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1/2022

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EDUCATIO ARTIS GYMNASTICAE**

1/2022

DOI:10.24193/subbeag.67(1)

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Volume 67 (LXVII) 2022
MARCH
1

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PATIENT SATISFACTION SURVEY IN HOSPITALS PROVIDING SPA CARE IN HUNGARY

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Received 2022 March 05; Revised 2022 March 25; Accepted 2022 March 28;
Available online 2022 May 5; Available print 2022 May 30.

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ABSTRACT. Introduction: Balneotherapy and hydrotherapy treatments with a proven therapeutic effect are of great help to patients in early recovery. **Objective:** The aim of our study is to assess patient satisfaction in two health care institutions in Hungary. **Methods:** We conducted a questionnaire survey among the patients of two spas and other hospitals (H1: n=69 H2: n=59) in Hungary in 2019. The obtained results were evaluated with SPSS 25.0 software. **Results:** 74.22% of the respondents were female (n=95) and 25.78% were male (n=33), of whom 46.78% (n=60) were between 61 and 70 years of age. 71.88% (n=92) of the respondents were informed about the discounted treatments by their specialist and the majority were patients who return annually (n=106), who come again mainly (43.75%) for previous good experiences. They thought they would discover an 88.5% improvement in both the quality of care and treatments. Results of H1 and H2 hospital staff: help (H1: 6.61, H2: 6.05, p=0.001), pain relief (H1: 6.08, H2: 4.95, p=0.015) problem solving (H1: 6.16, H2: 5.46 p=0.009), information provision (H1: 5.82, H2: 5.05, p=0.050) were significantly higher in H1 hospital than in H2 hospital. In the overall picture of the institution, H2 achieved a higher result in terms of health improvement,

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despite the former lower evaluations, but there was no significance (H1: 5.86, H2: 6.00, $p=0.584$). **Conclusions:** Learning the use of treatments and patient satisfaction, constructive suggestions can be made to improve the quality of patient care.

Keywords: patient satisfaction, spa, spa service, quality patient care

Introduction

In recent decades, the need to maintain conscious health care has become more and more critical, and at the same time the need for quality patient care has become more prominent. The medical procedures used in qualified spas have a proven positive effect in the prevention, rehabilitation, and treatment of chronic diseases (Cantista & Maraver, 2020; Dias et al., 2017; Matsumoto, 2018; Menegatti et al., 2020; Koçak et al., 2020; Pinot et al., 2019), as a result, demand for spa services appears to be increasing. Residents with a valid Social Insurance Identification Number can take advantage of the various medical treatments available at the spa twice a year as part of their health insurance.

In addition to the effectiveness of health care, the basic expectation of patients may be the adequacy of institutional conditions. It must be in the interest of the healthcare provider to ensure continuous, high-quality care. Examining patient satisfaction in a health care institution is a form of self-monitoring that can be used to prepare quality improvement proposals, thereby improving the quality of patient care. Such a survey can point out, among other things, the demand for the service, as well as help the successful development of the organization's structure and operating strategy. Based on patients' opinions, we can get an idea of the factors influencing the quality they express, the institutional adequacy of the components of quality patient care perceived by the patients, which also contribute to the patient's well-being and recovery.

Several interpretations of the quality of health care have already emerged. According to the definition published by the World Health Organization (WHO): "Health care shall be of high quality and shall meet the requirements of maximizing its benefits and minimizing the health risk, taking into account scientific knowledge and available resources (Ágoston et al., 2011) The detailed introduction of the structure of the Hungarian health care system (Boncz & Sebestyén, 2006; Boncz et al., 2015; Endrei et al., 2014) and financing features (Boncz et al., 2004; Boncz et al., 2006; Endrei et al., 2014) can be found elsewhere.

By learning about the use of treatments in institutions providing spa services and patient satisfaction, suggestions can be made to improve the quality of patient care. The aim of our study was to assess patient satisfaction in two health care institutions in Hungary.

Material and method

The survey was conducted in 2019 in two spas and other rehabilitation institutes in Hungary. The sample consisted of patients receiving inpatient care in hospitals, for a total of 128 individuals (H1: n=69; H2: n=59). Our data were collected with our self-edited questionnaire containing 29 questions in addition to the basic data, which were evaluated with SPSS 25.0 software.

The first half of the questionnaire consisted of the following ten questions: How did you find out about the discounted (SSC-supported) spa hospital services?; Have you received information on the number of times you can use the spa each year?; Have your needs been taken into account when booking?; How long have you had to wait to start treatment compared to the time you requested at the referral?; Have you previously attended the institute?; and Why did you choose that spa?. We retrospectively examined the opinions of returning patients: the standard of care and treatments; the building and infrastructure; organization of benefits and treatments; and the number of staff.

The rest of the questionnaire examined the following three main aspects of patient satisfaction: staff and treatments, infrastructure, catering, and the overall picture of health centers.

Respondents could mark their answers on a 7-point Likert scale. Descriptive statistics and the Mann-Whitney U statistical test were used to evaluate the results, the latter as a non-parametric alternative to the two-sample T-test to compare the means of responses collected from the two hospitals. The significance level was determined to be $p < 0.05$.

Results

74.22% of the respondents were women (n=95) and 25.78% were men (n=33). Nearly half of the respondents were between the ages of 61 and 70 accounting for 46.78% (n=60), and 32.81% (n=42) were between the ages of 71 and 81. Respondents between the ages of 51 and 61, accounted for 8.59% (n=11) and between the ages of 41 and 50 accounted for 6.25% (n=8). In the lowest number of items, those under 40 years of age participated in the research with 3.91% (n=5) and those over 81 years of age with 1.56% (n=2). The distribution of patient population from the two hospitals (H1, H2) was: H1=53.91% (n=69), H2=46.09% (n=59).

71.88% (n=92) of the respondents were informed about the discounted treatments by their specialist, 18.75% (n=24) by relatives and acquaintances and 9.38% (n=12) by their GP (Figure 1).

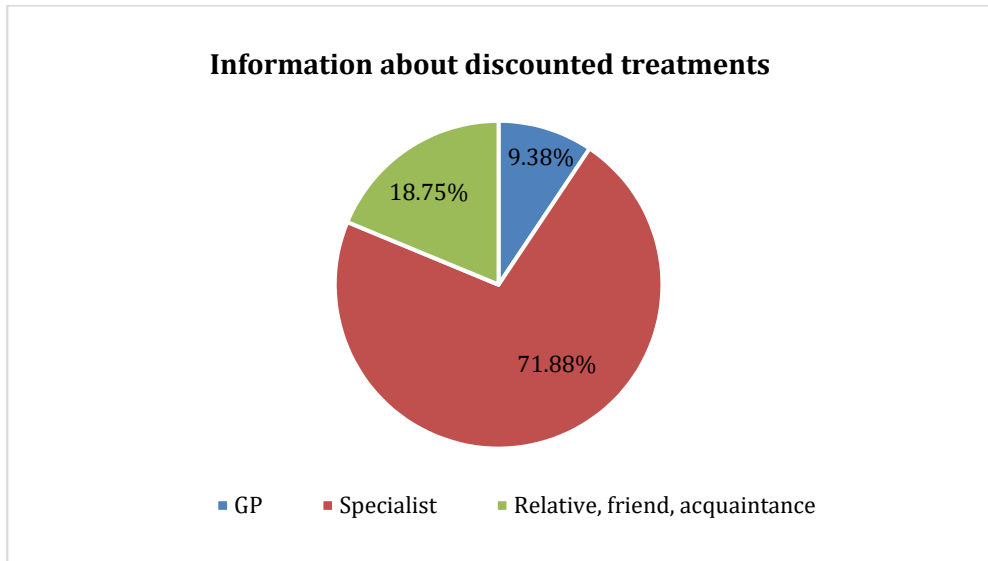


Fig. 1. How did you hear about treatment options?

Most of them, 87.50% of the respondents (n=112), also received detailed information about the possibilities of using these spa treatments. Between the referral and the start of rehabilitation, 33.59% of the respondents, i.e., 43 people, had to wait 9-12 months, 26 people had to wait between 3 and 6 months and another 26 people (20.31%) got into the treatment later than a year. Fourteen people (10.94%) were called in within a month. 10.16% (n=13) of the participants entered the treatment within three months, and another 4.69% (n=6) of them started it within 6-9 months (Figure 2).

Compared to new patients, a higher proportion of those who completed the questionnaire were those who had been returning for years (n=106). Of those returning patients, 43.75% were due to previous good experience, 25% were due to the reputation of the hospital, 15.63% were eligible, 14.84% were due to the doctors and staff working there, and 0,78% of them chose the given hospital for other reasons (Figure 3).

PATIENT SATISFACTION SURVEY IN HOSPITALS PROVIDING SPA CARE IN HUNGARY

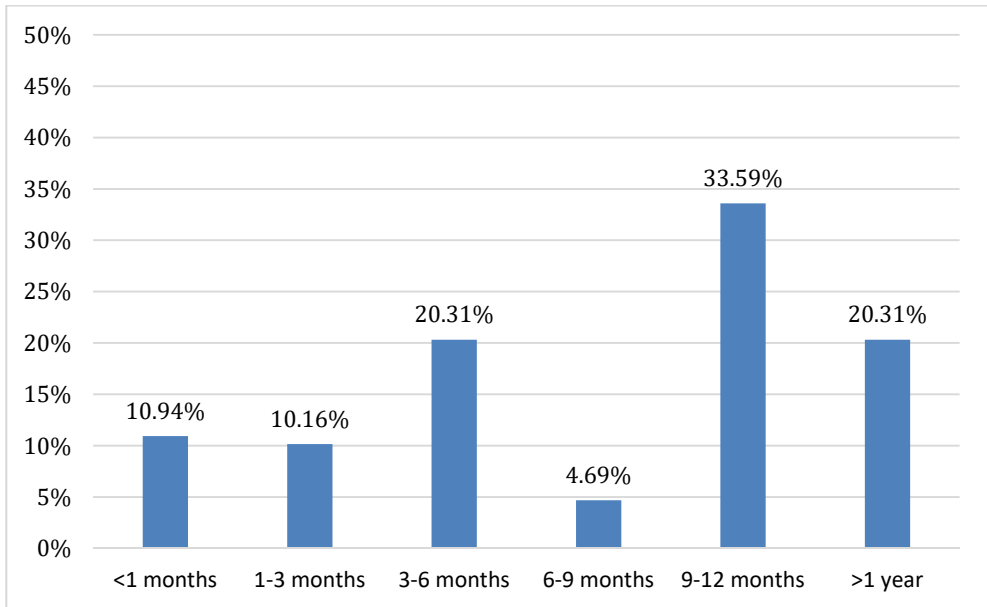


Fig. 2. Waiting time between referral and hospital admission

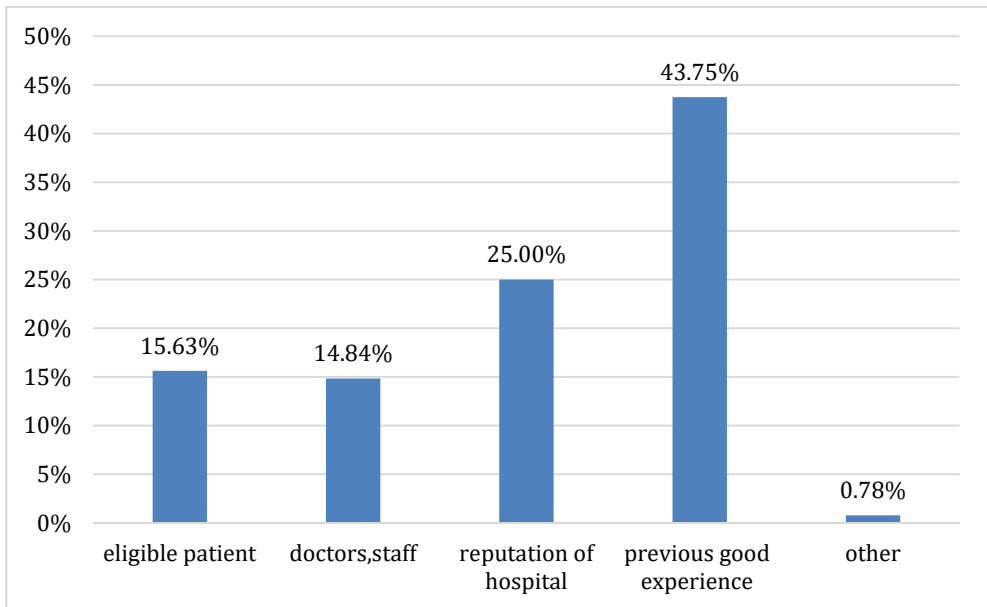


Fig. 3. Motivations for hospital choice

Analyzing the responses of these patients, we found an 88.5% improvement over previous years in the quality of care and treatments. The change in building and infrastructure was considered positive by 75.24% of patients (n=79). Almost without exception (90.48%), an improving trend has been observed over the years in care and treatment organization. The proportion of responses that positively assessed the change in the number of staff was 55.24%, while 44.76% of the respondents did not find this type of development (Figure 4).

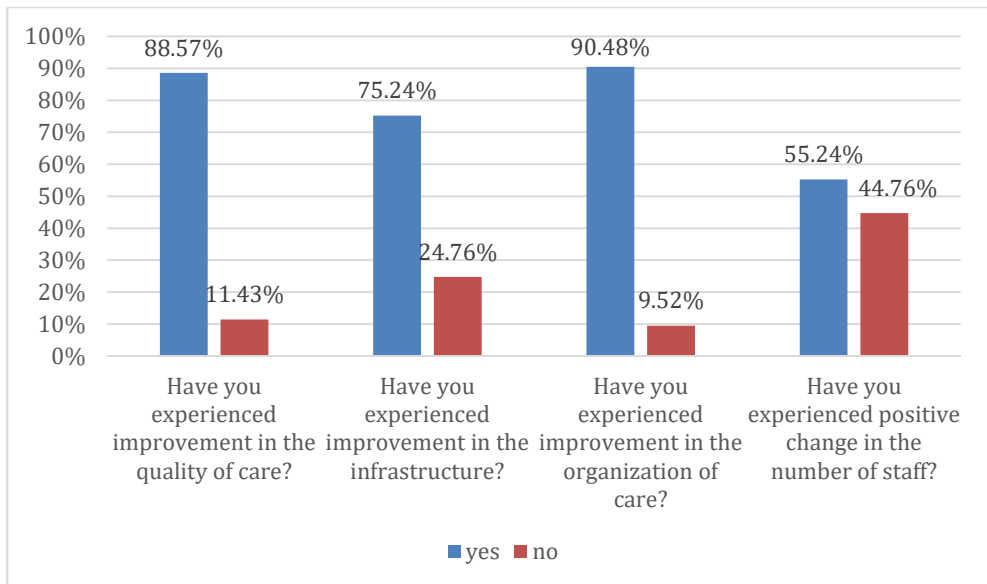


Fig. 4. Experiences of returning patients

The rest of our questionnaire was categorized separately, in which we first examined the issue of patient satisfaction with staff and treatments. There was no significant difference between the politeness and kindness of the staff based on the average of the responses of the patients interviewed in the two hospitals (H1: 6.39, H2: 5.51, $p=0.189$). There was no significant difference between the question on the smoothness and organization of patient admission (Q1: 6.35, Q2: 5.51) and the question on time spent by doctors and nurses for inpatients (Q1: 6.55, Q2: 6.29) among patients from two hospitals ($p < 0.218$, $p=0.494$). Examining a problem emerging in H1 hospital, the staff assistance was significantly better compared to that in H2 hospital (H1: 6.61, H2: 6.05, $p=0.001$). In the case of pain, H1 Hospital was rated significantly better than H2

Hospital for people seeking recovery (H1: 6.08, H2: 4.95, $p=0.015$) based on responses to the helpfulness of staff working in the institution. To the question of whether any concerns could be discussed with care providers (Q1: 6.16, Q2: 5.46) and whether all persons providing treatment introduced themselves and their responsibilities were clearly stated (Q1: 5.82, H2: 5.05). Assessments were significantly higher in H1 hospital than in H2 hospital. ($p=0.009$, $p=0.050$). We found no significant difference based on the responses of patients from the two hospitals to the question of whether treating physicians had regard for the patient's presence (Q1: 6.39, Q2: 5.24, $p=0.211$). Patients at H1 Hospital received significantly higher level of information about the medications needed during treatment than those treated at H2 Hospital (H1: 5.92, H2: 4.98, $p=0.021$). Based on the question of whether they were informed about signs of deterioration at the time of dismissal that requires a doctor immediately, H1 Hospital was rated significantly better than H2 Hospital (Q1: 6.27, Q2: 5.49, $p=0.007$) (Table 1).

