level of their sport movement and practical abilities for improvement of various movements and action in training sessions and competitions.

In this period of age, football players' height is in correlation with body mass (0.856**), with take-off from support maximum and average force (F) (0.693**, 0.774**), performed work (0.544*) and power (0.640**). Higher athletes possess a deeper squat (0.488*), thus prolonging body mass centre distance during the jump (0.466*).

Body mass is in correlation with body mass (0.821**), take-off speed (0.536*), maximum (0.742**) and average (0.921**) force, performed work (0.777**), absolute and relative power (0.845**, 0.510*), and running speed indices: 20 m (–0.563*), 30 m (–0.601**) and V m/sec (0.594**).

In this period of athletes' age, a very significant for them is BMI. It is in close correlation with majority of body movement indices, flight phase duration (0.498*), take-off speed (0.617**), total body mass centre lifting height (0.612**), jump height (0.519*), maximal (0.529*) and average force (0.794**), performed work (0.772**), absolute (0.772**) and relative power (0.529*), 20 m running (–0.555*), 30 m running (–0.602**), time of jumping in hexagon (–0.462*).

Squat duration in performing jump by both legs with a hand movement is in correlation with take-off duration (0.629**), jump duration (–0.903**), squat depth (–0.686**), maximal force (–0.645**).

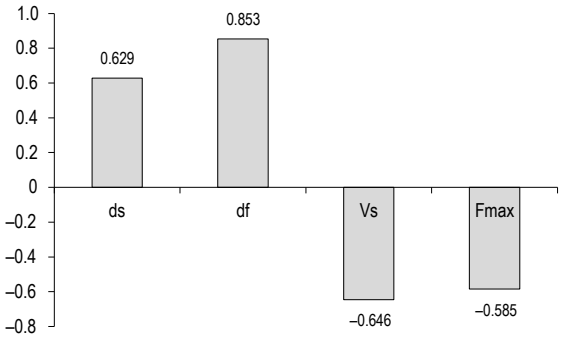

Figure 2. Take-off duration (dt) correlation

Jump height (h) is in correlation with BMI (0.519*), flight phase duration (0.998**), body movement speed (0.795**), total body mass centre lifting height (0.596**), work (0.639**), absolute power (0.627**), relative power (0.697**), 10 m running (0.568*), 20 m running (–0.596**), 30 m running (–0.664**) and average 30 m running speed m/sec (0.668**), as well as with angular body movement time (sec) (0.636**).

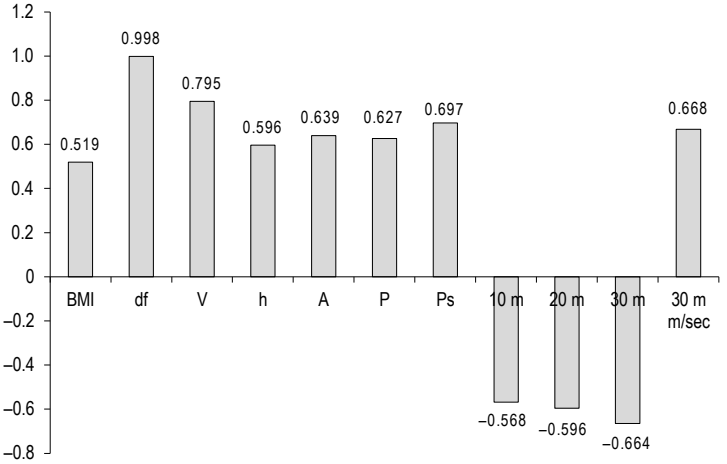

Figure 3. Jump height (h) correlation

Body movement speed V has correlation with majority of anthropometric and movement indices: body mass, BMI, flight phase duration, total body mass centre lifting height, jump height, average force, work, absolute and relative power, 10 m, 20 m, 30 m running results (Figure 4).

