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Influence of dispensing the body weight at the plant level over maintaining the balance

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ABSTRACT: *The balance, as a result of complex nervous processes with mechanical response in the muscles and joints, provides us a permanent study to clarify the less clear aspects. In the case of athletes, when they constantly struggle to re-balance the body during direct contact with the opponent or during the complex technical procedures, the problem of education through practice and repetition is vital. We were conducting a study on two female handballs athletes' groups (who were 12 and 16 years old), and we found significant correlations between balance, body's weight, the weight distribution on the three areas of the plant (top, middle and heel area) at plant level and lumbar muscular force. By applying the barometric test and the global stability test we obtained results that show that there is no significant correlation between the quality of the balance and the pressure exerted by the weight on the three plantar areas.*

The only right correlation (r = -41%) is that which requires the balancing of the weight distribution on both legs to increase the quality of the balance. For the 12 year- old's we noticed a significant relationship between the quality of the balance and the strength of the lumbar muscles (r = 0.62%). These findings must be considered with care, because they are specific to this group of subjects.

KEYWORDS: *Balance, muscle strength, weight distribution on the plant.*

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I. INTRODUCTION

The whole human motricity is based on the ability to permanently maintain the body in a perfect balance. We can only approach any physical activity if that can be relayed on a very complex system, which is designed to provide countless postural adjustments based on direction, speed, gravity, external interference etc. The balance is the result of the optimal relationship between sensory information received, proprioception, vestibular system, muscle reaction and psychological factors.

The first interaction of the body with the soil is achieved thru the legs, both during maintaining the static posture and in the displacement, and for this reason it is very important to diagnose the problems at this level (Abdul, 2012; Young-Hyeon, 2015).

In fact, the permanent balancing of the body is an effort to prevent the fall (Riann et al., 2002). For this reason, in sports activity, it is very important how the body constantly reports to numerous external factors that influence, in particular, technical executions. A possible affection at the level of the soles may affect the way of motor activity and it is recommended to be recovered from the childhood (Vorlickova and Korvas, 2013).

In handball, the balance it is especially important because players always come in contact with opponents and teammates. They constantly report to the environment, to the ball, to the tactics of the game, to the instructions of the coach or colleagues, all while being in free movement or in contact with the opponent and being pressured to make decisions to achieve the most perfect technical execution.

Studies have shown that they are occurring significant changes at the plantar level according to age (Hessert et al., 2005; Menz, 2015), so it is necessary we study and understand as much as possible the distribution of weight on the plant and the influence of this system on the balance of the body. We were testing forty-two female handball players divided in two age groups (who were 12 and 16 years old).

We can better notice if there are differences between age groups in how to support the body weight at the plant level and the quality of the tested balance. Thus, we can investigate whether the balance is influenced by the projection of the body's weight on the top of the plant, its average area or heel area at different ages, as well as the way the lumbar muscle force intervenes in this process.

II. METHODOLOGY

We were testing forty-two female handball players divided in two age groups (who were 12 and 16 years old). Please note that we were testing only athletes in good health, in order to perform the tests correctly and with maximum efficiency.

Baropodometric Test: To show the disposition of body's weight at the level of the plants, we used the static baropodometric method. This method offers objective values of the forces that are projected at the level of the plants and their segments (Danelciuc and Betiuc, 2011). After we transferred the imprint left by the soles into the computer and we digitally processed it, we were identifying points of body weight distributed on the three areas of the plants: top, middle and heel area (fig.1). The interface also shows the average of the three values for each foot. To correlate, we were using the average values obtained on each plant (abbreviations are found in table 1). The values obtained on the device are expressed in Newtons as measurement unit.