Table 1. Satisfaction with hospital staff

Question	No. 1 hospital	No. 2 hospital	Deviation	Mann-Whitney U ($p \leq 0.05$)
The hospital staff is polite and kind	6.39	5.51	0.88	0.189
Patient admission is smooth and well organized	6.35	5.51	0.84	0.218
Nurses and doctors spend enough time on the patient	6.55	6.29	0.26	0.494
Help from staff in case of problems	6.61	6.05	0.56	0.001
In case of pain, the staff is helpful	6.08	4.95	1.13	0.015
Discuss concerns with staff	6.16	5.46	0.69	0.009
Members of staff introduced themselves and explained their responsibilities	5.82	5.05	0.77	0.050
Doctors are mindful of the presence	6.39	5.24	1.15	0.211
Information about medicines to take	5.92	4.98	0.95	0.021
When leaving the hospital, information about signs of deterioration that requires a doctor	6.27	5.49	0.79	0.007

In the second topic, we did not find any significant difference between the patients' responses of the two hospitals in the examination of infrastructure and the question of satisfaction with hospital conditions (H1: 6.27, H2: 6.15, $p=0.929$). There was also no significant difference in the condition of the restrooms based on the responses to the two hospitals (H1: 5.65, H2: 5.20, $p=0.228$). Assessing the condition of the treatment rooms, those treated in H1 Hospital rated the treatment rooms significantly better than those in H2 Hospital (H1: 6.43, H2: 6.10, $p=0.023$). There was no significant difference in the amount of food received during hospital meals between the responses of the interviewed patients of the two hospitals (H1: 6.63, H2: 6.61, $p=0.289$), but H1 hospital proved to be significantly better in the adequacy of food quality (H1: 6.57, H2: 6.34, $p=0.049$) (Table 2).

Table 2. Satisfaction with infrastructure and catering

Question	No. 1 hospital	No. 2 hospital	Deviation	Mann-Whitney U ($p \leq 0.05$)
Hospital conditions are adequate	6.27	6.15	0.13	0.929
The condition of the restrooms is good	5.65	5.20	0.45	0.228
The treatments room is in good condition	6.43	6.10	0.33	0.023
The amount of food is right	6.63	6.61	0.02	0.289
The quality of the food is good	6.57	6.34	0.23	0.049

Turning to the issue of the overall picture of health centers, H2, despite the former lower evaluations, achieved a higher result in terms of the health improvement recognized by its patients, but no significance was found (Q1: 5.86, Q2: 6.00, $p=0.584$). There was no significant difference in the recommendation of the hospital to others (H1: 6.43, H2: 5.85, $p=0.208$). When examining satisfaction with the general condition of Hungarian health care, no significance was established between the stakeholders' responses in the two hospitals (Q1: 4.12, Q2: 3.95, $p=0.965$). Finally, in the case of the satisfaction of the overall picture of the care received during the hospital stay, we obtained an outstanding value in the case of both hospitals, although H1 received a higher average result, no significant difference was observed between the hospitals (H1: 6.63, H2: 6.24, $p=0.149$) (Table 3).

Table 3. An overview of the spa

Question	No. 1 hospital	No. 2 hospital	Deviation	Mann- Whitney U (p <= 0.05)
Health has improved	5.86	6.00	-0.14	0.584
Recommend a hospital to friends and family	6.43	5.85	0.58	0.208
Satisfaction with the general state of Hungarian health care	4.12	3.95	0.17	0.965
Satisfaction with hospital care	6.63	6.24	0.38	0.149

Discussion and conclusion

Health quality assurance is when the quality control of a health service is accompanied by a continuous feedback system that immediately signals deviations from the quality and initiates corrective mechanisms, identifies the factors and individuals responsible for the errors, and eliminates the factor that causes the errors (Boján & Belicza 1995).

The health insurance and utilization indicators related to the social security-supported services of the institutions providing spa care in Hungary are already known and published (Varga et al., 2017; Varga et al., 2017; Varga et al., 2017). Based on the number of treatments performed in spas and other medical services by age group and gender, the older persons are the most common users, and the appearance of the females is more typical in spa hospitals. Divided by counties, there were significant regional disparities in the number of treatments performed and the social security expenditures on treatments in Hungary in terms of the number of treatments performed (Varga et al., 2019).

Our survey shows that the younger age group is less present in the medical institutions. Based on research, it can be stated that musculoskeletal problems are becoming more and more common in this age group, for which the services provided by spa hospitals could be a solution (Dianat et al., 2017; Farkas & Fodor; 2014; Horváth et al., 2006; Kanchanomai et al., 2012; Mowatt et al., 2018; Scarabottolo et al., 2017; Syazwan, 2011). In this case, we can assume that physicians do not necessarily recommend rehabilitation in these institutions for patients who come to them. The communication between the doctor and the patient and its quality greatly influences the behavior of the patients (Antoinette et al., 2009; Fox et al., 2009; Jangland et al., 2009; Merckaert et al., 2009).

By facilitating the proper flow of information, balneotherapy, hydrotherapy, and related therapies with proven preventive and therapeutic effects in treating of various diseases could be effectively promoted (Ballagi, 2000; Bender et al., 2014; Gömör, 2013; Karagülle et al., 2018; Maeda et al., 2017; Oláh et al., 2010; Péter et al., 2017; Sebők & Lengyel, 2008; Verhagen et al., 2015).

It would be essential to emphasize the critical role of primary prevention and patient education as soon as possible to reduce any musculoskeletal or other health complaints that may arise later (Szilágyi et al., 2021).

During a hospital stay, a patient's satisfaction or dissatisfaction is not only determined by the factors that positively influence his or her condition or the lack of them. For example, a possibly long waiting list or inadequate infrastructure does not necessarily make patients dissatisfied. The polite and respectful treatment of hospital staff is far more decisive in examining the patient's satisfaction (Becker-Schiebe et al., 2015; Krupal et al., 2013). The attitude, burnout level, and possible migration habits of the staff working in the health care institution all have an impact on the efficient operation of the health care system and the quality of patient care (Sipos et al., 2019; Vizsy et al., 2021).

The overall picture of the two hospitals examined showed an outstanding value in each case, despite the fact that the respondents negatively assessed certain factors.

Based on our results, it can be stated that the patient satisfaction of the patients of the two hospitals was not negatively affected by the possible lack of human resources, the condition of the subjectively determined wards and toilets, or the lack of material conditions. The research of Oliveira and colleagues also shows a high degree of satisfaction with the quality of service, even though that patients underestimated certain factors (de Oliveira et al., 2006).

Since the beginning of the 2000s, our country has received remarkable support; therefore, a several spa investments and the development of related infrastructure have been implemented from EU and national funds. As a result, the labor market in the affected settlements increased, and the tourism infrastructure developed (Budai, 2002) which was also supported by the answers of the returning patients.

As a limitation of our research, it should be mentioned that our questionnaire was self-edited, so it is difficult to compare it with the results of other publications. By learning about the patient satisfaction of spas and other healthcare providers, providers can get feedback on the overall picture of their facility, which can help them improve the quality of the services they provide.

Authors' Contribution

Planning and conducting the study: VV, BI, MB Literature search: VV, JR, SGYM, SZB

Questionnaire survey: VV, BI Data processing: VV, BI, MB, KV Statistical analysis: VV, KV, JR. Manuscript wording: VV, SGYM, JR, MB, BI.

Acknowledgment

The research was financed by the Thematic Excellence Program 2021 Health Sub-programme of the Ministry for Innovation and Technology in Hungary, within the framework of the EGA-10 project of the Pécs of University.

REFERENCES

- Ágoston, I., Boncz, I., Gábor, K., Illei, G., Kriszbacher, I., Sándorné Szabó, I., & Sebestyén, A. (2011). *Egészségügyi finanszírozási, menedzsment és minőségbiztosítási alapismeretek [Hungarian]*. (I. Boncz, Ed.) Budapest: Medicina.
- Antoinette, S., William, F.C., Allegrante, J.P., Fernandez, S., Diaz-Gloster, M., Tobin, J.N., & Ogedegbe, G. (2009). Provider communication effects medication adherence in hypertensive African Americans. *Patient Education and Counseling*, 75, 185-191.
- Ballagi, F. (2000). Szénsavgázfürdő szerepe az időskori perifériás érbetegek rehabilitálásában [Hungarian]. *Gyógyfürdőügy, Gyógyidegenforgalom*, 21, 14-20.
- Becker-Schiebe, M., Pinkert, U., Ahmad, T., Schäfer, C., Hoffmann, W., & Franz, H. (2015). Predictors of overall satisfaction of cancer patients undergoing radiation therapy. *Patient Prefer Adherence*, 29, 1381-1388.
- Bender, T., Bálint, G., Prohászka, Z., Géher, P., & Tefner, K.I. (2014). Evidence-based hydro- and balneotherapy in Hungary-a systematic review and meta-analysis. *International Journal of Biometeorology*, 58, 311-323.
- Boján, F., & Belicza, É. (1995). *Bevezetés az egészségügyi minőségbiztosításba [Hungarian]* (Vol. 5). Debrecen: EMIKK.
- Boncz, I., & Sebestyén, A. (2006). Financial deficits in the health services of the UK and Hungary. *Lancet*, 368, 917-918.
- Boncz, I., Dózsa, C., Kaló, Z., Nagy, L., Borcsek, B., Brandtmüller, Á., Gulácsi, L. (2006). Development of health economics in Hungary between 1990-2006. *The European Journal of Health Economics*, 7, 4-6.
- Boncz, I., Evetovits, T., Dózsa, C., Sebestyén, A., Gulácsi, L., Ágoston, I., Getzen, T.E. (2015). The Hungarian Care Managing Organization Pilot Program. *Value Health Regional*, 7, 27-33.

- Boncz, I., Nagy, J., Sebestyén, A., & Korösi, L. (2004). Financing of health care services in Hungary. *The European Journal of Health Economics*, 5, 252-258.
- Budai, Z. (2002). Marketing a fürdőfejlesztésben [Hungarian]. *Turizmus Bulletin*, 6, 3-5.
- Cantista, P., & Maraver, F. (2020). Balneotherapy for knee osteoarthritis in S. Jorge: a randomized controlled trial. *International Journal of Biometeorology*, 64, 1027-1038.
- de Oliveira, D.F., Arieta, C.E., Temporini, E.R., & José-Kara, N. (2006). Quality of health care: patient satisfaction in a university hospital. *Arquivos Brasileiros de Oftalmologia*, 69, 731-736.
- Dianat, I., Alipour, A., & Asgari, J.M. (2017). Risk factors for neck and shoulder pain among schoolchildren and adolescents. *Journal of Paediatrics and Child Health*, 54, 1-8.
- Dias, J.M., Cisneros, L., Dias, R., Fritsch, C., Gomes, W., Pereira, L., Ferreira, P.H. (2017). Hydrotherapy improves pain and function in older women with knee osteoarthritis: a randomized controlled trial. *Brazilian Journal of Physical Therapy*, 21, 449-456.
- Endrei, D., Molics, B., & Ágoston, I. (2014). Multicriteria Decision Analysis in the Reimbursement of New Medical Technologies: Real-World Experiences from Hungary. *Value Health*, 17, 487-489.
- Endrei, D., Zemlényi, A., Molics, B., Ágoston, I., & Boncz, I. (2014). The effect of performance-volume limit on the DRG based acute care hospital financing in Hungary. *Health Policy*, 115, 152-156.
- Farkas, T., & Fodor, K. (2014). Fáradásos törések gyermekkorban [Hungarian]. *Magyar Traumatológia, Ortopédia, Kézsebészet és Plasztikai Sebészet*, 57, 17-24.
- Fox, S.A., Heritage, J., Stockdale, S.E., Asch, S.M., Duan, N., & Reise, S.P. (2009). Cancer screening adherence: does physician-patient communication matter? *Patient Education and Counseling*, 75, 178-184.
- Gömör, B. (2013). A balneo-hidroterápia helyének változása a medicinában [Hungarian] The changing position of balneo- and hydrotherapy in medicine. *Orvosi Hetilap*, 154, 1900-1904.
- Horvath, G., Than, P., Bellyei, Á., Kránicz, J., & Illés, T. (2006). Mozgásszervi panaszok gyakorisága felnőtt- és serdülőkorban [Hungarian]. *Orvosi Hetilap*, 147, 351-356.
- Jangland, E.L., Gunningberg, L., & Carlsson, M. (2009). Patients' and relatives' complaints about encounters and communication in health care: evidence for quality improvement. *Patient Education and Counseling*, 75, 199-204.
- Kanchanomai, S., Janwantanakul, P., Pensri, P., & Jiamjarasrangsi, W. (2012). Prevalence of and factors associated with musculoskeletal symptoms in the spine attributed to computer use in undergraduate students. *WORK*, 43, 497-506.
- Karagülle, M., Kardeş, S., Dişçi, R., & Karagülle, M.Z. (2018). Spa therapy adjunct to pharmacotherapy is beneficial in rheumatoid arthritis: a crossover randomized controlled trial. *International Journal of Biometeorology*, 62, 195-205.
- Koçak, F.A., Kurt, E.E., Sezgin, F.M., Şaş, S., Tuncay, F., & Erdem, H.R. (2020). The effect of balneotherapy on body mass index, adipokine levels, sleep disturbances, and quality of life of women with morbid obesity. *International Journal of Biometeorology*, 64, 1463-1472.

- Krupal, J., Kishor, S., Shyamal, P., & Girija, K. (2013). Patient satisfaction about health care services: a cross sectional study of patients who visit the outpatient department of a civil hospital at Surendranagar, Gujarat. *International Journal of Medical Science and Public Health*, 2, 659-633.
- Maeda, T., Kudo, Y., Horiuchi, T., & Makino, N. (2017). Clinical and anti-aging effect of mud-bathing therapy for patients with fibromyalgia. *Molecular and Cellular Biochemistry*, 87-92.
- Matsumoto, S. (2018). Evaluation of the Role of Balneotherapy in Rehabilitation Medicine. *Journal of Nippon Medical School*, 85, 196-203.
- Menegatti, E., Paganini, A., Avruscio, G., Mucignat, M., & Giancesini, S. (2020). The effects of thermal water physical exercise in patients with lower limb chronic venous insufficiency monitored by bioimpedance analysis. *Diagnostics Basel*. *Diagnostics*, 889. Retrieved 03 10, 2021, from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7694156/>
- Merckaert, I., Libert, Y., Bron, D., Jaivenois, M.F., Martiat, P., Slachmuylder, J.L., & Razavi, D. (2009). Impact of life-threatening risk information on the evolution of patients' anxiety and risk recall: The specific context of informed consent for experimental stem cell transplant. *Patient Education and Counseling*, 75, 192-198.
- Mowatt, L., Gordon, C., Santosh, A.B., & Jones, T. (2018). Computer vision syndrome and ergonomic practices among undergraduate university students. *International Journal of Clinical Practice*, 72, 1-7.
- Oláh, M., Molnár, L., Dobai, J., Oláh, C., Fehér, J., & Bender, T. (2010). A súlyfürdő, mint víz alatti trakciós terápia hatása komplex fizioterápia keretében a nyaki és ágyéki gerinc megbetegedésekben [Hungarian]. *Balneológia, Gyógyfürdőügy, Gyógyidegenforgalom*, 29, 12-26.
- Péter, I., Jagicza, A., Ajtay, Z., Boncz, I., Kiss, I., Szendi, K., Németh, B. (2017). Balneotherapy in Psoriasis Rehabilitation. *In Vivo*, 31, 1163-1168.
- Pinto, C., Salazar, A.P., Marchese, R.R., Stein, C., & Pagnussat, A.S. (2019). The Effects of Hydrotherapy on Balance, Functional Mobility, Motor Status, and Quality of Life in Patients with Parkinson Disease: A Systematic Review and Meta-analysis. *PM&R: The Journal of Injury, Function and Rehabilitation*, 11, 278-291.
- Scarabottolo, C.C., Pinto, R.Z., Oliveira, C.B., Zanuto, E.F., Cardoso, J.R., & Christofaro, D.G. (2017). Back and neck pain prevalence and their association with physical inactivity domains in adolescents. *European Spine Journal*, 26, 2274-2280.
- Sebők, B., & Lengyel, Z. (2008). A harkányi gyógyvíz antipsoriaticus hatásának vizsgálata [Hungarian]. *Balneológia, Gyógyfürdőügy, Gyógyidegenforgalom*, 27, 81-86.
- Sipos, D., Varga, V., Pandur, A.A., Kedves, A., Petőné Csima, M., Cseh, S., Kovács, Á. (2019). Radiológiai osztályon dolgozó szakdolgozók kiegészi szintje Magyarországon [Hungarian] Burnout level among radiology department workers in Hungary. *Orvosi Hetilap*, 160, 1070-1077.
- Syazwan, A. (2011). Poor sitting posture and a heavy schoolbag as contributors to musculoskeletal pain in children: an ergonomic school education. *Journal of Pain Research*, 4, 287-296.

