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EXPERIMENTAL STUDY ON THE EQUILIBRIUM AND STABILITY OF A SPORTIF ON THE MOBIL PLATFORM

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***Abstract** The drawing refers to the experimental establishment of the balance and posture of a sportsperson, on a moving platform. It is about a sportsperson, who practices two distinct sports: one winter – skiing and one summer – swimming. This experimental study seeks to establish how the athlete manages to adapt to situations created or imposed by an experimental system in the determination of equilibrium and stability. Their analysis is done through computerized programs.*

***Key words:** experimental study, active sportif, equilibrium and stability of the motion.*

1. INTRODUCTION

For measuring the posture and balance of the human body [1], [10], both moving and static, specific equipment is used, such as the spherical motion platform Huber 360 Md is shown in Figure 1.1.



Fig. 1.1. Huber 360 Md Platform

The Platform being produced by LPG Systems, this platform with a preset number of programs, being used mainly in hospitals and recuperation clinics, because it helps to restore patients with various pathologies, with the role and importance of Neuromuscular preparation and proprioception [8], [9].

The Device has 6 standard programs, which measure: stability, unipodal balance, stato-dynamics during walking, stability limit, mobility and power restrictions of the upper limbs [2], [3], [11].

Device designed for uninterrupted use, Huber 360 MD is marked as a medical device of Directive 93/42/EC (consolidated version, including Directive 2007/47/EC). HUBER 360 MD is a non-mobile device and must be connected by an authorized installation expert in accordance with all local/national regulations. The maximum permissible weight of the user is 140 kg.

These operating instructions describe how to use the device, periodic maintenance, and safety instructions. The Device must only be used by a professional who has been instructed by an authorized supplier. It is not suitable for home use [4], [5], [6], [7].

2. PREPARATION OF INVESTIGATIONS

In this paper Huber 360 Md will be used to investigate an active athlete, who carries out his professional activity in the sport of training for swimming and leisure skiing.

The investigated subject is male, 27 years of age, height 180 cm, weight of 110 kg, physically healthy, for measurements on the

platform. He, throughout his life, practiced sports at recreational level until he reached the age of 13, after which he practiced performance sports for 4 years, and after the end of this regular sport practice period

3. MEASUREMENTS MADE

For the investigated subject, tests are carried out in succession: stability test, for which the image of the subject on the monitor is found in figure 3.1., the picture of the subject is found in figure 3.2., registration of the investigation data on the subject with open eyes is given in table 3.1, and with eyes closed in table 3.2. The result of the stability investigation is found in figure 3.3. a, for the investigation with open eyes and figure 3.3. b for the investigation of the subject's stability with closed eyes.

3.1. STABILITY TEST

From the graphical representations shown in figure 3.3. a and figure 3.3. b on Subject subjected to the stability test, the following shall be found:

- On the investigation carried out with open eyes
- Representation of 50% is found outside the pre-defined area;
- Points played according to numeric data are the grouped in a narrow horizontal area, it means as the subject has stability in the right left movement (lateral).
- To the investigation carried out with closed eyes:
- All representation is distributed on a surface inside an ellipse, this means that stability is

ensured in the plan but in a widely distributed area;

- The registered area corresponding to this investigation is far outside the pre-defined stability zone.