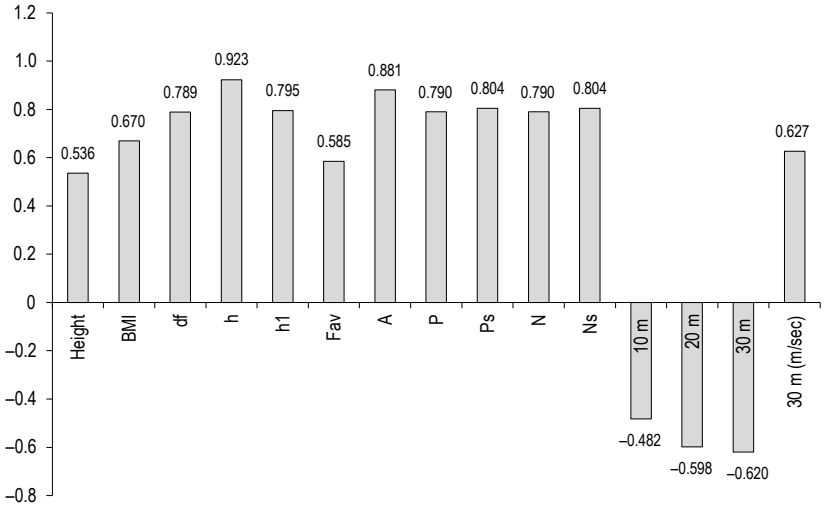

Figure 4. Body movement speed V (m/sec) correlation

Maximal and average force is in correlation with height (0.693**, 0.747**), body mass (0.742**, 0.921**), BMI (0.529*, 0.794**), ds (–0.645**), dt (0.585**), dj (0.634**), squat depth (0.733**, 0.532*), total body mass centre lifting height (–0.639**), work (0.730**), power (0.720**, 0.917**), relative power (0.547*, 0.697**), 5 m running time (0.463*), running speed m/sec (0.490*), 10 m running time (–0.637**, –0.488*), 20 m running time (–0.720**, –0.640**), 30 m running time (–0.729**, –0.642**), average 30 m running speed (0.723**, 0.636**) (Figure 5).

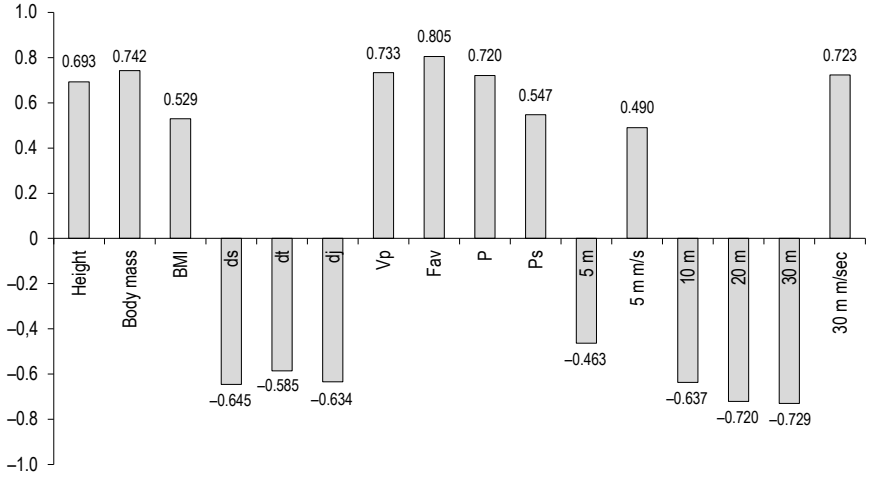

Figure 5. Maximal force F max correlation

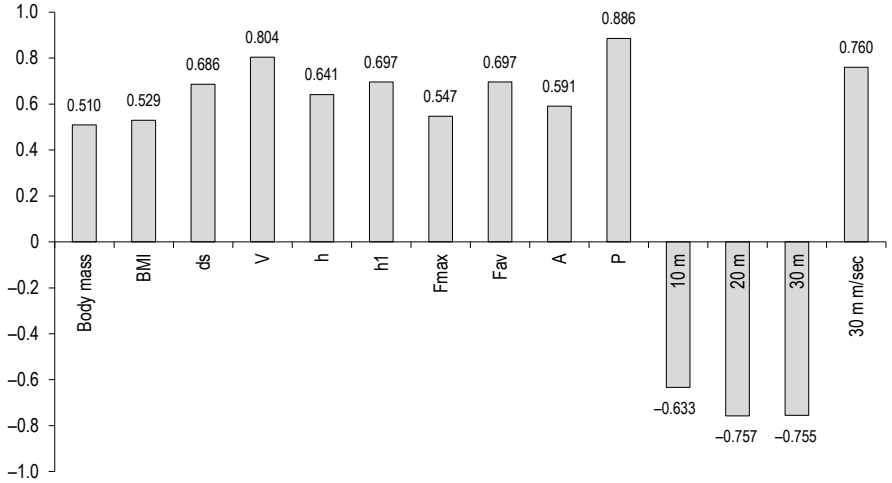

Figure 6. Relative power Ps correlation

Reactivity is in correlation with squat speed (0.642**), squat depth (0.586**), angular jumping (0.617*).