- Szilágyi, B., Makai, A., Tardi, P., Kovácsné Bobály, V., Simon-Ugron, Á., & Járomi, M. (2021). Back School Program: Development of Back Care Knowledge and Spine Disease Prevention and Trunk State Among 6-7 Year-Old-Children. *Studia Universitatis Babeş-Bolyai Educatio Artis Gymnasticae*, 66, 77-92.
- Varga, V., Boncz, I., Sebestyén, A., Endrei, D., Ágoston, I., Péter, I., & Molics, B. (2019). A gyógyfürdőellátások igénybevételi mutatói Magyarországon [Hungarian] Use of spa services in Hungary. *Orvosi Hetilap*, 160, 22-28.
- Varga, V., Bibó, A.Z., Hanzel, A., Kerner, Á., Elmer, D., Ács, P., Molics, B. (2017). Utilization and financial indicators of spa services in the south danubian region, Hungary. *Value in Health*, 20, p. 151.
- Varga, V., Jurasek, J.V., Koczka, V., Pónusz, R., Baumann, P., Endrei, D., Boncz, I. (2017). Regional distribution of the most common spa services in Hungary in 2014. *Value in Health*, (p. 543).
- Varga, V., Pónusz, R., Király, B., Raposa, L.B., Sipos, D., Szóts, B., & Koczka, V. (2017). Gyógyfürdő ellátások igénybevételi és finanszírozási mutatói Magyarországon [Hungarian] Utilization and financial indicators of spa services in Hungary. *Egészség-Akadémia*, 8, 137-146.
- Verhagen, A.P., Bierma-Zeinstra, S.M., Boers, M., Cardoso, J.R., Lambeck, J., de Bie, R., & de Vet, H.C. (2015, 04 11). Balneotherapy (or spa therapy) for rheumatoid arthritis. Cochrane Database of Systematic Reviews. Retrieved 03 09, 2021, from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7045434/>
- Vizsy, M., Pónusz, R., Sélleyné Gyuró, M., Kajos, L.F., Tardi, P., Ágoston, I., Molics, B. (2021). Causes of migration and working conditions abroad among phyiotherapists. *Studia Universitatis Babeş-Bolyai Educatio Artis Gymnasticae*, 66, 5-17.

THE PRESENCE OF UNCERTAINTY IN SPORT – A LITERATURE REVIEW

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*Received 2022 January 19; Revised 2022 March 03; Accepted 2022 March 03;
Available online 2022 May 5; Available print 2022 May 30.*

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ABSTRACT. The notions of luck, risk, noise, and uncertainty could be often read in sports-related literature. However, there was not published a study so far that attempts to summarize the differences and similarities among them. In this paper, we aim to review the most influential papers, books carried out in relation to these concepts. As the topic of uncertainty in sports literature is quite diverse, therefore, we followed a review method aiming for theory development instead of a systematic review. Using an alternative review methodology enabled us to organize the existing theories in three main categories based on who is affected by the uncertainty: spectator, athlete, and sport level. The main finding of our paper is that uncertainty has distinct consequences at different levels. The demand for sport requires a certain level of uncertainty from the fans' point of view to maintain the uncertainty of outcome. Athletes, on the other hand, are adversely affected by uncertainty. In sport level, the impact of the uncertainty on the results should be carefully managed. The topic of uncertainty in sport is characterized by contradiction. From the perspective of spectators, an adequate amount of uncertainty is required to maintain an interest in the sport. However, the athletes do not prefer uncertainty which they could not influence. It is up to decision-makers in sport to establish such regulation which they can balance with the uncertainty to maintain the interest of spectators and to encourage athletes for the best performance.

Keywords: *Uncertainty of Outcome, Competitive Balance, luck, noise, risk*

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Introduction

Uncertainty is a fundamental part of the sport, and especially of competitive sport. If all results of competitions could be perfectly predicted, the demand for sport tends to be ceased. No one would be interested in a competition where always the expected wins against the underdog because there would not be any excitement due to the certain outcome. Uncertainty in outcome is a mandatory element of sports contests, that makes the whole sports industry so particular. Many previous studies applied different concepts about uncertainty – like luck, risk, noise. The main conclusions of the previous findings are quite similar, consequently, all concepts could be interpreted rather as synonyms than as different meanings.

Uncertainty in sport has been studied from different perspectives in the scientific fields but mainly from two aspects. One aspect is the sport analytical studies, where researchers tried to quantify the amount of luck in sports which cannot be explained by the performance of teams, athletes (Aoki et al., 2017; Getty et al., 2018; Gilbert & Wells, 2019; Mauboussin, 2012). The other, and probably the more complex, aspect belongs to the sports economic and management disciplines, where the Uncertainty of Outcome Hypothesis (Alavy et al., 2010; Baimbridge, 1998; Borland & Macdonald, 2003; Buraimo & Simmons, 2015; Neale, 1964; Rottenberg, 1956; Szymanski, 2006) and competitive balance (Arboix-Alió et al., 2019; Budzinski & Pawlowski, 2014; Gyimesi, 2020; Szymanski, 2003; Zambom-Ferraresi et al., 2018) are extensively investigated. The economic concept of noise should be also mentioned (Lazear, 1986; Lazear & Rosen, 1981) which is the difference in workers' efforts and the output of production. The notion has been transposed into sport sciences as well, where the noise is the difference in the performance of athletes and the outcome of the contest (Csurilla et al., 2019; Sterbenz et al., 2014, 2019).

Previous studies mainly investigated uncertainty at a sports level. However, uncertainty influences the behaviour of athletes as well. From an economic point of view, Lazear & Rosen (1981) presented that the uncertainty, called noise in their study, causes performance retention on behalf of workers if they are not compensated for the negative effects caused by uncertainty. Sterbenz & Gulyás (2016) found a similar case in sport and formulated the theory of rational untrained athlete (RUA). The RUA says that in sports, where usually uncertainty in outcome appears, the rational attitude of athletes is performance retention. Due to the complexity, the real added value of an athlete could not be recognized or measured. In team sports, the phenomenon of social loafing exists (Latané et al., 1979) if the added value of a teammate to the victory could not be determined accurately (Sterbenz & Gulyás, 2016). Uncertainty in the environment also affects the preparation of athletes (Bortolotti, 2021).

The individual and the structure of sport play an important role when it is about the measurement of uncertainty or performance. This can be illustrated by the case of basketball and chess where the basketball has a closed and the chess an opened system. While a closed system is characterized by perfect information, there is not any hidden information; as in the case of an open system, the problem of asymmetric information occurs. In chess, the performance of an individual is represented by the Elo rating which gives a fairly accurate picture of the power ranking of chess players. In contrast, there are plenty of rating systems in basketball to illustrate players performances; however, none of these is as accurate as the Elo rating due to the asymmetric information.

As we briefly presented above, there are plenty of attempts in sport to measure uncertainty, or at least to separate from the results to get the real performance of teams, athletes. In this paper, we review and summarize the existing literature in connection with uncertainty, luck, risk or noise. Our primary goal is to systemize the previous studies to better understand the nature of uncertainty and the existing research directions. There are plenty of papers concerning luck, noise or uncertainty on sport; however, a review about them is still missing. We attempt to fill this gap in the literature with our paper.

Material & methods

As the topic of uncertainty in sports literature is quite diverse in terms of concepts, aims and disciplines, we did not intend to follow an ordinary review methodology. Furthermore, the topic of uncertainty and sport became popular only in the last decades, the number of papers published on the topic is limited. By following a systematic literature review methodology, we tend to miss essential papers and thoughts which cannot be found in scientific databases. Therefore, we used the review method aiming for theory development (Paul & Criado, 2020). We looked for scientific studies, articles, books written in relationship with uncertainty, noise, luck not only in sports literature but also in other multidisciplinary fields. We searched for sport-related literature in the databases with the following keywords: uncertainty, luck, noise, risk. Nevertheless, we did not intend to review all the studies carried out on the topics of uncertainty in the outcome and competitive balance; both topics would be worth a separate review article.

Results

In the economic literature, Knight (1921) was the first who attempted to separate the notation of risk and uncertainty. He stated that in the case of uncertainty, the probability of occurrence cannot be measured, while the risk

can be formulated mathematically. Later this theory or hypothesis was disproved and it is not even widespread (Bélyácz, 2010), neither researchers in sports science did not follow this distinction (Csurilla & Sterbenz, 2018). Since then, countless studies have been conducted to measure uncertainty in the sport. Using the existing literature on the, we formulated a framework for the uncertainty in sport from three perspectives: the spectator level (i.e., consumer), the athlete level, and the sport or the regulatory board level (i.e., the decision-maker of sports regulations). We present separately the results of the three perspectives.

Spectator level

One of the best known and widespread theories related to uncertainty is the Uncertainty of Outcome Hypothesis (UOH). The OUH is similar to the Competitive Balance (CB) studies; however, the UOH not only measures the degree of competitive balance but also investigates its consequences for the demand. In this respect, the CB relates rather to the decision making level.

The pioneers of OUH were Rottenberg (1956) and Neale (1964) who hypothesized first that the excessive dominance of a team or an athlete reduces the interest for a competition because the outcome of competition becomes predictable. This gave birth to the OUH which states that the closer the outcome of a competition, the higher the demand will be for it (Borland & Macdonald, 2003; Szymanski, 2006).

The OUH could be investigated in three different dimensions; match, seasonal and long-run levels (Borland & Macdonald, 2003; Szymanski, 2006). To measure OUH in a match level is the most difficult, and the existing evidence for it is also relatively weak (Borland & Macdonald, 2003). Moreover, the demand for a game is not determined by the uncertainty, rather the quality of the teams does matter concerning interest – fans prefer the massive victory of their own team over a close result (Borland & Macdonald, 2003; Szymanski, 2006). With seasonal data, there is a more reliable evidence for the relationship between uncertainty and attendance. If the degree of evenness is greater in a sporting competition within a season, the higher the attendance will be (Borland & Macdonald, 2003). For the long-run effect, two studies also found evidence for the higher demand when the competition is balanced (Humphreys, 2002; Schmidt & Berri, 2001).

While the existing literature on the topic of OUH is profound, there is still controversial evidence for the existence of UOH. The UOH may have some effect on the demand of sport; however, uncertainty in outcome affects demand only intra-seasonal or inter-seasonal (Borland & Macdonald, 2003). Mainly three factors tend to cause the changes in demand for sports competitions. The quality of the contest, the quality of viewing, and the price of a game ticket (which differs between teams) are associated with higher attendance (Borland

& Macdonald, 2003). More recent studies argue that the UOH is no longer important (Buraimo & Simmons, 2008, 2015; Pérez et al., 2017). Supporters of the home team do not prefer to attend on a game that is predicted to be close in the score (Buraimo & Simmons, 2008), and UOH also does not affect the demand of television audience (Buraimo & Simmons, 2015; Pérez et al., 2017).

Athlete level

In the economic literature, the phenomenon of noise can be attributed to uncertainty at an individual level (Csurilla & Sterbenz, 2018). In economics, noise is the uncertainty during production and the resulting error in measurement (Lazear, 1986). If there is a significant amount of noise during the production, the labor's effort and the production output will not be consistent. The noise can be even positive or negative if the labor's performance is overestimated or underestimated. In the presence of noise, the labor's efforts will decrease (Lazear, 1998). Consequently, an incentive system must be set up for workers that protects them from the effects of noise, while making them responsible for their efforts (Milgrom & Roberts, 2005).

Sterbenz et al. (2014) were the first, who implemented the noise concept into the sport. Based on their interpretation, noise is the difference in the endeavors and efforts made by athletes in the hope of success during preparation and at the competition, and the results of the contests; this is the uncertainty in results. The uncertainty or noise is much more present in complex sports (like team sports) compared to individual sports (Sterbenz et al., 2014). The uncertainty can arise from different sources, like subjective judgment, weather conditions, or contact with the opponent (Sterbenz et al., 2014, 2019). The uncertainty affects the behavior of athletes in sport; therefore, incentive systems are needed to encourage sporting participants to perform at their best (Sterbenz et al., 2014).

For the problems arising from the noise or uncertainty, the Tournament Theory provides a solution to encourage maximal effort for employees or athletes (Lazear, 2018; Lazear & Rosen, 1981). The Tournament Theory was aimed to formulate a new incentive system for the business industry but the idea is derived from the design of tennis tournaments. In Tournament Theory, the payoff structure is pre-determined, the allowance is independent from the absolute, only dependent on the relative performance of the individual (Lazear, 2018). In most sports, it does not usually matter which team scored the most points or goals but who was able to overcome the opponent team as many times as possible.

Many sports competitions do not have a direct financial reward system, as is the case with the Olympic Games. However, the prestige of winning a medal at the Olympics and the subsequent business opportunities, make these competitions alike as the Tournament Theory. The lack of payoff structure makes the analyses of the incentive systems' efficiency in some sports impossible.

The measurement of uncertainty is also difficult at an individual level as the performance of athletes is hectic and influenced by several factors that could not be accounted for (Csurilla et al., 2019, 2021).

Sport level

The CB studies are strictly bounded to the OUH studies but without investigating the unpredictable results' effect on attendance. A general assumption is that a competition should be balanced to maintain interest in the long run (Fort & Maxcy, 2003; Humphreys, 2002; Zimbalist, 2002). As the UH, the CB could be analyzed in distinct time horizons as well, like the game, mid-term or seasonal, in the long-term (Gyimesi, 2020).

For the importance of CB, several ordinary examples can be found. For instance, in the early years of the 2000s, the FIA (Fédération Internationale de l'Automobile) has attempted to break Schumacher's victory series with numerous rule changes to restore uncertainty in winners of Formula 1 world championships (Vörös, 2017). It is up to decision-makers in sport to prevent monopoly or duopoly situations in sports competitions to secure uncertainty in outcomes (Zimbalist, 2002).

In recent decades, the number of studies, examining the uncertainty in sports at the sport level, has been increased. Perhaps the main reason behind the popularity of this topic is the nature of sports competitions. Competitions in sports are usually held in isolated, closed systems; the same rules are followed in the matches and the competitions. Consequently, a large amount of data is created that allows researchers to analyze the statistical patterns in different sports (Aoki et al., 2017).

The studies mostly applied the conceptual framework of luck and skill (Aicinena, 2013; Aoki et al., 2017; Croson et al., 2008; Elias et al., 2012; Getty et al., 2018; Gilbert & Wells, 2019; Loland, 2016; Mauboussin, 2012; McKinnon, 2013; Simon, 2007). Luck is usually defined as the uncertainty of the outcome or the randomness in a game (Elias et al., 2012; Furtado, 2020; Gilbert & Wells, 2019; Pluchino et al., 2018). Based on another approach, luck is the difference between the expected outcome and the actual outcome of a game (Mauboussin, 2012; McKinnon, 2013). The expected outcome is essentially the power ranking of the participants before a season, cup or tournament that can be based on an official (e.g., Elo rating in chess) or an unofficial (e.g., betting odds) ranking. The degree of luck depends on how many times and by how much an underdog team can prevail over its higher-ranked opponent. In a sport where the higher-ranked always wins, the expected and actual output will be the same, there is no luck involved in the sport. The difference between the two expected and actual outcomes will therefore be the unexpected results, in other words, the uncertainty or the randomness (Elias et al., 2012; Taleb, 2007; Tetlock & Gardner, 2015).

Luck, whether it is good or bad, plays a significant role in sport, all sports are a combination of merit and luck. In sports, merit is the dominant principle but sometimes luck also influences the outcome of contests (Loland, 2006; Mauboussin, 2012). The competitive sports contests are basically skill-based; however, the influence of luck should be minimized (Simon, 2007). If luck dominates instead of skill in a sport, the luck distorts and undermines the essence of sport (Simon, 2007).

If the sports are compared based on the degree of luck, the luck, or uncertainty, plays a greater role in team sports – and mainly in ball games due to the complexity and the random effects involved (Loland, 2006, 2016; Sterbenz et al., 2014). Mauboussin (2012) introduced the phenomenon of ‘paradox of skill’ which can be occurred when highly skilled teams meet and the game will be decided by the luck. However, if we compare sports based on luck over several seasons, we can get similar results due to the high level of skill in competitive sports (Csurilla & Sterbenz, 2018; Elias et al., 2012; Mauboussin, 2012).

There is still no clear empirical evidence for the more luck or uncertainty involved in team sports because only a study applied data about the team and individual sports as well. Getty et al. (2018) compared major league sports with the fantasy counterpart, and with the cyclocross. In this case, the team sports were clearly luckier compared to the individual one. Between the team sports, most of the studies found that basketball is the best predictable, there is the least uncertainty involved in the outcome of games (Aoki et al., 2017; Getty et al., 2018; Mauboussin, 2012). Only the findings of Gilbert & Wells (2019) present a different result, they found the most skill-based sport is the American football, the basketball was only the second one. However, compared to other papers, Gilbert & Wells (2019) followed a different methodology. They predicted game level uncertainty that tends to lead the distinct results. Aoki et al. (2017) applied data about team sports in European leagues but also found basketball as the most skill-based sport.

Interestingly, studies that measured luck, mostly predicted the uncertainty in the team, not in individual sports. Only a study focused on the individual sports, predicting the luck-based noise in Olympic sports. (Csurilla et al., 2021) compared 14 sports at the Summer Olympic Games. They found swimming, table tennis, and gymnastics as the three sports with the least luck involved, the shooting, tennis, and modern pentathlon as the most affected by luck in the sample.