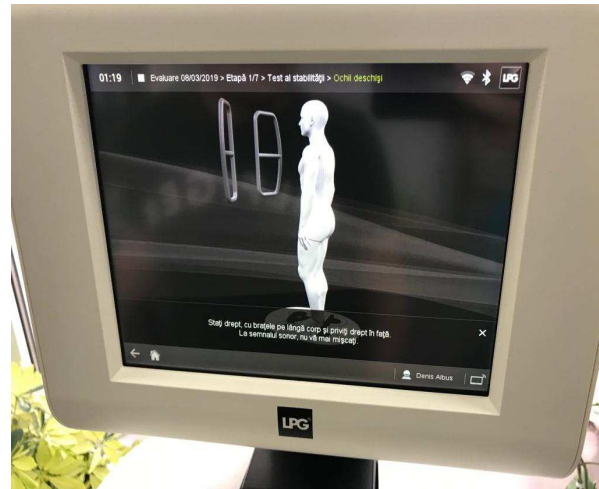


Fig. 3.1. The subject's image on the monitor to the stability test

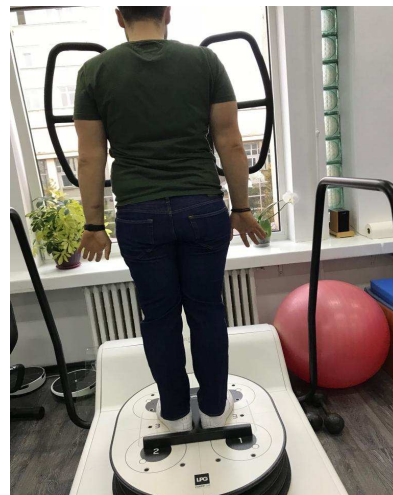


Fig. 3.2. Photo subject to experimental test of stability

Tabel 3.1.

Excerpt from the stability data of subject with eyes open

Point	x	y	Point	x	y	Point	x	y
3	705939;6	703635;-2	0	677641;9	205981;2	1	076356;15	714758;11
1	949434;2	511135;0	3	708312;8	277484;0	2	099394;12	910429;2
3	360951;3	592746;-0	2	776426;10	014974;0	0	728042;16	546394;12
6	984992;6	85258;1	2	334854;14	05883;5	1	076356;15	714758;11
0	363769;7	308452;-4	0	479552;12	352672;4	4	958094;14	509482;3
-5	0E-6;6	929583;-6	-1	174287;11	560922;5	10	189044;49	291164;12

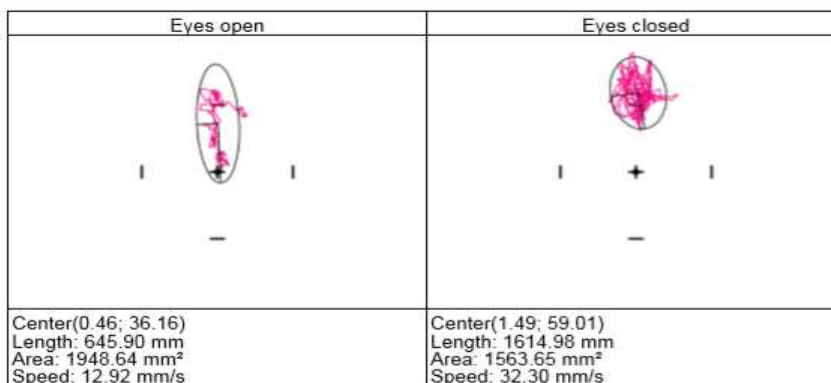
1	12127;7	024448;-8	2	000903;12	914912;2	8	688348;50	803635;12
6	073053;6	768055;-2	4	720214;14	657503;3	0	744141;16	685192;12
-1	174287;11	560922;5	2	064903;13	000621;2	14	466548;46	84248;10
0	95853;11	865925;5	5	22613;14	218387;3	0	910446;16	172815;12

Tabel 3.2

Excerpt from the stability data of subject with closed eyes

Point	x	y	Point	x	y	Point	x	y
8	137162;55	910522	-4	609926;72	21889	-10	652018;61	643322
1	759486;53	863846	-2	71863;52	380623	1	114766;43	195728
5	338905;60	844074	0	049379;66	874611	-9	732302;69	785767
-2	551323;51	874046	2	378011;49	245567	5	772406;60	25782
0	881833;55	616291	-1	48943;73	114578	1	003056;72	60745
3	92977;41	586075	-11	904517;63	29713	0	881833;55	616291
5	388207;60	424809	3	990973;54	154869	2	675337;48	730061
1	98096;53	31897	-3	939675;54	697575	1	932846;53	549416
3	361484;54	195511	-10	995446;61	94051	-3	776161	270363;57
2	705916;54	142254	0	568803;53	125843	1	899263;53	164421

Note: The table registered by the machine with which the graphical representation is made is 100x higher than the abbreviated table shown above.



a.

b.

