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ASPECTS OF THE POSTURAL ALIGNMENT AND PLANTAR STRUCTURE IN JUNIOR FEMALE TABLE TENNIS PLAYERS

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Abstract

The purpose *of the present scientific research in performance table tennis at the level of junior female athletes was to determine the postural alignment and structure of the foot sole at static level, in order to create an amelioration program specific to kinetotherapy in the future, in case of identifying deficiencies.*

Hypothesis*: It is assumed that by using modern means of assessing posture and plantar footprints at dynamic level, we can identify the correlations between them in order to facilitate effective compensation systems.*

The aim *of this research is to improve the quality of life and sports performance in junior female table tennis players.*

Methods*: The assessment of body posture and plantar footprint was performed by using images, using the freeStep software by Sensor Medica and the assessment of the static plantar pressure and surface was performed by using the FreeMedbaropodometric platform. The study was conducted on a group of 9 female table tennis athletes with ages between 10 and 12 years old. The deviations from the normal postural and plantar values were calculated with IBM SPSS Statistics software, Version 23.*

Results and Conclusions*: The values ($p < 0.001 < \alpha = 0.05$) for the left sole, respectively ($p = 0.001 < \alpha = 0.05$) for the right sole, highlight significant differences between the total plantar area and the reference value on both soles of the foot, from the postural assessment resulting a significant difference between the group values and the reference value for all measurements ($p < 0.001 < \alpha = 0.05$).*

Keywords*: kinetotherapy; female junior athletes, FreeSteps, table tennis, postural unbalances*

1. Introduction

The human body determines the information from visual, sensorial, vestibular, muscular and cerebellar systems, all in a multi-sensorial process (Neto, H. P., et. al., 2015)in order to help the body posture in a spatial and temporal environment.

The changes in body postures and lines of movement have been encountered in table tennis players, mainly due to the torsions at trunklevel and to various movement-specific muscle contributions (Wong, DWC, Lee, WCC, & Lam, WK, 2020).

It was stated in approximately 90% that the plantar disorders are the most important causes leading to lower limb injuries, an aspect mentioned by Zenovia, S., EUGEN, B., & Constantin,

R. (2016); thus, it is necessary to correct the anomalies in the sole of the foot for a better control of the postural tonus (Neto, HP, et al., 2015).

In order to identify postural deficiencies and plantar imbalances in time, an objective assessment is necessary because repetitive and unilateral movements in speed regime are found in sports competitions, which can cause stress on intervertebral discs (Muyor et al., 2013; Bańkosz, Z., &Barczyk-Pawelec, K., 2020), as well as deviations from normal posture.

According to Mocanu., M and Negulescu.I. (2018), the forehand topspin and smash are the main technical-tactical elements of the attackin table tennis, these blows being performed at high speed, involving in their execution the whole osteo-muscular-articular system, at the level of the trunk and implicitly of the spine, being performed an accelerated twist, a motor action that in some cases generates in time the appearance of postural deficiencies with implications on sports performance and on the quality of life of the female athletes.

In this age group, 10-12 years old, we can identify an intensification of growth and other related changes; the establishment of the athlete in table tennis should be at an age between 15 and 18 years old, according to Balint, G., Ganzenhuber, P., Balint, T., &Spulber, F. (2013) and failing to meet this target could be due to some osteo-muscular-articular imbalances generating pain. Table tennis is one of the fastest ball sports games (Kondrič, M., Zagatto, A. M., &Sekulić, D., 2013) requiring numerous qualities and physical overstraining in achieving the desired performance.

11 years old children present a wrong posture in a percentage of 38% of them, aspect mentioned by Kratěnová J. et al. (2007), and frequently, in table tennis, the vicious posture is accentuated because certain executions are performed by a rapid movement of the torso in flexion-extension and twisting, according to Muyor et al., (2013). This aspect is highlighted in its twin sports, tennis, where the asymmetry of the body is highlighted from the youngest age category, and the reason for occurrence of the problems in the spine (Filipcic, A., Cuk, I., &Filipcic, T. 2016).

It is necessary to include a kinetotherapist in the multidisciplinary team in order to periodically evaluate the musculoskeletal system, implicitly the introduction of some asymmetric acting systems specific to kinetotherapy, with the purpose of preventing some possible body posture deficiencies, which in time can generate pain, aspect mentioned by the authors (Folorunso, O., et al., 2010; Munivrana, G. et al., 2011), stating that vicious postures during the game cannot be avoided.