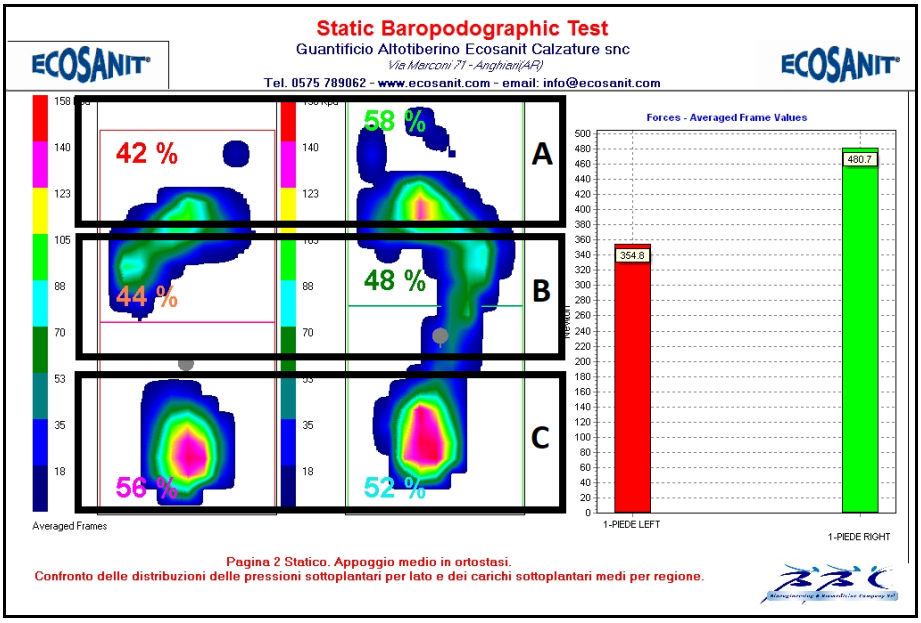

Figure 1 - The baropodometric test with areas A, B and C highlighted.

Global Stability Test (SDG): We did realize this test with a proprioceptive LIBRA PLUS platform under the Easytech platform at SC NEW Multimedica SRL Galati. (De Gunsch et al., 2017).

The subjects performed the test at the "fixed point" maintaining the equilibrium on the plate for 30 seconds. The evaluation scale for this test is the following: optimal (9-11), good (11-12), satisfactory (12-13), weak (13-14) and very poor (14-16). We were presenting two examples of graphical representation for this test. Figure 2 shows the larger weight transfer to the left foot. This foot is the basic in this case, it provides very large balancing of the body, so it is highly in demand. In figure 3, the weight is distributed almost equally on the two plants and the balance is provided by both legs.

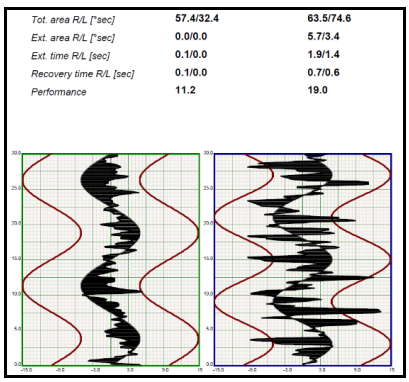

Figure 2: Shows the larger weight transfer the left foot.

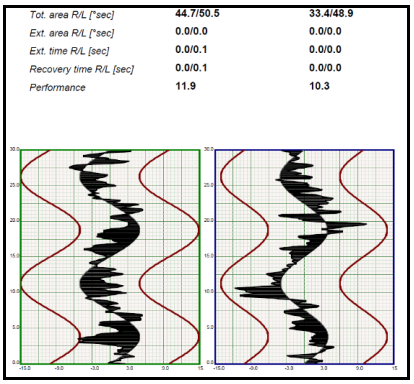

Figure 3: The weight is distributed almost equally.

Testing Lumbar Muscular Strength: Classic test performed by dynamometry.

III. FINDINGS

The collected data was processed using SPSS v. 20 for Windows. The 25 correlations between these variables, by age group, have r values between 0.01% and -0.62%. The confidence coefficient for statistical significance is 95%. The abbreviations are presented in Table 1.

Table 1: Abbreviations in use

ABBREVIATIONS	DESCRIPTION
BAL	Balance test
TLF	The top of the left foot (area A fig. 1)
TRF	The top of the right foot (area A fig. 1)
MLF	The middle of the left foot (area B fig. 1)
MRF	The middle of the right foot (area B fig. 1)
LFH	The left foot heel (area C fig. 1)
RFH	The right foot heel (area C fig. 1)
DIF.	The difference
ALP	The average value obtained from the left plant
ARP	The average value obtained from the right plant
LB	Lumbar muscle strength test.

Table 2 contains the test results for the 16-year-olds. The averages of the test values show a greater pressure on the plant in the 16-year-olds due to the weight. There was also a significant difference between the values of lumbar muscle strength (77 kgf in the 16-year-olds and 51.8 kgf in the 12-year-olds). The average values for the balance test are better for the 12-year-olds (r=3.6 versus r=4.4).