Fig. 3.3. Graphic human subject during the stability measurement

3.2. UNIPODAL TEST

For the subject are performed the Tests in succession: unipodal test, for which the image of the subject on the monitor is found in figure 3.4., the picture of the subject is found in figure 3.5., the recording of the investigation data on the subject with the left leg is given in table 3.6, and with the right leg in table 3.7.

The result of the stability investigation is found in figure 3.8.a, for the investigation with the left leg and 3.8.b for the investigation of the subject's stability with the right leg.



Fig. 3.4. Monitor display for the unipodal test of the subject



Fig.3.5. Human subject with eyes open, during the unipodal test

Note: The table registered by the machine with which the graphical representation is made is 100x higher than the abbreviated table shown above.

From the graphical representations shown in figure 3.6 on subject subjected to the unipodal test, the following:

- At the investigation carried out with the left leg
 - The subject has the stability center facing the left side, being at the limit of the points distribution area;
 - It is located inside the distribution area of the points;

Tabel 3.3.

Extract from subject unipodal data sitting in left leg

Point	x	y	Point	x	y	Point	x	y
-100	024216;-8	371484;130	-173	62709;5	571819;168	-180	636337;18	095324;189
-101	414513;17	831495;124	-174	010605;5	816471;170	-181	830582;16	906324;189
-67	769997;21	208412;69	-192	156174;0	424726;186	-183	045532;15	354595;189
-39	560688;24	365635;116	-192	589478;0	901296;184	-184	125031;14	996531;189
-36	492764;24	227972;141	-191	780167;-1	744069;189	-185	721542;12	934743;180
-10	904887;23	224897;197	-191	543915;-1	75299;190	-186	2509;13	017628;180
-9	759048;19	652702;200	-191	813721;12	543874;180	-186	702637;13	000726;181
-95	149834;-9	272213;178	-192	318375;12	05768;179	-187	352631;12	654851;183
-114	564857;11	330595;177	-191	813721;12	543874;180	-192	976151;20	260653;181
-188	490891;-3	692602;175	-178	784195;18	956888;188	-190	742004;25	639521;190
-189	05191;-2	040065;174	-178	817841;19	623701;189	-189	775238;25	70933;190

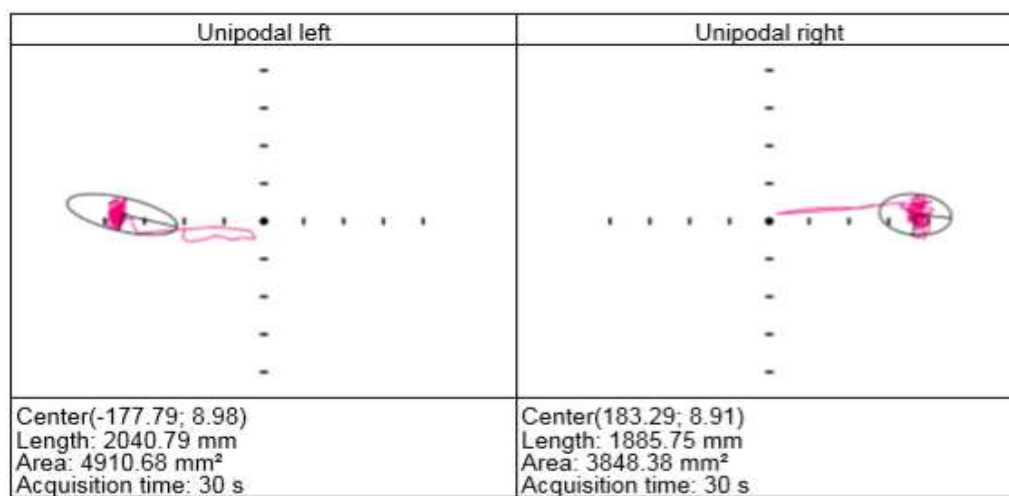
Tabel 3.4.