At last, a theoretical methodology to compare sports based on skill should be mentioned as well. Mérő (2008) uses the notion of ‘class difference’ as a unit of measurement to investigate the depth of a sport. A ‘class difference’ exists when the stronger player has at least a 75% chance of defeating the other one. The threshold of 75% was benchmarked from chess where this is roughly the difference between the classifications of chess players. The main concern with the method is that it requires huge data sets that do not available in most sports.

Discussion

In this paper, we attempted to review and synthesize the most essential literature carried out on the topic of uncertainty and sport. As the topic of uncertainty in sport has become the focus of interest for researchers in the last decade, and a review study has been missing so far, our paper fills an important gap in the literature.

Uncertainty is a central element of the sport, especially of the elite sport. The uncertainty in outcome provides the excitement towards the unpredictable or surprising results which make the sport so special and affects the demand for a sport. It could be assumed that the more uncertainty in a sport, the more the demand will be for it. However, the correlation between uncertainty and sport is not linear, uncertainty could have a bad influence on demand for sport in extreme cases. If a sport is completely unpredictable, the outcome will be decided only by luck, the interest would disappear for it. No one would be interested in a sporting event where the efforts of athletes do not affect the results of the competition. Also, from the athlete's point of view, if the outcome of a contest is dependent on their efforts, they would not be motivated to prepare for the competition. As the economic theory claims about noise, which is basically the uncertainty in production, the labor must be protected from the effects caused by noise (Milgrom & Roberts, 2005). In sports, where uncertainty or noise plays a significant role, incentive systems should be designed that encourages the athlete to perform at their best (Sterbenz et al., 2014, 2019). For that purpose, the Tournament Theory could provide a possible solution (Lazear & Rosen, 1981) in which individuals are rewarded by their relative performance instead of absolute.

The lack of uncertainty in outcome would not so harmfully affect the athletes' attitudes towards the preparation to the game in short term, but the consequences would be quite the same as with the full predictability in long term. If an athlete is aware that a better position cannot be achieved despite any efforts, the motivation would also disappear.

The uncertainty plays an important role in the case of spectators as well. The demand for a sporting event depends on several factors, and uncertainty is also an essential one, even if it matters only in the long run. The matchday attendance is influenced by the quality of the game or an overwhelming victory over the away team. From the perspective of demand, the importance of uncertainty in sport does not have a significant impact as researchers assumed before. Maybe the spectators are accustomed to a certain degree of uncertainty, they only realize its importance when there is a noticeable change in it. This finding may give a new impetus to new UOH research which has not paid attention to the change in uncertainty so far.

The whole topic of uncertainty in sport is characterized by contradiction. From the perspective of spectators, an adequate amount of uncertainty is required to maintain an interest in the sport. However, the athletes do not prefer uncertainty which they could not influence. It is up to decision-makers in sport to establish such regulation which they can balance with the uncertainty to maintain the interest of spectators and to encourage athletes for the best performance.

The papers, carried out on the topic of CB, could provide essential information for decision-makers when they have to intervene in the regulation of a competition to maintain interest for it. The CB differs from sport to sport, from season to season; it is a data-intense measure of uncertainty that provides an opportunity to examine interventions in the short term. In contrast, the papers, quantified luck, examined the predictability of sports, the relationship between efforts of athletes, teams and the outcomes of contests. Both could be essential at the reregulation of a sport. The CB solves the spectators needs to break the monopoly of a team and make the sport interesting for them again. With quantifying luck, the needs of athletes could be monitored to maintain the role of skill in a sport. For example, comparing the sports based on the luck could help for the International Olympic Committee to maximize the demand for the events by modifying the existing regulations.

We hope that our paper, with reviewing the existing literature, provided a deeper and better understating of the nature of uncertainty in sport. We presented that uncertainty is an essential part of the sport that is important for all actors (spectators, athletes, decision-makers) from different aspects. Based on our findings, we strongly encourage decision makers in sport to pay more attention to measuring and monitoring uncertainty in sporting contest to maintain the interest toward them.

Conclusions

The topic of uncertainty in sport has a steadily growing literature, however, a review article has been missing so far. We attempted to fill this gap with our paper. We created a framework that enabled us to investigate the uncertainty in sport from three perspectives: the spectator level, the athlete level, and the sport level. The main finding of our paper is that uncertainty has distinct consequences at different levels; therefore, the impact of the uncertainty on the results should be carefully managed.

Authors' Contribution

All authors have equally contributed to this study and should be considered as main authors.

REFERENCES

- Aicinena, S. (2013). The Impact of Chaos, Complexity, and Luck on Coaching Success. *International Journal of Social Sciences and Education*, 3(3), 551–565.
- Alavy, K., Gaskell, A., Leach, S., & Szymanski, S. (2010). On the Edge of Your Seat: Demand for Football on Television and the Uncertainty of Outcome Hypothesis. *International Journal of Sport Finance*, 5(2), 75–95.
- Aoki, R.Y.S., Assuncao, R.M., & Vaz de Melo, P.O.S. (2017). Luck is Hard to Beat: The Difficulty of Sports Prediction. *Proceedings of the 23rd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, 1367–1376. <https://doi.org/10.1145/3097983.3098045>
- Baimbridge, M. (1998). Outcome uncertainty in sporting competition: The Olympic Games 1896–1996. *Applied Economics Letters*, 5(3), 161–164. <https://doi.org/10.1080/758521374>
- Bélyácz, I. (2010). Kockázat vagy bizonytalanság?. Elméletörténeti töredék a régi dilemmáról [Risk or uncertainty?. A fragment of the history of theory on an old dilemma]. *Közgazdasági Szemle (Economic Review - Monthly of the Hungarian Academy of Sciences)*, 57(7), 652–665.
- Borland, J., & Macdonald, R. (2003). Demand for sport. *Oxford Review of Economic Policy*, 19(4), 478–502. <https://doi.org/10.1093/oxrep/19.4.478>
- Budzinski, O., & Pawlowski, T. (2014). The Behavioural Economics of Competitive Balance: Implications for League Policy and Championship Management. *SSRN Electronic Journal*, 19(89), 1–32. <https://doi.org/10.2139/ssrn.2493764>
- Buraimo, B., & Simmons, R. (2008). Do Sports Fans Really Value Uncertainty of Outcome? Evidence from the English Premier League. *International Journal of Sport Finance*, 3(3), 146–155.
- Buraimo, B., & Simmons, R. (2015). Uncertainty of Outcome or Star Quality? Television Audience Demand for English Premier League Football. *International Journal of the Economics of Business*, 22(3), 449–469. <https://doi.org/10.1080/13571516.2015.1010282>
- Croson, R., Fishman, P., & Pope, D. G. (2008). Poker Superstars: Skill or Luck? *CHANCE*, 21(4), 25–28. <https://doi.org/10.1007/s00144-008-0036-0>
- Csurilla, G., Gyimesi, A., Kendelényi-Gulyás, E., & Sterbenz, T. (2019). Nyári Olimpiai Játékokon Szereplő Sportágak Összehasonlítása a 'Zaj' Szerepén Keresztül [Comparison of Summer Olympic Sports through the Role of 'Noise']. *Magyar Sporttudományi Szemle*, 20(5), 3–7.
- Csurilla, G., Gyimesi, A., Kendelényi-Gulyás, E., & Sterbenz, T. (2021). Where is Victory Most Certain? The Level of Luck-based Noise Factor in Summer Olympic Sports. *Acta Oeconomica*, 71(3), 369–386. <https://doi.org/10.1556/032.2021.00018>
- Csurilla, G., & Sterbenz, T. (2018). A bizonytalanság szerepe a sportban [The role of uncertainty in sport]. *Magyar Sporttudományi Szemle*, 19(5), 18–22.
- Elias, G.S., Garfield, R., & Gutschera, K.R. (2012). *Characteristics of games*. MIT Press.
- Fort, R., & Maxcy, J. (2003). "Competitive Balance in Sports Leagues: An Introduction". *Journal of Sports Economics*, 4(2), 154–160. <https://doi.org/10.1177/1527002503004002005>

- Furtado, B.A. (2020). *Contributions of Talent, Perspective, Context and Luck to Success* [Preprint]. <https://arxiv.org/abs/2001.00034>
- Getty, D., Li, H., Yano, M., Gao, C., & Hosoi, A. E. (2018). Luck and the Law: Quantifying Chance in Fantasy Sports and Other Contests. *SIAM Review*, 60(4), 869–887. <https://doi.org/10.1137/16M1102094>
- Gilbert, D.E., & Wells, M.T. (2019). Ludometrics: Luck, and how to measure it. *Journal of Quantitative Analysis in Sports*, 15(3), 225–237. <https://doi.org/10.1515/jqas-2018-0103>
- Gyimesi, A. (2020). League Ranking Mobility Affects Attendance: Evidence From European Soccer Leagues. *Journal of Sports Economics*, 21(8), 808–828. <https://doi.org/10.1177/1527002520944451>
- Humphreys, B. (2002). Alternative Measures of Competitive Balance in Sports Leagues. *Journal of Sports Economics*, 3(2), 133–148.
- Knight, F.H. (1921). *Risk, uncertainty, and profit*. Houghton Mifflin Company.
- Latané, B., Williams, K., & Harkins, S. (1979). Many hands make light the work: The causes and consequences of social loafing. *Journal of Personality and Social Psychology*, 37(6), 822–832. <https://doi.org/10.1037/0022-3514.37.6.822>
- Lazear, E.P. (1986). Salaries and Piece Rates. *The Journal of Business*, 59(3), 405. <https://doi.org/10.1086/296345>
- Lazear, E.P. (1998). *Personnel Economics for Managers*. Wiley. <http://www.loc.gov/catdir/toc/wiley022/97007933.html>
- Lazear, E.P. (2018). Compensation and Incentives in the Workplace. *Journal of Economic Perspectives*, 32(3), 195–214. <https://doi.org/10.1257/jep.32.3.195>
- Lazear, E.P., & Rosen, S. (1981). Rank-Order Tournaments as Optimum Labor Contracts. *Journal of Political Economy*, 89(5), 841–864.
- Loland, S. (2006). Olympic Sport and the Ideal of Sustainable Development. *Journal of the Philosophy of Sport*, 33(2), 144–156. <https://doi.org/10.1080/00948705.2006.9714698>
- Loland, S. (2016). Simon on Luck and Desert in Sport: A Review and Some Comments. *Journal of the Philosophy of Sport*, 43(1), 15–25. <https://doi.org/10.1080/00948705.2015.1119048>
- Mauboussin, M.J. (2012). *The Success Equation: Untangling Skill and Luck in Business, Sports, and Investing*. Harvard Business Review Press.
- McKinnon, R. (2013). Getting Luck Properly Under Control. *Metaphilosophy*, 44(4), 496–511. <https://doi.org/10.1111/meta.12044>
- Mérő L. (2008). *Észjárások—Remix—A racionális gondolkodás ereje és korlátai*. Tericum.
- Milgrom P., & Roberts J. (2005). *Economics, Organization & Management*. Nemzeti Tankönyvkiadó.
- Neale, W.C. (1964). The peculiar economics of professional sports. *The Quarterly Journal of Economics*, 78(1), 1–14. <https://doi.org/10.2307/1880543>
- Paul, J., & Criado, A.R. (2020). The art of writing literature review: What do we know and what do we need to know? *International Business Review*, 29(4), 101717. <https://doi.org/10.1016/j.ibusrev.2020.101717>

- Pérez, L., Puente, V., & Rodríguez, P. (2017). Factors Determining TV Soccer Viewing: Does Uncertainty of Outcome Really Matter? *International Journal of Sport Finance*, 12(2), 124–139.
- Pluchino, A., Biondo, A. E., & Rapisarda, A. (2018). *Exploring the role of talent and luck in getting success*. edsarx.
<http://search.ebscohost.com/login.aspx?direct=true&db=edsarx&AN=edsarx.1811.05206> <=hu&site=eds-live
- Rottenberg, S. (1956). The baseball players' labor market. *Journal of Political Economy*, 64(3), 242–258.
- Schmidt, M.B., & Berri, D. J. (2001). Competitive Balance and Attendance: The Case of Major League Baseball. *Journal of Sports Economics*, 2(2), 145–167.
<https://doi.org/10.1177/152700250100200204>
- Simon, R. (2007). Deserving to Be Lucky: Reflections on the Role of Luck and Desert in Sports. *Journal of the Philosophy of Sport*, 34(1), 13–25.
<https://doi.org/10.1080/00948705.2007.9714706>
- Sterbenz, T., & Gulyás, E. (2016). The Rational Untrained Athlete: An Attempt to Resolve Sport Managerial Dilemmas with the Methods of Game Theory. In A. Gál, J. Kosiewicz, & T. Sterbenz (Eds.), *Sport and social sciences with reflection on practice* (pp. 191–203). University of Physical Education.
<https://books.google.hu/books?id=iHT6swEACAAJ>
- Sterbenz, T., Gulyás, E., & Kassay, L. (2014). Incentive System in Hungarian High Performance Sport. *Physical Culture and Sport. Studies and Research*, 64(1), 53–63.
- Sterbenz, T., Világi, K., & Csurilla, G. (2019). Sport Analytics as a Tool for Effective Decision-Making. In M. Hughes, I. M. Franks, & H. Dancs (Eds.), *Essentials of Performance Analysis in Sport* (3rd ed., pp. 172–183). Routledge.
- Szymanski, S. (2003). The Economic Design of Sporting Contests. *Journal of Economic Literature*, 41(4), 1137–1187.
- Szymanski, S. (2006). Uncertainty of outcome, competitive balance and the theory of team sports. In W. Andreff & S. Szymanski (Eds.), *Handbook on the economics of sport* (pp. 597–600). Edward Elgar Publishing.
https://ideas.repec.org/h/elg/eechap/3274_62.html
- Taleb, N.N. (2007). *Foiled by Randomness: The Hidden Role of Chance in Life and in the Markets* (2nd ed.). Penguin Books.
<https://search.library.wisc.edu/catalog/999944746002121>
- Tetlock, P.E., & Gardner, D. (2015). *Superforecasting: The art and science of prediction* (1st ed., p. 340). Crown Publishers.
- Vörös, T. (2017). Ösztönző szabályozás a versenyrendszerek kialakításában – A fizetési struktúra hatása a sportteljesítményre [Incentive regulation in competition design – the influence of pay-off structure on sport performance]. In M. Szmodis & G. Szóts (Eds.), *A Sportirányítás gazdasági kérdései – 2017: Vol. Magyar Sporttudományi Füzetek XVI*. (pp. 23–36). Magyar Sporttudományi Társaság.
- Zimbalist, A.S. (2002). Competitive Balance in Sports Leagues: An Introduction. *Journal of Sports Economics*, 3(2), 111–121.

WHEN LIFE AND JOB SKILLS MEET: TOWARDS A MODEL FOR THE DEVELOPMENT OF SPORTS SCIENCES STUDENTS' CAREER

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*Received 2022 February 22; Revised 2022 March 20; Accepted 2022 March 22;
Available online 2022 May 5; Available print 2022 May 30.*

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ABSTRACT. The development of soft skills and critical-reflexive skills for the design and implementation of sport activities that respond to the new challenges of the sport labour market is fundamental for the expert in Sport Sciences. The paper presents the results of the implementation of the ESLP project at the Foro Italico University in Rome, which aimed to develop the necessary soft skills for leadership in future experts in sport sciences.

Keywords: *University of sport, Soft skill, European Sports Leadership Programme.*

Introduction

Data on the current labour market show how important it is to know how to match technical skills (hard skills) and behavioural skills (soft-skills), considering the latter as the most strategic to develop and manage competitors among enterprises. More specifically, the World Economic Forum Report (2020) highlights the importance of problem solving, self-management, working with people, technology use and development skills.

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The sports labour market has changed profoundly over the last few years, evolving around a new model of contemporary sport, which is, in the words of Marcel Mauss (1923), a *social fact*, diversified in terms of the aims it sets out to achieve, and therefore in a complex whole of activities that encompasses different areas, ranging from the purely sporting activities to the political ones. These changes inevitably entail the need to rethink organisational models and to develop workers' skills so that they can be able to accept and meet the challenges of the new sports sectors.

For this reason, it is important that university sports curriculum and courses focus on training transversal, flexible, adaptable and specific knowledge to prepare students for the actions of sports professionals (Isidori, 2015). Despite the fact that sport degree programmes mainly focus on the development of hard skills for sport professional as well as on technico-practical sport activities and biomedical skills (Isidori, 2017; Aldous, Sparkes, & Brown, 2016), it is widely agreed that it is important for experts in sport sciences to develop transversal skills, soft skills and critical-reflective skills (Schön, 1999; Connaughton, Lawrence, & Ruben, 2003; DeRue, Sitkin, & Podolny, 2011; Dugan, Torrez, & Turman, 2014; Cappelli, 1999). The European Sports Leadership Programme (ESLP), developed through the European Erasmus+ programme, had the opportunity to pilot interventions to develop specific competences for university students to promote their leadership (Sánchez-Pato, Brunton, Leiva-Arcas, Isidori, & Decelis, 2020; Cánovas-Alvarez, Meroño, Arias-Estero, Leiva-Arcas, Ortiz, Brunton, Isidori, Decelis, Samantzis, Balli, Fazio, Mallia, Koustelios, Ekmekçi, Sánchez-Pato, 2020). Nine student leaders from the Foro Italico University of Rome joined the ESLP project on a voluntary basis. They were in charge of organising and implementing specific courses related to more "unconventional" sport activities (breakdancing, calisthenics, self-defence and evolutionary aerial exercise) which were not included in the university curriculum. Such courses provided student leaders and participants with a personal experience that goes beyond traditional courses offered by the university. A sample of 70 students from the University of Foro Italico participated in the courses/activities on a voluntary basis. The activities were monitored by four mentors who provided their expertise and professional experience to guide the leaders in the development of soft skills and leadership.