Table 2 - Data obtained from the 16-year-olds

NR.	BAL	TLF	TRF	DIF	MLF	MRF	DIF	LFH	RFH	DIF	ALP	ARP	DIF	LB
1.	3.6	41	59	18	52	47	5	48	53	5	405.8	585.3	180	67
2.	3.7	45	55	10	50	49	1	50	51	1	439.7	534.9	95.2	72.2
3.	4.3	44	56	12	53	53	0	47	47	0	407.3	523.9	117	64
4.	7.6	50	50	0	37	42	5	63	50	13	455	449.1	5.9	64
5.	5.3	48	52	4	46	39	7	54	61	7	507.2	551.3	44.1	77.8
6.	4.2	45	55	10	54	50	4	46	50	4	458.7	559.3	101	76.8
7.	6.4	49	51	2	58	57	1	42	43	1	518.2	538.1	19.9	82.1
8.	4	44	56	12	56	52	4	44	48	4	514	647.9	134	85
9.	3.8	49	51	2	54	61	7	46	39	7	568.9	588.1	19.2	78.4
10.	5.6	44	56	12	58	55	3	42	45	3	629.8	787.3	158	89.4
11.	3.4	43	57	14	43	44	1	57	56	1	571	754.6	184	92.4
12.	3.8	43	57	14	29	37	8	71	63	8	458.7	523.9	65.2	82
13.	4.3	43	57	14	42	42	0	58	58	0	570.6	762.9	192	76
14.	3.2	49	51	2	39	52	13	61	48	13	611.9	634.4	22.5	65
15.	3.6	52	48	4	65	67	2	35	33	2	576	545.3	30.7	75
16.	3.9	38	62	24	69	58	11	31	42	11	378	614.3	236	48
17.	3.9	54	46	8	37	45	8	63	55	8	661.8	568.7	93.1	68
18.	3.8	45	55	10	54	44	10	46	56	10	622.3	749.2	127	107
19.	4.3	43	57	14	58	60	2	42	40	2	369.9	493.5	124	87.2
20.	4.5	48	52	4	48	34	14	52	66	14	566.3	603.5	37.2	82.2
21.	4.5	45	55	10	48	51	3	52	49	3	511.9	617.1	105	76.8
M	**4.4**	**45.8**	**54.2**	**9.5**	**50**	**49,5**	**5.2**	**50**	**50.1**	**5.6**	**514.4**	**601.6**	**99.5**	**77**

In the 16-year-olds we noticed:
Higher pressure at the tip of the right plant.
An approximately equal pressure in the middle area of the plant and of the heel.
The average pressure on the plant is higher at the level of the right plant.

Table 3 - Data obtained from the 12 year-olds

NR.	BAL	TLF	TRF	DIF	MLF	MRF	DIF	LFH	RFH	DIF	ALP	ARP	DIF	LB
1.	5.1	46	54	8	45	50	5	55	50	5	515.8	613.3	97.5	55
2.	4.6	55	45	10	43	63	20	57	37	20	454.1	370.5	83.6	56.3
3.	2.1	43	57	14	46	38	8	54	62	8	473.2	623.3	150.1	49.6
4.	3.6	47	53	6	35	47	12	65	53	12	353.7	403.3	49.6	38.2
5.	4.1	42	58	16	47	41	6	53	59	6	684.4	941.7	257.3	60.5
6.	1.4	45	55	10	43	41	2	57	59	2	454.6	550.2	95.6	40.3
7.	3.1	42	58	16	49	53	4	51	47	4	411	572.6	161.6	58
8.	4.6	41	59	18	53	53	0	47	47	0	415.3	602	186.7	43.2
9.	2.4	46	54	8	41	52	11	59	48	11	427.2	504.5	77.3	48.6

10.	5.6	43	57	14	42	43	1	58	57	1	444.4	587.9	143.5	52.8
11.	4.6	46	54	8	50	54	4	50	46	4	407.9	470.4	62.5	61
12.	2.1	46	54	8	55	57	2	45	43	2	439.5	512.7	73.2	65.1
13.	3	46	54	8	51	47	4	49	53	4	458.9	536.5	77.6	44.1
14.	3.8	48	52	4	52	42	10	48	58	10	491.4	532.5	41.1	56
15.	2.4	43	57	14	72	59	13	28	41	13	428.1	567.1	139	66.5
16.	5.7	42	58	16	64	54	10	36	46	10	486.8	664.6	177.8	71
17.	3.3	50	50	0	51	60	9	49	40	9	364.9	364.8	0.1	34.7
18.	3.1	45	55	10	43	53	10	57	47	10	387.3	481.7	94.4	44
19.	3.6	51	49	2	45	45	0	55	55	0	344.8	331.1	13.7	43.4
20.	4.6	49	51	2	43	57	14	57	43	14	310.4	327.1	16.7	40.3
21.	3	44	56	12	47	50	3	53	50	3	434	554.8	120.8	59
M	**3.6**	**45.7**	**54.3**	**9.7**	**48.4**	**50.4**	**7**	**51.6**	**49.6**	**7**	**437.5**	**529.2**	**100.9**	**51.8**

For the 12 year-olds:
Higher pressure at the tip of the right plant.
Slightly higher pressure in the mid area of the right plant.
Slighty higher pressure in the area of the left heel.
The average values for the whole plant are higher for the right foot.

If we produce a graph of the average values on the three areas of the plant, we see that in the 12 year-olds the weight is distributed diagonally (fig. 4).