Extract from the subject's unipodal data sitting in the right leg

Point	x	y	Point	x	y	Point	x	y
-100	578384;21	93557	-32	853302;22	382221	-191	540253;9	93559
-99	297394;22	804554	-32	906769;19	771156	-191	805557;9	42807
-99	568771;22	870092	-129	93222;25	847204	-180	795761;34	497601
-101	436127;19	8982	-163	518677;13	79867	-182	367737;34	61692
-102	747749;18	505276	-164	37561;11	444938	-185	005508;9	270391
-102	983414;18	143524	-177	175735;17	528845	-185	02211;10	305521
-77	667511;17	905058	-177	457764;16	517702	-187	44696;5	911998
-73	020233;18	208084	-180	380676;16	277124	-184	128235;6	622137
-57	464287;10	751533	-183	605392;16	286131	-181	110535;7	367054
-177	449326;8	826118	-178	886261;8	632698	-179	249054;8	496739

- Representation in the proportion of 90% is found inside the preset area;
- Points played according to numeric data are the grouped in a narrow horizontal area, it means as the subject has stability in the left movement;
- At the investigation carried out with the right leg:
 - The subject has the stability center facing the right side, being at the limit of the distribution area of points;

- All representation is distributed on a surface inside an ellipse, this means that stability is ensured in the plan but in a widely distributed area;
- Representation in the proportional of 90% is found inside the preset area.



a b
Fig. 3.6. Human subject during the measurement of the unipodal test

3.3. WORKING TEST

For the investigated subject, tests are carried out in succession: unipodal test, for which the image of the subject on the monitor is found in figure 3.7., the picture of the subject is found in figure 3.8., recording the data of the investigation on the subject in the time of walking is given in table 3.5.



Fig. 3.7. Afisaj monitor

The result of the stability investigation is found in figure 3.9. a, for the investigation with the left leg and 3.9. b for the investigation of the subject's stability with the right leg.



Fig.3.8. Human subject, during measurement of the walking test

Tabel 3.5.

Extract from the data of the human subject, during the test

Point	x	y	Point	x	y	Point	x	y
-22	678549;-19	898167	-96	825493;-7	485665	-43	266495;57	6332
-23	014931;-19	226601	-80	148193;-8	915873	-64	714592;50	576324

-23	199812;-18	576605	-61	625881;-10	18603	-86	769394;40	289127
-23	348524;-17	754263	-52	817635;-8	538435	-104	065765;29	481176
-23	842649;-16	743433	-46	123493;-3	298195	-112	301346;22	67406
-24	357746;-16	48647	-37	023418;5	340271	-111	046669;20	518179
-24	858809;-15	605906	-23	511646;14	251119	-109	437943;20	588543
-25	42989;-15	311547	-7	251408;20	251526	-107	607574;20	681099
-25	891628;-15	320881	10	687094;23	337112	-105	722572;20	460878
-26	110611;-15	565941	29	293285;26	144171	-104	096291;20	595892

Note: The table registered by the machine with which the graphical representation is made is 100x higher than the abbreviated table shown above.



Fig.3.9. Graphic human subject during the measurement of the walking test

From the graphical representations shown in the figure 3.9 on the subject 1 subjected to the walking test, the following shall be found:

- The investigation carried out with left foot:
 - The subject has the pressure on the lower left leg;
 - It is inside the graph distribution area, within the lower limit of the.
- The investigation carried out with the right leg:
 - It is inside the graph distribution area, within the upper limit of the area;
 - The subject has the pressure on the right leg high and is roughly constant.

3.4. STABILITY LIMIT TEST

The result of the stability limit investigation is found in figure 3.10.