2. Material and Methods

2.1. Subjects

The study was performed between 10.08.2020 and 15.09.2020, on a group of 9 junior female athletes III,with right active (skillful) arm, players registered in the Romanian Table Tennis Federation, with ages comprised between 10 and 12 years old, from three different cities.

In order to participate in this study,the consent of parents, coaches and athletes was required; also, another requirement was to be registered at Federation level and to participate in competitions for at least 3 years. We have concluded 3 partnership agreements with the 3 medical practices, bearing the registration number RF 3686, in view of a better future collaboration.

2.2. Procedures

The measurements were performed by the specialist from the medical practice, including the diagnosis following the assessment of the postural and footsole alignment.

The body postural assessment was performed with the help of the digital camera, then the measurements were processed by the FreeSteps By Sensor Medicasoftware, having the following specifications in its composition: image calibration, objective measurements, following to a protocol for positioning markers at the level of the following landmarks: **A** - Vertex, **B** - C7Vertebra, **C** - Right shoulder, **D** - Left shoulder, **E** - Right scapula, **F** - Left scapula, **G** – The prominence of the right posterior superior iliac spine, **H**–The prominence of the left posterior superior iliac spine can be traced in Figures no 1, 2.

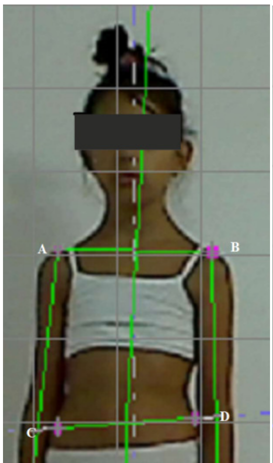


Figure no. 1. Body posture by (FreeSteps) images in frontal plan, anterior view of one of the subjects

*A – Right shoulder, **B** - Shoulder, **C** – Right antero-superior iliac spine, **D** - Left antero-superior iliac spine

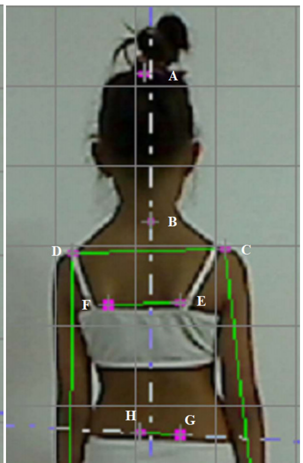


Figure no. 2. Body posture by (FreeSteps) images in frontal plan, posterior view of one of the subjects

*A – Subject's vertex, **B** – Prominence of C7 vertebra, **C** – Right shoulder, **D** – Left shoulder, **E** – Apex of right scapula, **F** - Apex of left scapula, **G** – Prominence of posterior – superior right iliac spine, **H** - Prominence of posterior – superior left iliac spinere no. 1.

According to Munivrana, G., Paušić, J., &Kondrič, M. (2011), the values of all postural deviations should be equal to 0, for an ideal postural alignment.

The analysis of FreeMedbaropodometric platform was performed statically, through pictures and processed with FreeStep software, which shows the numerical information on foot pressure distribution, surfaces, rear / front percentage, foot axis, and automatic analysis report and comparison with normal values, according to Figure no. 2 of a junior female athlete.