The development of the project and the different phases of ex-ante, in itinere and post-evaluation were conducted by the University of Foro Italico research unit in collaboration with the project partner universities. A questionnaire was administered to all the participants. Focus groups and workshops were also delivered in person for the professional development of the participants. The aim of this work was to show the leaders' perception of the soft skills they believe they have developed or improved through their participation in the ESLP project carried out at the University of Rome Foro Italico.

Method

In order to monitor the progress of the actions planned in the project and to carry out a final evaluation of the training intervention implemented through the European Sport Leadership Programme (ESLP), a qualitative-quantitative methodology was applied. Regarding the collection of quantitative data, the Questionnaire for the Evaluation of the Transversal Competences of Graduates by Martínez and González (2018) was administered. The questionnaire, adapted from Spanish to English (Cánovas-Alvarez et al., 2020), was structured on a 5-point Likert scale, from 1 (not at all) to 5 (very much) and consisted of 58 items aimed at investigating the degree of development, dominance and relevance of instrumental skills, personal skills and systemic skills in the pre- and post-intervention phase.

For the statistical analysis of the data the SPSS 26.0 programme was used, with which the average of the scores given by the leaders on the Likert scale was calculated with respect to the development, domain and relevance for each descriptive item of each sub-dimension of competence, in the pre- and post-intervention phases. The questionnaire was administered to the 9 student leaders (7 females and 2 males) of the project. The 9 student leaders also participated in the 3 focus groups (Krueger, 2014) that were specifically devoted in the research design to the qualitative part of the survey. The first focus group was run during the pre-intervention phase, the second in itinere phase and the third in the post-intervention phase, e.g. at the end of the actions planned for the ESLP programme development.

Results and discussion

The intervention determined an increase in the participants' development of most of the soft skills on which the ESLP was structured. In this paper, we synthetically report and discuss the sub-dimensions that showed more significant increases in quantitative (Table 1) and qualitative (Table 2) data.

Amongst the competences shown in the previous tables (Table 1 and 2), the dimension of *instrumental skills*, the perception related to the organisation and planning of activities shows a greater importance than the ability to take the initiative. In fact, one of the activities developed for the ESLP programme was the involvement of the student-leaders in planning and promoting courses for their peers (Sánchez-Pato et al., 2020). This action of empowerment, with respect to organisational components, made them aware of the importance of this skill for their own employability pathway and allowed them to develop expertise in the post-intervention. The action of empowerment and awareness, as stated during the post-intervention focus group, must be constantly "trained".

Table 1. Quantitative results

Dimension	Sub-dimensions	Items	Development		Domain		Relevance	
			Pre	Post	Pre	Post	Pre	Post
Instrumental Skills	Organization and planning	Taking the initiative	4,1	4,4	3,9	4,4	4,3	4,9
		Discern what is important and what is a priority	4,2	4,4	4,0	4,3	4,4	5,0
Personal Skills	Teamwork	Willing to compromise and identify with other points of view	4,2	4,3	3,9	4,6	4,4	4,7
		Being able to respect and tolerate the ideas of others	4,3	4,3	4,1	4,7	4,8	4,6
		Being able to solve problems through dialogue and negotiation	4,3	4,6	4,3	4,6	4,9	4,7
		Being able to inspire and motivate groups	4,0	4,4	4,0	4,4	4,9	4,6
	Social interaction	Being able to express own ideas with confidence	3,8	4,3	3,8	4,1	4,2	4,9
	Emotional control	Being able to work under pressure	4,2	4,3	3,7	4,1	4,7	4,9
		Being able to manage stress	4,4	4,4	3,8	4,0	4,6	5,0
		Being able to tolerate frustration and adversity	3,9	4,3	3,8	3,9	4,7	4,9
	Systemics Skills	Autonomous work	Knowing how to access available and necessary resources	4,0	4,1	3,8	4,1	4,4
Being actively involved in continuous learning and improvement			4,3	4,7	4,0	4,4	4,9	4,9
Motivation		Having a desire to overcome difficult situations	4,3	4,4	4,3	4,6	4,6	4,9
		Having a positive attitude towards work	4,4	4,4	4,0	4,7	4,8	4,9
		Being involved at work	4,2	4,6	4,3	4,6	4,7	4,9
		Being committed to achieving quality	4,6	4,7	4,3	4,6	5,0	4,9

Table 2. Qualitative results

Results of pre- and post-focus groups: competences that leaders feel they have mastered or need to improve	
PRE – FOCUS GROUP	POST – FOCUS GROUP
<p>Emotional control: “If I am emotionally distressed or have a big emotional change, or something emotional going on, it is difficult for me to concentrate on what I am doing while maintaining 100% as I normally do”.</p> <p>Social interaction: “Understanding other people and communicating in a way that other people can understand what you want to do... also listening to another person”.</p>	<p>Working autonomously: “The ability to work autonomously has grown, the project has allowed me to challenge myself as an instructor, I also proposed and organised the course activities and I realised that you can work well on your own if you are confident in your abilities”.</p> <p>Emotional control: “Loss of patience is something we always have to work on because maintaining a positive atmosphere makes us cope better with the situation in general”.</p> <p>Organisation and planning: “This is a skill that always needs to be improved. In the field of sport, the more precise you are, the more you get results”.</p>

Regarding the dimension of *personal skills* through group work, the participants reported that they developed a greater awareness of the importance of being open to confrontation and recognition of other peers' viewpoints. This allowed participants to perceive they have greatly improved their personal skills thanks to their direct and autonomous involvement in the project and in the management of groups where they had to motivate and engage less active students in the “unconventional” sports courses mentioned above (Connaughton et al., 2003; DeRue, 2011; Dugan et al. 2014; Cappelli, 1999). Moreover, the co-management of activities by two leaders certainly fostered respect and the ability to tolerate the ideas of others in order to be able to face the different challenges together. This dimension is enhanced by the perception of having developed and mastered skills that are significant for the smooth functioning of group work in which respect for others, motivation and the ability to solve problems together through dialogue and negotiation are crucial. Regarding

social interaction, leaders have become more aware of the importance of expressing their own ideas, a skill they felt they developed and mastered through constant discussion with mentors and other leaders and which in the pre-intervention focus group they indicated as a fundamental skill for building positive relationships. The importance of emotional control, already perceived in the pre-intervention phase, as can be seen from both the qualitative and quantitative data, was further strengthened. The leaders became more capable and aware of the values of being able to tolerate frustration and adversity in the professional domain, as well as of being able to work effectively under pressure and manage stress. They became aware of the importance of developing these aspects, as also indicated in the post-intervention focus group data.

Regarding the dimensions of *systemic skills*, qualitative and quantitative data show that leaders learned to work autonomously. They became aware of the importance of this skill as well as mastering how to access resources and being open to continuous professional development and continuous learning. These skills are also crucial for the necessary adaptation to new situations where participants show increased development, expertise and perception of the importance of flexibility in coping with change and uncertainty, being able to transfer information and apply knowledge to practice. The challenges faced by the leaders in implementing the project and the ESLP programme, as revealed by the focus group conducted in the post project phase, encouraged the development of this competence. Participants in the ESLP project felt that they were more motivated. The value of motivation, which was already high in the pre-intervention phase, was further consolidated as leaders recognised it as a factor in overcoming difficult situations, having a positive attitude and greater involvement and commitment to work activities.

Conclusion

In conclusion, we can claim that the ESLP programme has achieved the objectives for which it was conceived and designed, proving to be a positive experience for the students who took part in it and who, with their feedback, contributed to the implementation and application of the competence model identified for the development of soft skills.

The University of Foro Italico, intends to further develop the ESLP project by including the activities of the Programme in the official academic offer in the coming academic years, by involving leaders in the activities of some University services and by activating courses related to counselling and sports coaching professions, in order to widen the opportunities of insertion in the labour market.

Authors' Contribution

All authors have equally contributed to this study and should be considered as main authors.

REFERENCES

- Aldous, D., Sparkes, A.C., & Brown, D.H. (2016). Trajectories towards failure: Considerations regarding post-16 transitions within the UK Sport-Education sector. *Sport, Education and Society*, 21, 166-182.
- Cánovas-Alvarez, F.J., Meroño, L., Arias-Estero, J.L., Leiva-Arcas, A., Ortiz, B.Z., Brunton, J, Isidori, E., Decelis, A., Samantzis, C., Balli, Ö.M., Fazio, A., Mallia, O., Koustelios, A., Ekmekçi, A.D., Sánchez-Pato, A. (2020). Effects of a sport leadership programme on the perceptions of university students about their leadership competencies (Efectos de un programa de liderazgo deportivo sobre las percepciones de alumnado universitario). *Cultura, Ciencia y Deporte*, 15 (45).
- Cappelli, P. (1999). *The new deal at work: Managing the market-driven workforce*. Boston, MA: Harvard Business Press.
- Connaughton, S.L., Lawrence, F.L., & Ruben, B.D. (2003). Leadership development as a systematic and multidisciplinary enterprise. *Journal of Education for Business*, 79 (1), 46-51.
- DeRue, D.S., Sitkin, S.B., & Podolny, J.M. (2011). Teaching leadership issues and insights. *Academy of Management Learning & Education*, 10 (3), 369-72.
- Dugan, J.P., Torrez, M.A., & Turman, N.T. (2014). Leadership in intramural sports and club sports: Examining influences to enhance educational impact. Corvallis, WA: NIRSA.
- Isidori E. (2015). La pedagogia dell'orientamento sportivo: una prospettiva teorica. *CQIA Rivista. Formazione, Lavoro, Persona*, 13, 1-16.
- Isidori E. (2017). *Pedagogia e sport. La dimensione epistemologica ed etico-sociale*. Milano: Franco Angeli.
- Krueger, R.A. (2014). *Focus groups: A practical guide for applied research*. Sage publications.
- Martínez, P., González, N. (2018). Las competencias transversales en la universidad: Propiedades psicométricas de un cuestionario. *Educación XXI*, 21, 231-261.
- Mauss, M. (1923). Essai sur le don. Forme et raison de l'échange dans les sociétés archaïques, *L'Année Sociologique*, 1923 (trad. it, Saggio sul dono. Forma e motivo dello scambio nelle società arcaiche, Einaudi, Torino, 2002).

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- Sánchez-Pato, A., Brunton, J., Leiva-Arcas, A., Isidori, E., & Decelis, A. (2020). European Sport Leadership Programme (ESLP)-Toolkit, Retrieved from:
http://shura.shu.ac.uk/27020/1/e2b8a7_6414ea94099b450e8b62e6a062c51ac5.pdf.
- Schön D. (1999). *Il professionista riflessivo. Per una nuova epistemologia della pratica professionale*. Bari: Dedalo.
- World Economic Forum (2020). The Future of Jobs Report 2020. Retrieved from:
http://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf

THE MEDIATING ROLE OF JACOBSON RELAXATION TECHNIQUES IN THE RELATIONSHIP BETWEEN ANXIETY AND PERFORMANCE OF FEMALE HANDBALL PLAYERS

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Received 2022 March 04; Revised 2022 April 11; Accepted 2022 April 11;

Available online 2022 May 5; Available print 2022 May 30.

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ABSTRACT. One of the most discussed relationships in sport psychology is the relationship between competitive anxiety and sport performance. The issues addressed in this paper refer to the affective state of female competitive players and its link to the effectiveness/achievement of their long-term game. **Objectives:** The current work aimed to study how a high degree of anxiety affects the playing efficiency of the SCM Gloria Buzău handball team and to what extent the level of anxiety and, implicitly, of performance, can be modified in a beneficial way, by using the Jacobson technique. **Methods and means.** To carry out this study, the SAS-2 questionnaire, a multidimensional instrument that measures cognitive and somatic characteristics related to anxiety, was applied in the context of practicing performance sports. To analyse the data obtained, the SPSS Statistics V.20 analysis software was used, thus performing a multiple regression analysis, with anxiety as a predictor and efficiency as a criterion. In order to capture the effect of the Johnson method on the athletes' performance, a two-way mixed ANOVA analysis of the 2x2 type was used. **Results.** Following this analysis, the following aspects can be noted: efficiency and anxiety correlate strongly, in the opposite direction, with a negative correlation coefficient between the two variables, $r = -0.902$. This correlation has high statistical significance ($\text{sig} < 0.001$). We observed that there is a strong, positive correlation between the level of control of emotions acquired as a

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result of therapy and the level of performance in the game, $r=0.96$, the result being statistically significant, $\text{sig}<0.001$. **Conclusions.** The hypothesis on how a certain relaxation technique, applied in a consistent manner over a sufficient period of time, leads to an improvement in the quality of the athletes' game was confirmed. Thus, following Jacobson relaxation techniques applied on female handball players, an increase in performance level was observed in both anxious and low-anxious individuals.

Keywords: *anxiety, performance, handball, Jacobson method*

REZUMAT. Rolul mediator al tehnicilor de relaxare jacobson în relația dintre anxietate și performanța jucătoarelor de handbal. Una dintre cele mai discutate relații în psihologia sportului este relația dintre anxietatea competitivă și performanța sportivă. Problemele abordate în această lucrare se referă la starea afectivă a jucătoarelor competitive și legătura acesteia cu eficacitatea/realizarea jocului pe termen lung. **Obiective.** În această cercetare, autorii, și-au propus să studieze modul în care un grad ridicat de anxietate afectează eficiența jocului echipei SCM Gloria Buzău și în ce măsură nivelul de anxietate, și implicit, de performanță, poate fi modificat în mod benefic prin utilizarea metodei Jacobson. **Metode și mijloace.** Pentru realizarea acestui studiu a fost aplicat în contextul practicării sporturilor de performanță chestionarul SAS-2, un instrument multidimensional care măsoară caracteristicile cognitive și somatice legate de anxietate. Pentru analiza datelor obținute s-a utilizat software-ul de analiză SPSS Statistics V.20, realizându-se astfel o analiză de regresie multiplă, cu anxietatea ca predictor și eficiența ca și criteriu. Pentru a surprinde efectul metodei Johnson asupra performanței sportivilor, a fost utilizat testul de analiză ANOVA mixtă bidirecțională de tip 2x2. **Rezultate.** În urma acestei analize se remarcă următoarele aspecte: eficiența și anxietatea se corelează puternic, în sens invers, cu un coeficient de corelație negativ între cele două variabile, $r = -0.902$. Această corelație are o semnificație statistică puternică ($\text{sig.} < 0.001$). Am observat că există o corelație puternică, pozitivă, între nivelul de control al emoțiilor dobândit în urma terapiei și a nivelului de performanță în joc, $r = 0.96$, rezultatul fiind semnificativ statistic ($\text{sig.} < 0.001$). **Concluzii.** S-a confirmat faptul că o anumită tehnică de relaxare, aplicată în mod consecvent pe o perioadă suficientă de timp, conduce la o îmbunătățire a calității jocului sportivilor. Astfel, în urma tehnicilor de relaxare Jacobson aplicate pe jucătoarele de handbal, s-a observat o creștere a nivelului de performanță atât la sportivele anxioase, cât și la cele cu o anxietate mai scăzută.

Cuvinte cheie: *anxietate, performanță, handbal, metoda Jacobson*

Introduction

One of the most discussed relationships in sport psychology is the relationship between competitive anxiety and sport performance, as high levels of stress during competition lead to decreased ability to concentrate and thus regulate emotions (Amanendra et al., 2008).

The issues addressed in this paper refer to the affective state of female performance players and its link to the effectiveness/performance of their game in the long term.

According to the literature, the affective component is a particularly important element in maintaining a successful career, thus we chose to specifically explore the effect of anxiety on the life of an athlete, having a significant impact on performance (Amit, 2016; Hossein et al., 2016; Miftakhul, 2018).

Performance sport is strongly shaped by the emotions that athletes display, forming an interdependent relationship between these components. Many athletes experience emotions that have a strong impact on them, therefore, we can observe differentiated behaviour and moods when the athlete wins a match (joy, excitement) or when they experience a defeat (disappointment, sadness) (Smith et al., 2006; Gucciardi et al., 2014).

In performance sport, anxiety arises especially in public competitions, where everyone in that context knows the performance of the athletes. These people present, may have positive opinions, but also some negative ones, which arouse anxiety in performance athletes (Lazarus, 2000; Algani et al., 2018).

The method proposed by Edmund Jacobson is an effective way to relax quickly, but also to learn to differentiate between tension and muscle relaxation, involving a relaxation technique that focuses on tensing muscle groups gradually, combined with breathing exercises or specific mental images.