According to the representation in Figure 3.10. Which plays the test of the subject 1 stability limit investigated is found:

- On the direction of the rear front there is a balance in terms of stability because the number of points recorded is roughly equal;

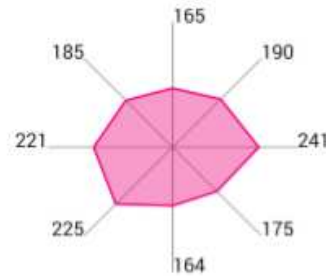


Fig.3.10. Graphic human subject during the measurement of the stability limit test

- On the right left direction there is an imbalance in stability, to the right side the number of recorded points is significantly higher than on the left side;
- At 45% to the left it seems that stability is more noticeable because the number of points is comparable;
- At 45% res the right stability is not insured, the tendency is higher towards the back than towards the face.

3.5. MOBILITY RESTRICTION TEST

The result of the stability limit investigation is found in Figure 3.11. Which play the investigated mobility restriction test shall be found to:

- On the direction of the rear front there is a similarity to the mobility because the number of points recorded is identical;
- On the right left direction there is an imbalance in mobility, to the right side the number of recorded points is almost double than on the left side;
- At 45% to the left there is a similarity to the mobility because the number of points recorded is identical;

- At 45% to right mobility is not insured, the tendency is higher towards the back than towards the face.

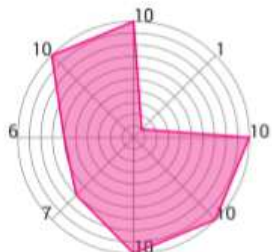


Fig.3.11. Graphic human subject during the measurement of the mobility restriction test

3.6. POWER TEST

The result of the investigation of the power exerted by the subject on the 2 handles in front of it is found in figure 3.12.a., and for pushing arms on the two handles, they are in the flight 3.12. b the pulling of the subject on the handles is presented.

The results of the measurements in the force unit are found centered in table 3.6.

The powers are different from firing and different to pushing.

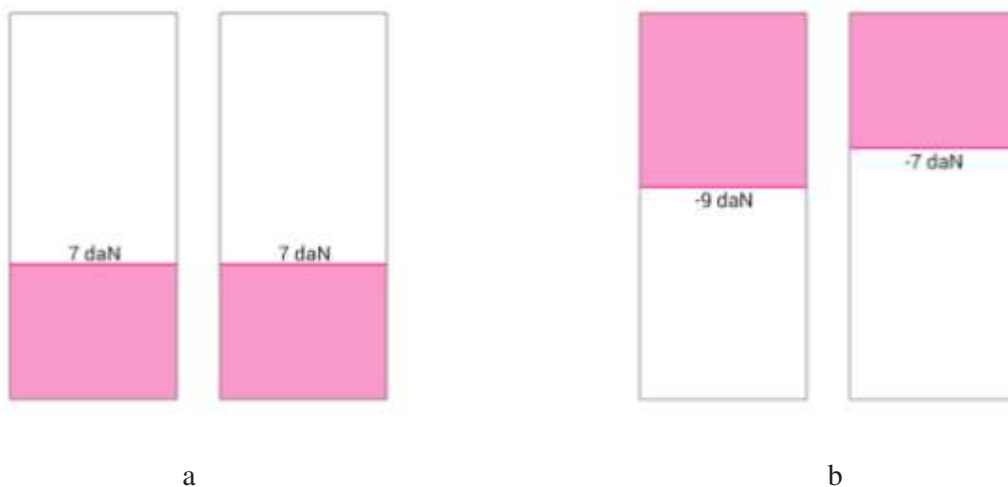


Fig.3.13. Graphic human subject during the measurement of the power test

Tabelul.3.6.

Power Test

	Max strength Left:	Max strength Right:
Push	7 daN	7 daN
Pull	-9 daN	-7 daN

3.7. COORDINATION TEST

Coordinating the upper limbs means alternating the pressing and pulling on the handles positioned in front of the subject the action is coordinated according to the images on the monitor. The Result of the stability limit investigation is found in figure 3.14.



Fig.3.14. Graphic human subject during the measurement of the coordination test

The Result of the investigation shows that the subject is unbalanced in the favor of the left upper limb being noticed that the actuation of the lever is unsynchronized.