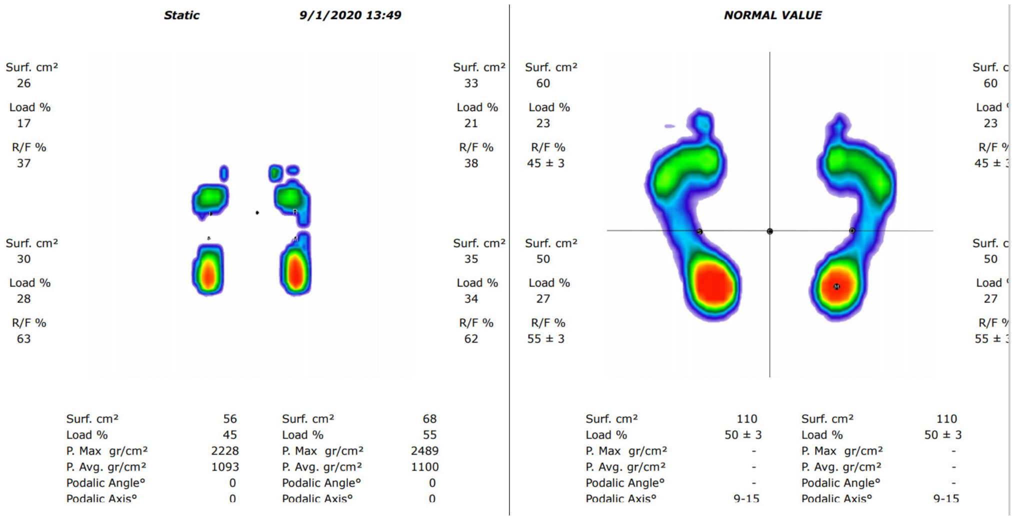


Figure no 3. The plantar analysis of one of the subjects in comparison to the reference value, in static phase, achieved with Freemed by Sensor Medicabaropodometric platform

3. Results

The present scientific research conducted among junior female performance athletes, highlighted very important aspects at body posture level, according to the figures and tables presented below. The collected data were processed with the statistical-mathematical analysis software IBM SPSS Statistics, Version 23, calculating the standard deviation, the associated probability (p) or Sig. (2-tailed) and the z test (95% Confidence Interval of the Difference).

Table no.1. Mean values achieved by the junior female athletes at the postural assessment

	N	Minimum	Maximum	Mean	Standard deviation
Shoulder inclination	9	1	4	2.22	0.833
Scapula inclination	9	1	5	2.56	1.236
SIPS inclination	9	2	7	3.56	1.590
Pelvis inclination	9	1	4	2.78	1.302
Valid N (list wise)	9				

***SIPS –**postero-superior iliac spine

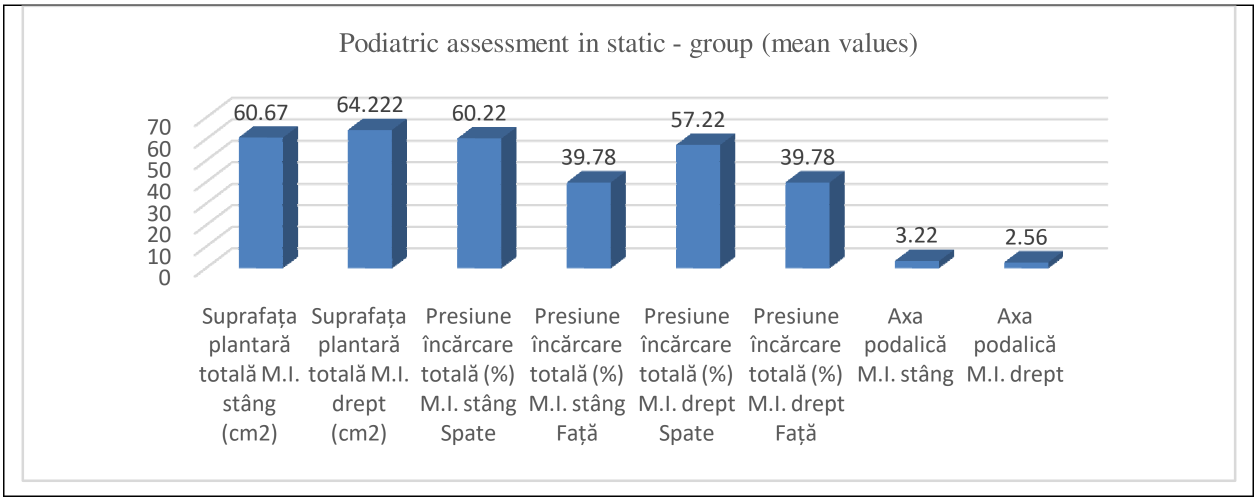
According to highest mean value, 3.56, it results that SIPS inclination is the most pronounced and the one with the farthest value from the normal one – 0.

Table no. 2. Values of the subjects on postural testing between the mean value and the reference value of the female athletes

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Lower**	**Upper**
Shoulder inclination	8.000	8	0.000	2.222	1.58	2.86
Scapula inclination	6.203	8	0.000	2.556	1.61	3.51
SIPS inclination	6.709	8	0.000	3.556	2.33	4.78
Pelvis inclination	6.402	8	0.000	2.778	1.78	3.78

Because $p < 0.001 < \alpha = 0.05$, it shows the fact that it does not contain zero value, resulting **significant differences** between the values of the subjects and the reference value **for all measurements.**

Following the podiatric assessments statically with the help of the baropodometric platform, various values and multiple correlations resulted at the plantar level, all favoring a perspective highlighted in Figure no. 4, Tables no. 3 and no. 4.