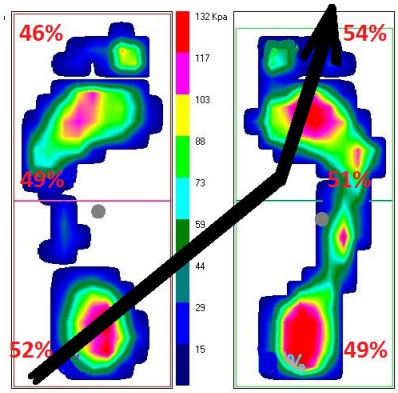

Figure 4: 12-year-olds

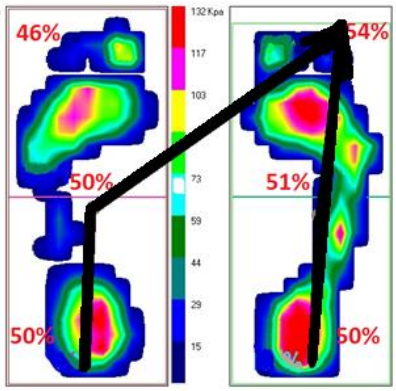

Figure 5: 14-year-olds

There is a distribution in line between the right tip-medium right to the equalization towards the left heel. We found that due to age the muscular tensions dominate the moment of equilibrium and this diagonal exists due to the frequent use of the right arm, to most athletes.

The arm extension and torso twisting movements, when handing over and dropping the handball, have firm support on the left heel. In the 16 year-olds we found an almost uniform distribution of body weight on the six areas of both plants (fig. 5). Global growth of muscular strength and the stabilization of the nerve processes have already formed a harmony of the muscular chains involved in the specific movements of the sporting branch.

Table 4 - Correlations between plant test footprint, data balance and strength of the lumbar muscles

16-year-olds	**NR.**	**BAL**	**TLF**	**TRF**	**DIF**	**MLF**	**MRF**	**DIF**	**LFH**	**RFH**	**DIF**	**ALP**	**ARP**
BAL	0.24	-0.25	-0.41	-0.05	-0.12	-0.18	-0.05	-0.02	0.1	-0.09	-0.28	-0.34	-0.17
LB	0.08	-0.08	-0.17	-0.11	-0.32	-0.02	0.11	0.39	-0.12	0.50	-0.48	-0.12	-
12-year-olds	**NR.**	**BAL**	**TLF**	**TRF**	**DIF**	**MLF**	**MRF**	**DIF**	**LFH**	**RFH**	**DIF**	**ALP**	**ARP**
BAL	0.04	-0.04	0.09	-0.01	0.15	0.07	0.02	-0.15	0.07	0.10	0.07	0.14	0.62
LB	-0.33	0.33	0.51	0.60	0.19	-0.10	-0.60	-0.19	-0.10	0.50	0.49	0.47	-

We noticed that there are no significant correlations between the balance and the body weight projected areas (peak, mid area and heel) at the plant level.

There are, however, two exceptions: in the 16-year-olds there is a good correlation between the balance and the difference in the pressure on the toes (r = -0.41%) and a significant correlation, in the 12-year-olds, between the balance and the strength of the lumbar muscles = -0.62%).

The correlations between the lumbar muscular force and the pressure on the three areas of the plant are evident in the 12-year-olds. Although the correlations of the average values are approximately equal (0.50 and 0.49) we noticed that on the mid area and the heels the correlations are significant in the left foot.

IV. DISCUSSION

Significantly higher **r** values in the case of lumbar muscular force show a significant influence on predominant muscle responses at the young age, as confirmed by the GeWu studies in 1996. The dominance of greater pressure on a foot was also evidenced by Sulofana et.al in 2015, thus confirming conflicts of results related to leg dominance and the influence of this on body's posture.

Pei Xuan Ku et al. in 2014 confirm the lateral rebalancing on the stronger foot, fact reinforced by Gehan et. al in 2017.

The significant influence of lumbar muscles on balance has been studied and confirmed by Andrew et. al in 2013. Simone Tassani et al., In 2018, points out that muscle tensions significantly influence balance and that relaxation would improve this. Sung-Sun et al., in 2015, also argues that relaxation by using exercise in water leads to an improvement in rebalancing the body.

V. CONCLUSION

In this study, we shown that there is no significant link between the quality of the balance and the pressure exerted by the weight on the three plant areas (top, middle and heel). It is the only value (r = -41%) that shows the need for the weight to be distributed evenly on the two legs in order for the balance to be as good as possible. In the 12 year-olds we found a significant link between the quality of the balance and the strength of the lumbar muscles.

This good connection is a result of strong correlations between lumbar force and weight projection on the middle and heel areas. In the 12 year-olds, the body balancing is achieved by muscle tension and a projection of weight to the middle area and heels, mainly due to the contraction of the lumbar muscles.

In the 16 year-olds, due to the development of sensory and motor control systems, the dependence on lumbar muscle tension no longer exists. It is necessary to have at each sport training distinct exercises to develop the ability to maintain the balance of the body in the most difficult situations.

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