4. CONCLUZIONI

With the help of HUBER 360 Md, the static, dynamic and posture balance has been determined, using the stability, unipodal and walking test.

Because the athlete made more sports throughout life, measurements were favorable to it.

It was not possible to quantify the effects or to classify them (in negative or benefic) during measurements.

The subject behaved well during the measurements and managed to maintain the platform for a long time.

5. REFERENCES

- [1] www.asbweb.org- American Society of Biomechanics;
- [2] Marin, C., Huidu, T. (1999) - Mecanica, Printeh, București, ISBN 973 – 652 – 042 – 0;
- [3] <http://ro.wikipedia.org/wiki/Anatomie>;
- [4] Ranga, V. (1993) - Tratat de anatomia omului, ed. Medicală, București, ISBN 973-39-0097-4;
- [5] Marieb, E.N., Hoehn, K. (2006) - Human anatomy & physiology, 7th ed., Pearson Education, ISBN: 0805359095
- [6] Sergiu VESCAN, Mariana ARGHIR, The Biodynamic Model of Human Body, ACTA TECHNICA NAPOCENSIS; Series: Applied Mathematics, Mechanics, and Engineering, Vol. 57, Issue I, Pag. 123-128, Ed. UT Pres, ISSN 1221-5872, Cluj-Napoca, March, 2014;
- [7] Claudiu Alin GLIGOR, Mariana ARGHIR, Contributions to the Modeling of the Human Hand-Arm System, ACTA TECHNICA NAPOCENSIS; Series: Applied Mathematics, Mechanics, and Engineering, Vol. 57, Issue II, Pag. 235-238, Ed. UT Pres, ISSN 1221-5872, Cluj-Napoca, June, 2014;
- [8] Aurora Felicia CRISTEA, Transmissibility Vibrations about Hand-Arm System when Used a Simulating Vibration Attenuation, ACTA TECHNICA NAPOCENSIS; Series: Applied Mathematics, Mechanics, and Engineering, Vol. 62, Issue I, Pag. 115-120, Ed. UT Pres, ISSN 1221-5872, Cluj-Napoca, March, 2019;
- [9] Cornelia Florentina DOBRESCU, Analysis of the Dynamic Regime of Forced Vibrations in the Dynamic Compacting Process with Vibrating Rollers, ACTA TECHNICA NAPOCENSIS; Series: Applied Mathematics, Mechanics, and Engineering, Vol. 62, Issue I, Pag. 71-76, Ed. UT Pres, ISSN 1221-5872, Cluj-Napoca, March, 2019;
- [10] Florin COVACIU, Actuation and Control of a Serial Robotic Arm with Four Degrees of Freedom, ACTA TECHNICA NAPOCENSIS; Series: Applied Mathematics, Mechanics, and Engineering, Vol. 61, Issue IV, Pag. 347-356, Ed. UT Pres, ISSN 1221-5872, Cluj-Napoca, November, 2018;
- [11] Corneliu DRUGĂ, Power Generation and Storage System Adapted to a Medical Bicycle, ACTA TECHNICA NAPOCENSIS; Series: Applied Mathematics, Mechanics, and Engineering, Vol. 61, Issue IV, Pag. 357-362, Ed. UT Pres, ISSN 1221-5872, Cluj-Napoca, November, 2018.

Studiul experimental asupra echilibrului si stabilitatii unui sportiv pe o platform in miscare

Rezumat : Luararea se refera la stabilirea experimentală a echilibrului si posturii unui sportiv, aflat pe o platforma in miscare. Este vorba despre un sportiv, care practica doua sporturi distincte: unul de iarna – schiul si unul de vara – innotul. Prin acest studiu experiental se cauta sa se stabileasca modul in care sportivul reuseste sa se adapteze situatiilor create sau impuse, de catre un iystem experimental in stabilirea echilibrului si a stabilitatii. Analiza acestora se realizeaza prin programe computerizate specializate.

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