Left L.L.total plantar area (cm^2)	Right L.L.total plantar area (cm^2)	Back leftL.L. total load pressure (%)	Front left L.L. total load pressure (%)	Back right L.L. total load pressure (%)	Front right L.L. total load pressure (%)	Left L.L. podiatric axis	Right L.L. podiatric axis

nior female
athletes

***L.L.** – lower limb

According to mean values, 64.22, it results the fact that the plantar area is larger on the right sole, 60.22 –the plantar pressure is higher on the left sole foot and an internal abnormal rotation on the left foot - 8.

Table no. 4. Values of the subject on the plantar area at static level between the mean of the value of the female athletes vs. the reference value

	Test Value = 110					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Left L.L.total plantar area (cm^2)	-5.627	8	.000	-49.333	-69.55	-29.12
Right L.L.total plantar area (cm^2)	-4.824	8	.001	-45.7778	-67.660	-23.895

Because $p < 0.001 < \alpha = 0.05$ for the left foot, respectively $p = 0.001 < \alpha = 0.05$ for the right foot does not contain zero value, it results that there are significant differences between the total plantar area of the female juniors from the experiment group and the reference value on both soles of the foot.

Table no. 5. – Correlations at the level of the structure of the foot sole (area, pressure, podiatric axis)

		Left L.L. total plantar area (cm^2)	Right L.L. total plantar area (cm^2)	Back left L.L. total load pressure (%)	Front left L.L. total load pressure (%)	Back right L.L. total load pressure (%)	Front right L.L.total load pressure (%)	Left L.L. podiatric axis	Right L.L. podiatric axis
Left L.L. total plantar area (cm^2)	Pearson Correlation	1	**.971****	-.128	.128	.070	.128	-.319	-.346
	Sig. (2-tailed)		**.000**	.742	.742	.858	.742	.402	.362
	N	9	**9**	9	9	9	9	9	9
Right L.L. total plantar area (cm^2)	Pearson Correlation	**.971****	1	-.034	.034	.242	.034	-.319	-.405
	Sig. (2-tailed)	**.000**		.931	.931	.530	.931	.402	.280
	N	**9**	9	9	9	9	9	9	9
Back left L.L. total load pressure (%)	Pearson Correlation	-.128	-.034	1	**-1.000****	**.693***	**-1.000****	-.179	.478
	Sig. (2-tailed)	.742	.931		**.000**	**.038**	**.000**	.646	.193
	N	9	9	9	**9**	**9**	**9**	9	9
Front left L.L. total load	Pearson Correlation	.128	.034	**-1.000****	1	**-.693***	**1.000****	.179	-.478

pressure (%)	Sig. (2-tailed)	.742	.931	.000		.038	.000	.646	.193
	N	9	9	9	9	9	9	9	9
Back right L.L.total load pressure (%);	Pearson Correlation	.070	.242	.693*	-.693*	1	-.693*	.098	.299
	Sig. (2-tailed)	.858	.530	.038	.038		.038	.802	.435
	N	9	9	9	9	9	9	9	9
Front left L.L total load pressure (%)	Pearson Correlation	.128	.034	-1.000**	1.000**	-.693*	1	.179	-.478
	Sig. (2-tailed)	.742	.931	.000	.000	.038		.646	.193
	N	9	9	9	9	9	9	9	9
Left L.L. podiatric axis;	Pearson Correlation	-.319	-.319	-.179	.179	.098	.179	1	.444
	Sig. (2-tailed)	.402	.402	.646	.646	.802	.646		.231
	N	9	9	9	9	9	9	9	9
Right L.L. Podiatric axis;	Pearson Correlation	-.346	-.405	.478	-.478	.299	-.478	.444	1
	Sig. (2-tailed)	.362	.280	.193	.193	.435	.193	.231	
	N	9	9	9	9	9	9	9	9

*. Correlation is significant at the 0.01 level (2-tailed).