Objectives

The current work aimed to study how a high degree of anxiety affects the playing efficiency of the SCM Gloria Buzău handball team and to what extent the level of anxiety and, implicitly, of performance, can be beneficially modified by using the Jacobson technique.

Methods and means

To carry out this study, the SAS-2 questionnaire, a multidimensional instrument that measures cognitive and somatic characteristics related to anxiety, was applied in the context of practicing competitive sports. It contains 3

subscales of 5 items each, ranging on the Lichter scale from 15 (low anxiety) to 60 (high anxiety). SPSS Statistics V.20 analysis software was used to analyse the data obtained, thus performing a multiple regression analysis with anxiety as predictor and efficiency as criterion. To capture the effect of the Johnson method on athletes' performance, a 2x2 two-way mixed ANOVA was used.

Research subjects

This study was conducted between 28.01.2021 - 16.05.2021, within the SCM Gloria Buzău women's handball team, participating in the Romanian National Women's Handball League. The studied group was composed of 26 female subjects, aged between 20 and 39 years. This group was divided into an experimental group and a control group in a randomized way.

The research process

Table 1. Research stages

Stage I (28.01.2021 - 01.02.2021)	Measuring the effectiveness of each player by recording data from 8 official matches.
Stage II (28.02.2021)	Application of the Sport Scale Anxiety-2 questionnaire on the two groups - experiment and control.
Stage III (01.02.2021 - 23.04.2021)	Applying the Jacobson relaxation technique with the help of a sports psychologist. A session lasts 8-10 minutes and the progress of the relaxation technique was monitored at the end of each week through an anamnesis of the athletes' anxiety levels.
Stage IV (26.04.2021 - 16.05.2021)	Measuring the effectiveness of each player by recording data from the last 8 official matches played and analysing the data obtained.

Results

In the first stage of this scientific work, a multiple regression analysis was performed, with anxiety as predictor and efficiency as criterion.

THE MEDIATING ROLE OF JACOBSON RELAXATION TECHNIQUES IN THE RELATIONSHIP BETWEEN ANXIETY AND PERFORMANCE OF FEMALE HANDBALL PLAYERS

Table 2. Analysis of anxiety data

		performance	anxiety
Pearson Correlation	performance	1.000	-.902
	anxiety	-.902	1.000
Mr (1-tailed)	performance	.	<.001
	anxiety	.000	.
N	performance	26	26
	anxiety	26	26

Following this analysis, the following aspects can be noted: efficiency and anxiety correlate strongly, in the opposite direction, the correlation coefficient between the two variables being negative, $r = -0.902$. This correlation has high statistical significance ($\text{sig} < 0.001$). What can be observed is that 81% of the variability in performance can be explained by differences created by the level of anxiety of the players, so the level of anxiety can be considered an important predictor in the playing effectiveness of athletes.

Table 3. Analysis of emotion of control data

		Performance	MT
Pearson Correlation	performance	1.000	.815
	MT	.815	1.000
Mr (1-tailed)	performance	.	<.001
	MT	.000	.
N	performance	26	26
	MT	26	26

We observed that there was a strong positive correlation between the level of control of emotions acquired as a result of therapy and the level of performance in the game, $r=0.96$, the result being statistically significant, $\text{sig}<0.001$.

In the second part of the statistical research, a 2x2 mixed two-way ANOVA was used to investigate the effect that a specific relaxation technique has on the performance of female professional handball players according to their degree of anxiety. Using the GPOWER test, we assumed a mean statistical effect of the within-subjects and between-subjects variable ($\text{eta}^2=0.06$), and a type I error rate of 0.05.

Table 4. Bifactor Anova analysis

		Descriptive Statistics		
	Anxiety	Mean	Std. Deviation	N
Before	grown	20.9091	6.26825	11
	low	64.2667	17.15254	15
	Total	45.9231	25.64515	26
After	grown	26.6364	4.98543	11
	low	67.9333	16.91773	15
	Total	50.4615	24.55888	26

Table 5. Analysis of the effect of relaxation techniques on athletes

Source	performance	Type III Sum of Squares	df	Mean Square	F	Mr	Partial Eta Squared
performance	Linear	280.012	1	280.012	23.600	<.001	.496
performance * anxiety	Linear	13.473	1	13.473	1.136	.297	.045
Error(performance)	Linear	284.758	24	11.865			

Following the two-way mixed ANOVA test, the effect that relaxation techniques can have on the performance of female competitive players was observed. Thus, a main effect on performance was found, $F(1.4) = 23.6$, $p<0.001$. A significant main effect was also found for anxiety, $F(1.24) = 64.33$, $p<0.001$. Furthermore, the interaction effect between anxiety and performance was not significant, $p = 0.297$, allowing direct comparisons between the means of the two groups.

Conclusions

The current study is focused on how emotions affect the quality of play of performance athletes. The selected sample consisted of 26 female professional handball players in Romania, and what was investigated was the extent to which the degree of anxiety affects the players' performance, with the effects of the variable taken independently. Following the results, we concluded that a high level of anxiety, predicts a lower level of efficiency on the court; and, moreover, this aspect can be improved by applying a valid relaxation technique.

The hypothesis of how a particular relaxation technique, applied consistently over a sufficient period of time, leads to an improvement in the quality of play of athletes has been confirmed. Thus, following Jacobson relaxation techniques applied to female handball players, an increase in performance levels was observed in both anxious and low-anxious individuals (albeit to a lesser extent). One explanation is that these techniques help athletes to focus better in the current situation, their cognition being shifted from threatening stimuli (e.g. spectator disappointment) to how to manage their emotions so that they are fully dedicated to the end goal.

The current study contributes to the literature by reinforcing the findings of previous studies on the effect of anxiety on elite athlete performance. By the fact that this research was conducted within a specific spatial and cultural context, the current results may also help to reflect certain particularities of Romanian competitive athletes.

Authors' Contribution

All authors have equally contributed to this study and should be considered as main authors.

REFERENCES

- Algani, P., Yuniardi, M., & Masturah, A. (2018). Mental Toughness Dan Competitve Anxiety Pada Atlet Bola, Voli. *J Imiah Psikologi Terapan*, 6(1), p. 93-101.
- Amanendra, M., Gurmeet, S., & Himanshu, H. (2008). Mental toughness and competitive anxiety between high and low perform's football players. *Int J Physol Nutr Phys Educ*, 3 (1), p. 938-941.
- Amit, K. (2016). A study on mental toughness and sports competition anxiety for male and female basketball player. *Int J Phys Educ Sports Health*, 3 (2), p. 379-381.

- Gucciardi, D., Hanton, S., Gordon, S., Mallett, C., & Temby, P. (2014). The Concept of Mental Toughness: Tests of Dimensionality, Nomological Network and Traitness. *J.L. Person, 83* (1), p. 26-44.
- Hossein, A., Mohd, R., Soumendra, S., Anwar, H., & Huzaimi, M. (2016). Relationship Between Mental Toughness and Trait Anxiety in Sports. *Int J Pharm Bio Sci, 7*(3), p. 275-281.
- Lazarus, R. S. (2000). How emotions influence performance in competitive sports. *The Sport Psychologist, 14*(3), p. 229-252.
- Miftakhul, J., Lina, H., Nabila, N., & Widohardono, R. (2018). Anxiety and Mental Toughness Among Athlete Students. *Adv Social Sci, Educ Hum Res., vol. 212*.
- Smith, R., Smoll, F., Cumming, S., & Grossbard, J. (2016). Measurement of multidimensional sport performance anxiety in children and adults: The Sport Anxiety - 2. *J Sport Exerc Psychol, 28*(4), p. 479-501.

CONSIDERATIONS ON THE PROPHYLAXIS OF SEVERE FORMS OF COVID-19 THROUGH ENDURANCE EXERCISES

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Received 2021 November 1; Revised 2022 January 09; Accepted 2022 January 10; Available online 2022 May 5; Available print 2022 May 30.

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ABSTRACT. Prophylaxis of severe forms of COVID-19 can be achieved by combating sedentary lifestyle, preferably through moderate intensity endurance exercises, dosed so as not to cause immune disorders. The mechanism is likely to be to protect the mitochondria from oxidative stress. The anti-inflammatory effects may also occur in the organs affected by the virus. The high intensity of the effort (interval training or resistance training) can promote, in addition to immune disorders, even the penetration of the virus into the target cells (according to a hypothesis to be confirmed by future studies). However, there are preliminary results according to which some high-intensity exercises can be adapted to avoid hypoxia and thus be used for COVID-19 prophylaxis. Prevention of serious complications of SARS-CoV-2 infection through exercise may be of interest to obese, diabetic and the elderly, high-risk categories.

Key words: COVID-19, exercises, mitochondria

REZUMAT. Considerații privind profilaxia formelor severe de covid-19 prin exerciții de anduranță. Profilaxia formelor severe de COVID-19 se poate realiza prin combaterea sedentarismului, de preferință prin exerciții de anduranță de intensitate moderată, dozate astfel încât să nu provoace tulburări imunitare. Este posibil ca mecanismul să fie protejarea mitocondriilor de stresul oxidativ. Se poate ca efectele antiinflamatoare să se manifeste inclusiv în organele afectate de respectivul virus. Intensitatea mare a efortului (antrenament pe intervale sau antrenament cu rezistență) poate favoriza, pe lângă tulburările

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imunitare, chiar și pătrunderea virusului în celulele țintă (conform unei ipoteze ce urmează a fi confirmată de studii viitoare). Există însă rezultate preliminare conform cărora și unele exerciții de intensitate mare pot fi adaptate în sensul evitării hipoxiei și astfel să fie folosite pentru profilaxia COVID-19. Prevenirea complicațiilor grave ale infecției cu SARSCOV-2 prin exerciții fizice poate fi de interes pentru categoriile cu risc ridicat: obezi, diabetici și vârstnici.

Cuvinte cheie: COVID-19, exerciții, mitocondrii

Introduction

A statistical study conducted in the UK shows that the physically inactive population is more exposed to developing forms of COVID-19 that require hospitalization, the paper concluding that the adoption of simple lifestyle changes results in decreased risk of severe SARSCOV-2 infections (Hamer et al., 2020). According to the medical hypothesis published in the International Journal of Pharmaceutical Research (Hagiu, 2020a), moderate intensity endurance exercises are indicated for the prevention of severe forms of COVID-19. The arguments are that exercise induces an adaptation of mitochondria to oxidative stress (Lawler et al., 2016), which is particularly important given that these organelles are indirectly attacked by the SARSCOV-2 virus by increasing the concentration of plasma iron, mitochondrial damage contributing to the cytokine storm that characterizes COVID-19 complications (Saleh et al., 2020). The purpose of this review is to analyze, based on the literature, whether mitochondrial biogenesis interested organs affected by SARSCOV-2 virus, what effect the various types of exercise have on the immunity and virus ability to enter cells, and the applicability of the hypothesis in some pathological situations.

Stimulation of mitochondrial biogenesis through exercise in organs affected by complications of COVID-19

Because liver damage in COVID-19 can be attributed to inflammatory storm rather than direct viral attack (Ali, 2020), the question arises whether exercise stimulates liver mitochondrial biogenesis. Recent work shows that exercise has the effect of modulating the structure and functions of liver mitochondria (Stevanović et al., 2020). Also in the case of myocarditis that appeared as a complication of COVID-19, the etiology is inflammatory rather than the direct attack of the virus on myocardial cells (Pirzada et al., 2020). The benefit of endurance training on myocardial energy metabolism in heart failure has been shown (Ventura-Clapier et al., 2007). Exercise increases the biogenesis of mitochondria in the brain, the experiment being performed on experimental

animals (mice), and the exercises can be assimilated to endurance (treadmill) (Steiner et al., 2011). This fact can be taken into account if we consider the possibility of neurological complications in the case of COVID-19 infection (Sheraton et al., 2020), complications that have become more frequent in recent times.

Why moderate intensity endurance exercises?

Citrate synthase may be a marker of mitochondrial oxidative stress, and it is proposed to protect this enzyme with antioxidants (Chepelev et al., 2009). It is also a marker of adaptation to oxidative stress induced by sports training in striated muscle, being admitted a relationship with total aerobic capacity (Vigelsø et al., 2014). After 6 weeks of endurance training (continuous training of moderate intensity) citrate synthase activity increases (Meinild Lundby et al., 2018), so probably the resistance of mitochondria to oxidative stress present in the evolution of COVID-19. Mitochondrial biogenesis can also be stimulated by high-intensity exercise (Bishop et al., 2019), but these may have some disadvantages for the prevention of severe forms of COVID-19. First, it is considered, there is a consensus, that regular bouts of short-lasting (ie up to 45 minutes) moderate intensity exercise is beneficial for host immune defense, particularly in older adults and people with chronic diseases (Simpson et al., 2020). In young subjects an interval training session (HIIT) induces a modest systemic inflammatory response, and two weeks of training did not alter the inflammatory response to an acute bout of HIIT exercise (Zwetsloot et al., 2014), a fact that I consider unfavorable in the presence of an COVID-19 infection. In contrast, in elderly people with rheumatoid arthritis, ten weeks of HIIT improved innate immune function (Bartlett et al., 2018), which raises the question of whether, under special conditions and in certain subjects, this type of training could be effective in the prophylaxis of severe forms of COVID-19. However, continuous training of moderate intensity, not HIIT, improves markers of immunity in young men (Khammassi et al., 2020). High-intensity exercise increases the plasma concentration of ACE2 ("spike" protein to the angiotensin-converting enzyme 2, which conditions the entry of SARSCOV-2 virus into the cell), which is under investigation to determine whether it is beneficial or detrimental (Wackerhage et al., 2020). The main cause is hypoxia, which can promote the entry of the virus into vascular endothelial cells (Hagiu, 2020b, 2021a). Resistance training increases the respiratory capacity and intrinsic functions of skeletal muscle mitochondria (Porter et al., 2015). However, it involves a high intensity of effort and probably an increase in the plasma concentration of ACE2. On the other hand, resistance exercises also produce transient disturbances of immunity (Freidenreich & Volek, 2012).

It turns out that moderate intensity endurance is the surest way to increase the antioxidant capacity of mitochondria and thus prevent the cytokine storm as an unwanted event during COVID-19 infection. This fact is supported even by genetic arguments (Hagiu, 2021b). I believe that future research needs to be done for other forms of training. In fact, in a previous paper, we showed that during Kangoo Jumps training of moderate intensity does not reach hypoxia, even if the heart rate can exceed 80% of the maximum value (Hagiu, Turculeț & Dumitru, 2021).

Mitochondrial dysfunctions in diseases at risk for the development of severe forms of COVID-19

Obesity, insulin resistance and type 2 diabetes are conditions accompanied by mitochondrial dysfunction (Montgomery, 2019). There is evidence that exercise reverses impairments in mitochondrial density and size (Lumini et al., 2008). On the other hand, mitochondrial dysfunctions are known in the elderly (Haas, 2019), but there is the possibility of restoring those cellular organs through exercise (Nilsson & Tarnopolsky, 2019). Obese people, diabetics and the elderly are at risk for developing severe forms of COVID-19, and this risk can be reduced by practicing exercises. According to Wang et al (2020), obese sufferers can benefit from exercise programs to prevent mortality with COVID-19, but the authors propose combining medium-intensity endurance with interval exercise.

Conclusions

Decreasing the incidence of cases requiring hospitalization for COVID-19 infection can be achieved by combating physical inactivity, probably best through moderate intensity endurance exercise. The anti-inflammatory effects of exercise-stimulated mitochondrial biogenesis may also occur in organs directly or indirectly affected by the virus. Interval resistance training, due to the high intensity of the effort, can produce immune disorders, and even, according to a hypothesis being tested, favors the penetration of the virus into the target cells. The same goes for high intensity resistance training. So, until these phenomena are elucidated by future research, these types of exercises should probably be avoided for the intended purpose. However, the possibility of avoiding hypoxia during high-intensity training is a direction for research into COVID-19 prophylaxis through exercise. The prophylaxis of severe forms of COVID-19 through exercise can benefit including the obese, diabetics and the elderly, all categories at high risk.