Work has correlation ties with height (0.544*), body mass (0.777**), BMI (0.772**), flight phase duration (0.619*), jump height (0.639**), total body mass centre lifting height (0.940**), jump height (0.639**), Fav (0.730), absolute power (0.792**) and relative power (0.591**), 20 m running speed (–0.466*), 30 m running speed (–0.498), 30 m running speed (0.501*), angular jumping time (–0.558*).

It should be noted that body movement in hexagon and angular jumping time has weaker correlation with other indices. This fact testimonies more difficult performance of such tests, as well as points out devoting more attention to training and use of such tests in training sessions.

The research results confirm existing wide practical possibilities in perfecting and improving young football players', aged form 13 to 14 years, moving in various directions abilities, using our presented tests, adequate to football game activity. Creation and evaluation of various special training programs and their practical effectiveness can be given evaluation according to the main indices of movement effectiveness, such as force, which is the main cause of moving, absolute, momentum speed, acceleration and power, ensuring advantage in space and time aspect.

Discussion

The results of our research confirm that sport movement of young football players (13 to 14 years old) is a complex and specific training system, which requires fast, mighty and precise learning of moving in various directions, as well as effective performance of it.

It was established that take-off force and duration are the main indices of locomotion moving. They determine momentum, absolute, average body movement speed in various directions, and its acceleration, as well as absolute and relative power. Change in these indices make preconditions for effective learning and performance of similar movement possessing a ball.

Our research confirms and supplements research data of similar trend, carried out on basketball players of various age (Radžiukynas 1997), as well as on track-and-field athletes (Žilinskienė 2008), handball and football players (Gražulis 2013).

Presumably, body movement in vertical direction speed of football players, aged from 13 to 14 years, as well as of basketball players of the same age, in future might increase from 2.42 m/sec (established in this research) to 2.90 m/sec, at the age of 20–21. Take-off force index might increase from 1529 N till 1600 N, while the jump height – till 43–44 cm. These would be the main factors, making influence on the effectiveness of moving in various directions with or without a ball, and this is the relevant trend for future investigations.

The data of this and previous researches, carried out by us and other authors confirm that in other sport games (such as volleyball, basketball and other), sport locomotion movement of the athletes in various directions might be evaluated according to the same indices, the main ones being take-off force and duration, which are followed by optimal to each athlete squat duration, depth, speed, body movement speed, take-off and flight phase duration, absolute and relative power, and muscle reactivity. Integral expression of all those indices and their change ensure athletes' possibilities to successfully move in space and time. Such research results might be the guidelines for changing and improving young athletes' training systems, programs, impact of training load and its change, duration, content and forms of recovery after training sessions. Its implementation can be ensured by: 1) individual and purposeful group special educational tasks; 2) coach-athlete creative interaction; 3) knowledge on 13 to 14 years old athlete's mechanical and biological movement possibilities.

Conclusions

It was established that young football players' (13 to 14 years old) height mean is 168 cm, body mass – 55.58 kg, BMI – 19.58 c/u. Such anthropometric indices make favorable preconditions for abilities of moving in various directions. Their vertical body movement speed in standing take-off by both legs is 2.49 m/sec, in running 10 m they reach 5.31 m/sec, in 20 m – 6.04 m/sec, in 30 m – 6.41 m/sec, in jumping in hexagon – 1.38 m/sec, angular movement speed – 2.35 m/sec. Such movement in various directions speed makes preconditions to effectively move in various directions with a ball, too.

Football players, aged 13 to 14, have already reached appropriate physical condition level of legs muscles, which are the main to ensure the locomotion movement effectiveness. Performing intense vertical standing jumps by both legs, the average number of take-offs being 45 in 30 seconds, the athletes do not experience fatigue. Take-off force, jump height and take-off duration indices do not remarkable change after such load, which means that in this period of age, more difficult trainings loads of similar character might be applied.

As demonstrated correlation analysis of significance of all movement directions kinematic and kinetic indices, the main indices for the most objective evaluation, prognosis and correction of football players', aged 13 to 14 years, level and possibilities for movement in various directions, is BMI, take-off duration, flight phase duration and jump height, absolute force and relative power, as well as body movement speed. Change of these indices' interrelation significance indicates peculiarities of athletes' biological maturity, biometric indices change, purposefulness of training sessions, body functional systems adaptation to training loads, and serves as an effective methodic trend in improving young football players' training.

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