**. Correlation is significant at the 0.05 level (2-tailed).

Following the results related to Table no. 5, the following resulted from Pearson correlation coefficient, which indicates a strong correlation between:

- **Left L.L. total plantar area and right L.L.total plantar area,** ($p < 0.001 < \alpha = 0.05$, $r = 0.971$);
- **Right L.L.total plantar area and left L.L.total plantar area,** ($p < 0.001 < \alpha = 0.05$, $r = 0.971$);
- **Left back L.L.total load pressure(%)and right backL.L.total load pressure (%)** ($p < 0.001 < \alpha = 0.05$, $r = 0.693$);
- **Left back L.L.total load pressure(%)and right frontL.L.total load pressure(%)** ($p < 0.001 < \alpha = 0.05$, $r = -1.000$);
- **Left back L.L.total load pressure(%)and left front L.L.total load pressure(%)**; ($p = 0.038 < \alpha = 0.05$, $r = -1.000$);
- **Left back L.L.total load pressure(%)and right backL.L.total load pressure(%)** ($p = 0.038 < \alpha = 0.05$, $r = 0.693$);
- **Left back L.L.total load pressure(%)and left frontL.L.total load pressure(%)** ($p = 0.038 < \alpha = 0.05$, $r = -1.000$);

- **Left front L.L.total load pressure(%)and right backL.L.total load pressure(%)** ($p = 0.038 < \alpha = 0.05$, $r = -0.693$);
- **Left front L.L.total load pressure(%)and right front L.L.total load pressure(%)** ($p = 0.038 < \alpha = 0.05$, $r = 1.000$);
- **Right front L.L.total load pressure(%)and right backL.L.total load pressure(%)** ($p = 0.038 < \alpha = 0.05$, $r = -0.693$);

5. Conclusions

From the correlations at the level of the structure of the sole of the left and right foot (total area, total pressure and podiatric axis), the most important conclusions addressed to specialists in order to improve the quality of life and sports performance have resulted:

- Strong correlation resulting from left front L.L. load pressure (%) assessment in relation to the right back L.L.load pressure (%) (r = - 0.693) means an inverse proportionality which demonstrates that a high pressure of the left forefoot implies a lower pressure in the right heel area of junior female athletes.
- In the case of the strong correlation resulting from the assessment of the right L.L.total plantar area in relation to the left L.L.total plantar area (r = 0.971), it means a directly proportional ratio that demonstrates that a larger total plantar area of the right lower limb implies a larger total plantar area of the left lower limb of female athletes.
- The strong correlation resulting from the assessment of the right L.L.total load pressure (%)in relation to the right back L.L.total loaded pressure (%)(r = - 0.693) means an inverse proportionality, demonstrating that a high pressure of the right forefoot implies a lower pressure in the right heel area of junior female athletes.

The most important conclusions following the measurements processed by the Freestep software and interpreted from statistical – mathematical point of view, related to body posture, have highlighted the following problems in our subjects:

- Slight asymmetry of the shoulders and scapula resulting from specific unilateral movements, causing muscle-joint imbalances.
- The most pronounced inclination was found at the posterior superior iliac spine (SIPS) and pelvis level. This results in significant differences between the subjects' values and the reference value with a 95% probability that the difference is true.

The results obtained after the assessment with modern devices, regarding the postural deficiencies and plantar imbalances in the female players with ages between 10 and 12 years old in table tennis, favored the filtering of some conclusions and favored the improvement of sports performance and quality of life.

We recommend the following specific actions, in order to achieve the proposed objectives:

- Periodic objective assessment of junior female athletes with the help of specific software to stop the accentuation of postural deficiencies and plantar imbalances;
- Based on the assessment of the athletes, the diagnosis was Postural Dysperception Syndrome in all 9 female athletes, requiring an individualized recovery program specific to physical therapy.
- Following the podiatric assessment, the female athletes presented the following imbalances: talus valgus at the plantar level, bilateral knee in the valgus, hollow foot, 2ndgrade flat foot, mixed foot and an accentuated internal rotation of the sole which can influence the pelvic and lumbar region, the recommendation being to wear individualized plantar supports.
- A kinetotherapist is required in the multidisciplinary team in order to achieve, propose and introduce an individualized postural improvement protocol that includes joint mobilizations, asymmetric actuation systems, specific massage and implicitly kinesiologic straps.

6. Future Research Directions

In the near future, we intend to evaluate a group of 18 sportswomen with ages between 10 and 12 years old, using our own methodological strategy for assessing and improving the postural deficiencies.

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