REFERENCES

- Ali N. (2020). Relationship Between COVID-19 Infection and Liver Injury: A Review of Recent Data. *Frontiers in medicine*, 7, 458. <https://doi.org/10.3389/fmed.2020.00458>.
- Bishop, D.J., Botella, J., Genders, A.J., Lee, M.J., Saner, N.J., Kuang, J., Yan, X., & Granata, C. (2019). High-Intensity Exercise and Mitochondrial Biogenesis: Current Controversies and Future Research Directions. *Physiology (Bethesda, Md.)*, 34(1), 56–70. <https://doi.org/10.1152/physiol.00038.2018>.
- Bartlett, D.B., Willis, L.H., Slentz, C.A. *et al.* Ten weeks of high-intensity interval walk training is associated with reduced disease activity and improved innate immune function in older adults with rheumatoid arthritis: a pilot study (2018). *Arthritis Res Ther* 20, 127. <https://doi.org/10.1186/s13075-018-1624-x>.
- Chepelev, N.L., Bennitz, J.D., Wright J.S., Smith, J.C. & Willmore, W.G. (2009) Oxidative modification of citrate synthase by peroxy radicals and protection with novel antioxidants, *Journal of Enzyme Inhibition and Medicinal Chemistry*, 24, 6, 1319-1331, DOI: 10.3109/14756360902852586.
- Haas R.H. (2019). Mitochondrial Dysfunction in Aging and Diseases of Aging. *Biology*, 8(2), 48. <https://doi.org/10.3390/biology8020048>.
- Hagiu, B.A. (2020a). The Relationship between Exercise and Medication in Preventing Severe forms of COVID-19 Infection. *Journal of Pharmaceutical Research International*, 32(14), 164-167. <https://doi.org/10.9734/jpri/2020/v32i1430616>.
- Hagiu, B.A. (2020b). Vasodilators, Enhancers of Prevention through Exercise of COVID-19?. *Journal of Pharmaceutical Research International*, 32(34), 126-131. <https://doi.org/10.9734/jpri/2020/v32i3430972>.
- Hagiu, B.A. (2021a). Moderate exercise may prevent the development of severe forms of COVID-19, whereas high-intensity exercise may result in the opposite. *Medical hypotheses*, 157, 110705. Advance online publication. <https://doi.org/10.1016/j.mehy.2021.110705>.
- Hagiu, B.A. (2021b). Genetic Arguments for the Prevention of Severe Forms of COVID-19 through Moderate-Intensity Exercise. *Journal of Pharmaceutical Research International*, 32(45), 23-29. <https://doi.org/10.9734/jpri/2020/v32i4531089>.
- Hagiu, B.A., Turculeț, I.D., Dumitru, I.M. (2021) Preliminary Data on the Prophylaxis of Severe Forms of Covid-19 Through Exercise, *Studia Universitatis Babeș-Bolyai, Educatio Artis Gymnasticae*, 66, 1, 79-84. DOI:10.24193/subbeag.66(1).08.
- Hamer, M., Kivimäki, M., Gale, C., & Batty, G. (2020). Lifestyle risk factors, inflammatory mechanisms, and COVID-19 hospitalization: A community-based cohort study of 387,109 adults in UK. *Brain, Behavior, and Immunity*, 87, 184 - 187.

- Khammassi, M., Ouerghi, N., Said, M., Feki, M., Khammassi, Y., Pereira, B., Thivel, D., & Bouassida, A. (2020). Continuous Moderate-Intensity but Not High-Intensity Interval Training Improves Immune Function Biomarkers in Healthy Young Men. *Journal of strength and conditioning research*, 34(1), 249–256. <https://doi.org/10.1519/JSC.0000000000002737>.
- Lawler, J.M., Rodriguez, D.A., & Hord, J.M. (2016). Mitochondria in the middle: exercise preconditioning protection of striated muscle. *The Journal of physiology*, 594(18), 5161–5183. <https://doi.org/10.1113/JP270656>.
- Lumini, J.A., Magalhães, J., Oliveira, P.J., & Ascensão, A. (2008). Beneficial effects of exercise on muscle mitochondrial function in diabetes mellitus. *Sports medicine (Auckland, N.Z.)*, 38(9), 735–750. <https://doi.org/10.2165/00007256-200838090-00003>.
- Meinild Lundby, A.K., Jacobs, R.A., Gehrig, S., de Leur, J., Hauser, M., Bonne, T.C., Flück, D., Dandanell, S., Kirk, N., Kaech, A., Ziegler, U., Larsen, S., & Lundby, C. (2018). Exercise training increases skeletal muscle mitochondrial volume density by enlargement of existing mitochondria and not de novo biogenesis. *Acta physiologica (Oxford, England)*, 222(1), 10.1111/apha.12905. <https://doi.org/10.1111/apha.12905>.
- Freidenreich, D.J., & Volek, J.S. (2012). Immune responses to resistance exercise. *Exercise immunology review*, 18, 8–41.
- Montgomery M.K. (2019). Mitochondrial Dysfunction and Diabetes: Is Mitochondrial Transfer a Friend or Foe?. *Biology*, 8(2), 33. <https://doi.org/10.3390/biology8020033>.
- Pirzada, A., Mokhtar, A.T., & Moeller, A.D. (2020). COVID-19 and Myocarditis: What Do We Know So Far?. *CJC open*, 2(4), 278–285. <https://doi.org/10.1016/j.cjco.2020.05.005>.
- Nilsson, M.I., & Tarnopolsky, M.A. (2019). Mitochondria and Aging-The Role of Exercise as a Countermeasure. *Biology*, 8(2), 40. <https://doi.org/10.3390/biology8020040>.
- Saleh, J., Peyssonnaud, C., Singh, K.K., Edeas, M. (2020). Mitochondria and microbiota dysfunction in COVID-19 pathogenesis. *Mitochondrion* 54, 1–7.
- Porter, C., Reidy, P.T., Bhattarai, N., Sidossis, L.S., & Rasmussen, B.B. (2015). Resistance Exercise Training Alters Mitochondrial Function in Human Skeletal Muscle. *Medicine and science in sports and exercise*, 47(9), 1922–1931. <https://doi.org/10.1249/MSS.0000000000000605>.
- Sheraton, M., Deo, N., Kashyap, R., & Surani, S. (2020). A Review of Neurological Complications of COVID-19. *Cureus*, 12(5), e8192. <https://doi.org/10.7759/cureus.8192>.
- Simpson, R.J., Campbell, J.P., Gleeson, M., Krüger, K., Nieman, D.C., Pyne, D.B., Turner, J.E., & Walsh, N.P. (2020). Can exercise affect immune function to increase susceptibility to infection?. *Exercise immunology review*, 26, 8–22.
- Stevanović, J., Beleza, J., Coxito, P., Ascensão, A., & Magalhães, J. (2020). Physical exercise and liver "fitness": Role of mitochondrial function and epigenetics-related mechanisms in non-alcoholic fatty liver disease. *Molecular metabolism*, 32, 1–14. <https://doi.org/10.1016/j.molmet.2019.11.015>.

- Steiner, J.L., Murphy, E.A., McClellan, J.L., Carmichael, M.D., & Davis, J.M. (2011). Exercise training increases mitochondrial biogenesis in the brain. *Journal of applied physiology (Bethesda, Md.: 1985)*, 111(4), 1066–1071. <https://doi.org/10.1152/jappphysiol.00343.2011>].
- Ventura-Clapier, R., Mettauer, B., & Bigard, X. (2007). Beneficial effects of endurance training on cardiac and skeletal muscle energy metabolism in heart failure. *Cardiovascular research*, 73(1), 10–18. <https://doi.org/10.1016/j.cardiores.2006.09.003>.
- Vigelsø, A., Andersen, N.B., & Dela, F. (2014). The relationship between skeletal muscle mitochondrial citrate synthase activity and whole body oxygen uptake adaptations in response to exercise training. *International journal of physiology, pathophysiology and pharmacology*, 6(2), 84–101.
- Wackerhage, H., Everett, R., Krüger, K., Murgia, M., Simon, P., Gehlert, S., Neuberger, E., Baumert, P., Schönfelder, M. (2020). Sport, exercise and COVID-19, the disease caused by the SARS-CoV-2 coronavirus. *Dtsch Z Sportmed.*; 71: E1-E12.
- Wang, M., Baker, J.S., Quan, W., Shen, S., Fekete, G., & Gu, Y. (2020). A Preventive Role of Exercise Across the Coronavirus 2 (SARS-CoV-2) Pandemic. *Frontiers in physiology*, 11, 572718. <https://doi.org/10.3389/fphys.2020.572718>
- Zwetsloot, K.A., John, C.S., Lawrence, M.M., Battista, R.A., & Shanely, R.A. (2014). High-intensity interval training induces a modest systemic inflammatory response in active, young men. *Journal of inflammation research*, 7, 9–17. <https://doi.org/10.2147/JIR.S54721>.

SPRAINED KNEE PROPHYLAXY USING THE STAR EXCURSION BALANCE TEST (SEBT)

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Received 2022 March 04; Revised 2022 April 15; Accepted 2022 April 15;

Available online 2022 May 5; Available print 2022 May 30.

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ABSTRACT. Introduction. To control the movement, the brain must process proprioceptive information provided by mechanoreceptors. The role of proprioception in daily activities, physical exercises, were presented, using the SEBT technique and the proprioceptive mechanisms that represent the base of dynamic postural control. **Objective.** The aim was to highlight the effects of proprioceptive training on lower limb balance in subjects with lower limb injuries but also in healthy subjects, and to evaluate the effectiveness of proprioceptive programs based on postural instability to reduce knee sprains by developing proprioceptive control. These findings indicate the improvement of proprioceptive control which may be a key factor in reducing knee sprain. **Methods.** The research was performed on 30 subjects, male and female, employees of the Ministry of National Defense, distributed in two experimental groups: G1 and G2. **Results.** SEBT has become a dynamic test used in clinical trials and research. The results of the research showed validity for SEBT. **Conclusions.** Knee sprain is a trauma that occurs frequently among athletes. Like athletes, the Ministry of National Defense employees represent a population at high risk of injury or recurrence.

Keywords: *knee sprain, postural control, neuromuscular control, dynamic balance test.*

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REZUMAT. Profilaxia entorsei de genunchi utilizând testul SEBT. Introducere. Pentru a controla mișcarea, creierul trebuie să proceseze informații proprioceptive, furnizate de mecanoreceptori. Rolul propriocepției în activitățile zilnice, exercițiile fizice, au fost prezentate utilizând tehnica SEBT și mecanismul proprioceptiv, care reprezintă baza controlului postural dinamic. **Obiectiv.** Obiectivul a fost de a evidenția efectele antrenamentului proprioceptiv asupra echilibrului membrelor inferioare la subiecți cu leziuni ale membrelor inferioare, dar și la subiecți sănătoși, și de a evalua eficacitatea programelor proprioceptive, bazate pe instabilitate posturală, pentru a reduce entorsele de genunchi prin dezvoltarea controlului proprioceptiv. Aceste descoperiri indică îmbunătățirea controlului proprioceptiv, care poate fi un factor cheie în reducerea entorsei genunchiului. **Metode.** Cercetarea a fost efectuată pe 30 de subiecți, bărbați și femei, angajați ai Ministerului Apărării Naționale, repartizați în două grupuri experimentale: G1 și G2. **Rezultate.** SEBT a devenit un test dinamic utilizat în studiile clinice și în cercetare. Rezultatele cercetării au demonstrat validitatea pentru SEBT. **Concluzii.** Entorsa genunchiului este o traumă care apare frecvent în rândul sportivilor. Asemenea sportivilor, angajații Ministerului Apărării Naționale reprezintă o populație cu risc crescut de accidentare sau recidivă.

Cuvinte cheie: entorsa genunchiului, control postural, control neuromuscular, test de echilibru dinamic.

Introduction

This dynamic postural control test has received attention in clinical and research settings is the Star Excursion Balance Test (SEBT, figure 1). Specialists recommend, with correct instructions and practices by subjects and normalization of contact distances, SEBT to be used to differentiate deficits and improve dynamic postural control related to lower limb injuries and induced fatigue, and has the ability to prevent lower limb injuries.

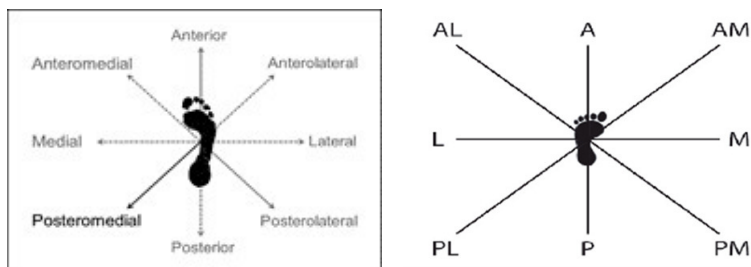


Fig. 1. SEBT (Panjan & Sarabon, 2010)

Star Excursion Balance Test (SEBT) is a tool for testing and assessing dynamic balance. SEBT is a specific test for joint injuries and is applied and described for over 22 years (Gribble & Hertel, 2003).

Researchers are continuously committed to investigate and analyze the biomechanical and neuromuscular factors that contribute to joint damage and their early recovery (Prakash et al., 2017).

We mention here injuries such as the anterior cruciate ligament injury without contact at the knee joint and the development of chronic instability of the ankle. SEBT has ability to report the postural control problems between limbs, both among the healthy population and among populations with lower limb joint injuries (Plisky, Rauh, Kaminski & Underwood, 2006).

In this context, adding the fact that the literature considers it one of the best tools for measuring the dynamic balance of the lower extremity, we considered that we can also apply it to monitor the performance of researched subjects (Munro & Herrington, 2010).

Note that, in its current form, the SEBT has been reduced to three directions becoming similar to the Y Test. Although the directions of touch are the same (anterior, posteromedial, posterolateral) and participants move in similar patterns (modified SEBT test and Y test), research indicated that previous contact distances were different when comparing the two tests. Therefore, the two instruments may not be directly comparable (Alnahdi, Alderaa, Aldali & Alsobayel, 2015).

Standardized testing (Gribble, Hertel & Plisky, 2012) must meet the following conditions:

- Lines drawn on the ground (figure 2).
- Starting position on the central point.
- Hands positioned on hips.
- Moving along the line and touching the line easily.
- The subject does not rest or pause on the line.
- The body weight is not transfer to the leg that reaches the maximum distance on that line.



Fig. 2. SEBT, lines drawn on the ground

Implementation of SEBT in the medical recovery- SEBT has been shown to be an effective test for highlighting chronic unilateral instability of the ankle and knee, but it has also been used to monitor patients with painful femur-patellar syndrome. The opinions of specialists converge towards the use of this test in other pathologies of the lower limb that may lead to disorders in terms of body stability. The test can also be predictable, as it can determine deficits and balance asymmetries in unipodal support, which help specialists in making decisions that are prophylactic, preventing injury.

Anterior, posteromedial and posterolateral directions appear to be important in identifying individuals with chronic ankle and knee instability, and athletes at higher risk of injury.

When the person shows a significant decrease in balance while standing on the affected lower limb, compared to the healthy lower limb, the star's balance test highlights the loss of dynamic postural control (Hegedus, McDonough, Bleakley, Baxter & Cook, 2015).

SEBT requires endurance, flexibility, neuromuscular control, basic stability, balance and proprioception. It proves to be an excellent test for physical and clinical examinations. SEBT is an excellent tool that helps us adapt our rehabilitation programs and sports training programs to address specific mechanical, sensory and functional issues.

It is a dynamic balance test that offers a significant challenge for athletes and physically active individuals, used to assess physical performance and to detect deficiencies in postural control.

How to perform SEBT-protocol:

1. The properly equipped subject is required to stand in the center of the star and wait for additional instructions, shoes removed to avoid measurement errors. You can perform some practical tests as a learning effect, you can show video instructions to increase the efficiency of the test protocol and standardize the instructions, you can perform the control test to improve the image in performing the test.

2. SEBT was described as a rehabilitation test consisting of placing the subject in the center of the star, in a standing position. The right foot is the touch leg and the left foot is for balance, the athlete must do it the circuit, in a clockwise. After the balancing on the right leg is done, the athlete must do it the circuit, in the counterclockwise (figure 3).

3. With the hands positioned at the hips, the subject must to reach with the foot, far as possible along the drawn line and with the tip of the foot of the lower contralateral limb lightly touch, in turn, each line (branch of the star), trying to slide as far away from the center of the star as possible along one of

the eight directions before returning to the starting position. Throughout the test, the hands remain fixed on the hips and a squatting position is maintained on the lower support member, and the heel remains in constant contact with the support surface.

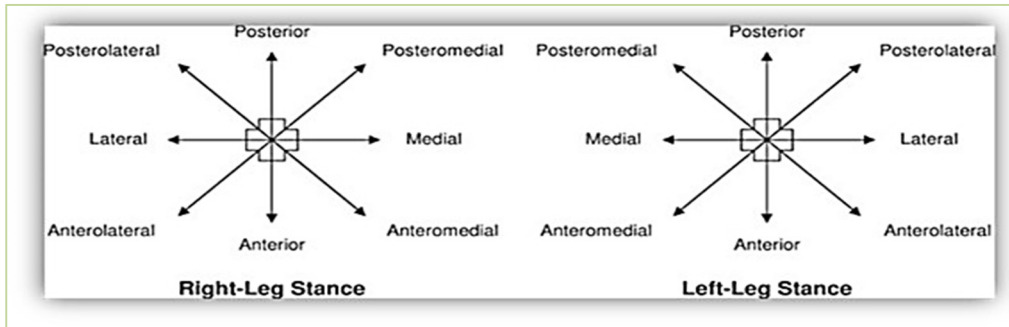


Fig. 3. SEBT directions of movement (Wingood, 2019)

4. Mark with a pencil or chalk the point at which the subject touches the line of that direction of movement. The subject returns to the original vertical position. The distance between the maximum point reached and the center point is measured in centimeters. Repeat the movement and the measurement procedure with the same lower limb in all 8 directions of movement. After each movement performed in one direction, return to the center point. The lower support member is changed and the movement and measurement procedure are repeated with the other lower limb, in each direction, performing again the 8 movements whose length is measured. The correct execution of the movements in the 8 directions represents a complete circuit.

5. Repeat the movements with the same foot for all eight other directions, and then change the leg.

6. To complete a full circuit this process must be performed three times on one leg, three circuits in the previous direction for the right leg and three for the left, keeping the same direction of movement.

7. After performing the three circuits, the subject moves away from the test area.

8. Record the distance to reach each successful attempt and calculate the subject's SEBT score when the test is finished.

Failure to follow one of these instructions resulted in the test being repeated in the direction in which the execution failed.

The protocol involves making 3 complete circuits with each leg. Thus, 3 performances are measured and recorded for each direction performed with each foot (distance 1 - at the first determination, distance 2 - at the second determination and distance 3 - at the third determination). The subject is then allowed to move away from the test area (Herrington, Hatcher, Hatcher & McNicholas, 2009).

In order to ensure the reproducibility of the measurement, we created a support for this test. I covered the floor with linoleum and drew on this support four lines intersected in the same central point, thus obtaining 8 branches, which represent the 8 directions of movement; the lines are extends from a central point and have 45 °, to each other.

The test subject must maintain balance on one lower limb (sitting on one lower limb) in the middle of the star test, while using the foot of the other lower limb to successively touch the 8 different directions, named, depending on foot orientation, as follows: anterior, anteromedial, medial, posteromedial, posterior, posterolateral, lateral and anterolateral direction.

The objective is to determine the subject to set a base of support on the position member and to maintain it, while the opposite member makes a maximum trip in one of the mentioned directions.

Scoring system- once the test is completed and all measurements are recorded, SEBT scores can then be calculated using this equations:

Average distance in each direction (cm) = distance 1 + distance 2 + distance 3/3.

Relative distance (normalized) in each direction (%) = Average distance in each direction / lower limb length x 100.

$$\text{Total score} = \frac{A+AL+L+PL+P+PM+M+AM}{8} \times 100$$

After these calculations, resulting in a total of 16 scores.

We took as a benchmark the values offered by Gribble and Hertel (2003), shown as a percentage of the length of the lower limbs, because from the literature, all bibliographic references refer to them, being considered normative values (Table 1). We mention that these data were obtained on sedentary subjects (Gribble & Hertel, 2003).

Table 1. Data on the normal values of the Star Excursion Balance Test

Direction	Normalized relative distances (expressed as a percentage of lower limb length)	
	Men	Women
Anterior (A)	79.2 +/- 7.0	76.9 +/- 6.2
Posterior (P)	93.9 +/- 10.5	85.3 +/- 12.9
Medial (M)	97.7 +/- 9.5	90.7 +/- 10.7
Lateral (L)	80.0 +/- 17.5	79.8 +/- 13.7
Anterolateral (AL)	73.8 +/- 7.7	74.7 +/- 7.0
Anteromedial (AM)	85.2 +/- 7.5	83.1 +/- 7.3
Posterolateral (PL)	90.4 +/- 13.5	85.5 +/- 13.2
Posteromedial (PM)	95.6 +/- 8.3	89.1 +/- 11.5

(Star Excursion Balance Test, 2017)

To compare the performance of an individual's limbs, comparisons can be made between the absolute touch distance on each limb. However, the reach distances must be normalized to the length of the limbs of each participant, measured from the anterosuperior iliac column to the medial ankle, being correlated with the touch performance. This performing is expressed as a percentage of limb length. The body height can be also correlated with touch distance.

The muscular activity of the medial vastus was higher in the anterior direction than in the other directions. The activity of the lateral vastus muscles was lower during the lateral excursion compared to the other directions. The activity of the hamstrings was higher in the anterolateral direction than in the anterior, anteromedial and medial directions. The activity of the femoral biceps muscles was higher in the posterior, posterolateral and lateral directions compared to the anterior and anteromedial directions.

Muscle differences between certain SEBT-specific travel distances can be helpful to specialists, who can decide which directions of travel can be used in patients with specific conditions that have a lack of muscle strength.

An important factor is also the gender. After different fatigue protocols, it was found that there was no difference in performance between the sexes.

In conclusion, the performance of SEBT became more consistent and more pronounced after fatigue. Fatigue changes the effectiveness of the ability to contract extrafusal muscle fibers that alter neuromuscular control.

Specifically, during local muscle fatigue, nociceptors are active through metabolic products of muscle contraction, including bradykinin, potassium, and lactic acid. Basic idea, it is that fatigue can influence SEBT performance.

Fatigue is a factor that could affect the dynamic postural control measured with SEBT.

SEBT's ability to differentiate the effects of external influences and interventions- in addition to identifying problems in dynamic postural control. SEBT can be used to highlight the influence of external interventions and influences on dynamic postural control. These comparisons demonstrate that SEBT can be used to address effective methods of recovery and prevention of lower limb joint injuries in clinical settings. Taping and orthoses are devices used to increase the stability and biomechanics of the joints, which show increased postural control (O'Sullivan, Murray & Sainsbury, 2009).

It is understood that the touch distance will be affected by limb length and sex.. Thus, there is a considerable percentual difference between the two lower limbs or between the subjects with injuries and the healthy, control ones.

The location of the foot, affects the different muscles of the thigh, which contribute to balance in different directions of movement:

- The medial vastus is most active in the anterior area.
- The lateral vastus is the least active in the lateral area.
- The hamstring is most active during anterolateral movement.
- The femoral biceps was most active during the posterior and posterolateral movement.

These directions of touch help us to direct our clinical reasoning and train specific muscles, using targeted directions of movement, in order to influence them.

Because the performance on SEBT varies by sport, gender, and age, specialists must collect normative data using different populations (in addition to those who practice different sports, even military, youth, the elderly, etc.). With normative data and objective studies resulting from SEBT, we can determine lesions for each population (Calatayud, Borreani, Colado, Martin & Flandez, 2014).

All directions have the ability to identify movement deficits in participants compared to healthy controls, however, the posteromedial direction is the most representative for the overall assessment.

The anterior direction is more affected by dorsiflexion and plantar skin sensation, which means that mechanical limitations and sensory deficits influence this movement.

The posteromedial and posterolateral direction is more affected by eversion and balance control.

The deficit in performance, before the implementation of a medical rehabilitation protocol, was confirmed, the injured lower limbs producing a weaker dynamic postural control than the healthy limbs for posteromedial, posterolateral and lateral directions.

Patients with chronic ankle instability are susceptible to increased use of torso flexion during the execution of the previous movement, suggesting a strategy to compensate for reduced ankle control by manipulating the pelvis and the trunk.

Reconstruction of the anterior cruciate ligament- anterior cruciate ligament injuries are common in pathological conditions of the lower limbs, and many studies about anterior cruciate ligament problems. The performance of SEBT compared with the performance of the healthy limb, in the anterior, lateral, posteromedial and medial directions, the limb with anterior cruciate ligament problems showed weaker dynamic postural control than the healthy limb, patients have low resistance of the quadriceps, which showed a reduced ability to touch in the anterior directions (Clagg, Paterno, Hewett & Schmitt, 2015). But upon returning to work, we hope that there will be no differences from one limb to another. This requires that this test be instituted earlier in our recovery plans.

Patellofemoral pain syndrome- SEBT performance was compared in the anterior direction due to its ability to cause a high level of quadriceps muscle activation, dorsiflexion in the ankle joint and a greater tension of the patellofemoral joint. There were shorter touch distances, this finding demonstrating a lack of dynamic postural control of those with femuropatellar syndrome (Aminaka & Gribble, 2008).

This direction of touch (anterior) is usually the most limited and highlights the patient's reduced ability to walk on slopes and stairs.

Use of SEBT to detect clinical deficiencies- SEBT was initially designed as a rehabilitation tool for pathological diseases of the joints of the lower limbs, specialists use this tool for diagnosing and detecting the risk of injury (Ahlden et al., 2012). SEBT can be a diagnostic tool in 4 clinical situations:

- 1) the ability to prevent the risk of injury.
- 2) the ability to differentiate patients with diseases of the joints of the lower limbs from healthy patients.
- 3) the ability to differentiate the influence of certain factors on sports performance.
- 4) the ability to demonstrate clear and objective results following the application of the SEBT.

Establishing these qualities will help specialists evaluate and establish the best way to implement SEBT in coordinating lower limb joint injuries. At the same time, it helps to carry out a comprehensive review of the general purpose of evaluating the effectiveness of SEBT as a tool for diagnosing and preventing joint injuries.

Working hypothesis

The application of a kinetic intervention protocol consisting of static proprioceptive exercises stimulates the maintenance of the body in balance in unbalanced situations and increases the stability of the knee joint in Ministry of National Defense workers with a history of sprained knee or predisposition to injury.

The purpose of the research

The proprioceptive system stimulated by specific exercises can restore segmental stability through static and dynamic tasks.

Participants

The population groups approached, respectively employees of the Ministry of National Defense services, underwent a complex evaluation using the star balance test, which is a novelty in our literature and a program of proprioception exercises used both as a means of primary prophylaxis, as well as therapy and secondary prophylaxis, prevention of recurrences in knee sprain in workers in the Ministry of National Defense services.

We emphasize that the detection of knee instability and its treatment before joint trauma is particularly important for this professional category who must be in very good physical condition to cope with regular physical tests and regular requests for training.

Methodology

Research methods

The research was performed on 30 subjects, male and female, employees of the Ministry of National Defense, distributed in two experimental groups: G1 and G2. Both groups were selected based on common criteria, namely: volunteers, who currently carry out a program of continuous physical-military training, aged between 25 and 45 years and with a length of service of at least 5 years in the practice of the physical activities previously mentioned. Healthy people were included in group G2. The G1 group was put together also based on specific criteria that we present below.

Common inclusion criteria

- the Ministry of National Defense employees, who are currently carrying out a continuous physical-military training program;
- ages between 25 and 45 years;
- seniority of at least 5 years in practicing a sports activity;

Criteria for inclusion in group G1

- at least one history of a previous knee injury;
- without knee surgery;
- without knee pain greater than or equal to 4, on VAS scale (visual analog scale).

Exclusion criteria from group G1

- ages under 25 and over 45;
- persons who have suffered injuries / surgeries in the knee (sprains, resections or ablations of the meniscus, etc.).

Healthy people were included in group G2.

The program applied to the researched subjects included:

1. *Warm-up program* - with a duration of 10-12 minutes and consisted of:
 - low-speed walking exercises, walking and high-speed walking variants;
 - stretching targeting:
 - the muscles of the anterior thigh (right femur, intermediate vastus, lateral vastus, medial vastus), which together make up the quadriceps muscle, with a major extensor role of the knee;
 - posterior thigh muscles (femoral biceps, semimembranosus, semitendinosus, gracilis);
 - calf muscles (gastrocnemius, popliteal, plantar);

2. *A program of proprioceptive reeducation through static exercises = the classic form of therapeutic intervention* in the studied pathology.

The program consisted of *static proprioceptive physical exercises to destabilize* the body performed with the lower limbs in a closed kinematic chain.

Proprioceptive exercise protocol

Weeks 1 and 2:

- posterior, anterior and lateral destabilizations (left / right), - 4 series lasting 45 seconds, 2 for each leg.

Weeks 3 and 4:

- posterior, anterior and lateral destabilizations (left / right), - 4 series lasting 1 minute.

- and an altitude component, consisting of a unipodal support on a device 70 cm high.

Destabilization on increasingly unstable planes, from bipodal support and then from unipodal support, using a series of accessories such as: bicycle, stepper, balance board, balls (double load).

To evaluate the researched subjects we performed a series of anthropometric and functional measurements, Body Height and Body Weight based on them we calculated the body mass index (Table 2) using the formula ($BMI = \text{current G} / I^2$) and Lower limb length

BMI: for F = 19-25 kg / m², for B = 20.5-25 kg / m²

Table 2. Interpretation of the body mass index UN and WHO

BMI value kg / m ²	Interpretation
< 18.5	Hypo ponderal, weak
18.5 – 24.9	NORMAL
25 – 29.9	Excess weight
30 – 34.9	Moderate obesity
35 – 39.9	Severe obesity
> 40	Morbid obesity

(U.S. Department of Health & Human Services, 2012)

3. SEBT - *The Star Excursion Balance Test*

The results

Group 1

The sports practiced by the subjects included in the experimental group were diverse: gymnastics 3 subjects (20%), martial arts 2 subjects (13%), judo 2 subjects (13%), football 2 subjects (13%), boxing 2 subjects (13 %), rowing, tennis, athletics and handball, 1 subject (7% each).

Analyzed individually, on each sport practiced by the researched subjects, the figures are small and seem insignificant, only systematized in pivot sports and contact sports, all figures acquire significance, as all sports practiced by G1 group subjects are characterized by an increased risk of sprained knee injuries.

Group G2

The sports practiced by the subjects included in the experimental group were diverse: judo 3 subjects (20%), football 2 subjects (13%), boxing 2 subjects (13%), athletics 2 subjects (13%) and gymnastics, basketball, volleyball, triathlon, martial arts, handball, 1 subject (7% each).

Discussion

SEBT has become a dynamic test used in clinical trials and research. The results of the research showed validity for SEBT, considered a representative uninstrumented dynamic balance test to prevent the risk of injury to the joints of the lower limbs, to identify the deficit of dynamic postural balance in patients with disorders of the joints of the lower limbs and subjects without joint injuries lower limbs. Specialists should be confident in using SEBT as a functional test for lower limb joints.

Clinicians and researchers commonly use the Star Excursion Balance Test (SEBT) to assess dynamic balance. Anterior, posteromedial, and posterolateral directions appear to be important in identifying individuals with chronic knee instability and athletes at higher risk of lower limb injury.

Conclusions

Knee sprain is a trauma that occurs frequently in athletes. Like athletes, the Ministry of National Defense employees represent a population at high risk of injury or recurrence. The sensory impairment caused by a sprain alters the sensorimotor integration that leads to the reorganization of motor control, consisting in decreased stability of the knee joint and postural stability.

The average seniority in practicing a sports activity is significantly close to the two groups, taking into account the type of employees. This is explained by the fact that keeping the staff active implies undertaking of regular specific tests of effort, involving a permanent physical training.

The average seniority in service within the Ministry of National Defense structures is 13.46 years for women (15 years for group G1 and 12.1 years for group G2), while for men the average is 15.41 years (15.11 years for G1 and 15.75 years for G2).

The body mass index registered a normal average value in both groups in the tests (initial and final), with initial values of 22.62 and final values of 22.66 of group G1, respectively with initial values of 23.15 and final values of 23.07 of group G2.

Proprioception plays a key role in balance control, and knee proprioception is very important. Proprioceptive re-education improves stability and balance control and reduces recurrences. Postural stability is considered a predictive factor of chronic knee instability and dynamic stability as an intrinsic risk factor for injury.

Significant increases in average distances and normalized relative distances in almost all directions, as well as increases in the total score in both groups, highlight the effectiveness of the program applied to both people who have experienced a sprained knee and those at risk of injury.

The research hypothesis is confirmed: applying a kinetic intervention protocol consisting of static proprioceptive exercises, performed with the lower limbs, stimulates the body to keep in balance in unbalanced situations and increases the stability of the knee joint in the Ministry of National Defense employees with a history of knee sprain or predisposition injury.

Authors' Contribution

All authors have equally contributed to this study and should be considered as main authors.

REFERENCES

- Ahlden, M., Araujo, P., Hoshino, Y., Samuelsson, K., Middleton, K.K., Nagamune, K. (2012). Clinical grading of the pivot shift test correlates best with tibial acceleration, *Knee Surg, Sports Traumatol, Arthrosc: Off J ESSKA*, 20(4):708–712. <https://doi:10.1007/s00167-011-1863-8>.
- Alnahdi, A.H., Alderaa, A.A., Aldali, A.Z., Alsobayel, H. (2015). Reference values for the Y Balance Test and the lower extremity functional scale in young healthy adults. *Journal of Physical Therapy Science*, 27(12), 3917e3921. <https://doi.org/10.1589/jpts.27.3917>.
- Aminaka, N., Gribble, P.A. (2008). Patellar taping, patellofemoral pain syndrome, lower extremity kinematics, and dynamic postural control. *Journal of Athletic Training*, 43(1), 21e28. <https://doi.org/10.4085/1062-6050-43.1.21>.
- Calatayud, J., Borreani, S., Colado, J.C., Martin, F., Flandez, J. (2014). Test-retest reliability of the star excursion balance test in primary school children. *The Physician and Sportsmedicine*, 42(4), 120-124. <https://doi:10.3810/psm.2014.11.2098>.
- Clagg, S., Paterno, M.V., Hewett, T.E., Schmitt, L.C. (2015). Performance on the modified star excursion balance test at the time of return to sport following anterior cruciate ligament reconstruction. *The Journal of Orthopaedic and Sports Physical Therapy*, 45(6),444e452. <https://doi.org/10.2519/jospt.2015.5040>.

- Gribble, P.A., Hertel, J., Plisky, P. (2012). Using the star excursion balance test to assess dynamic postural-control deficits and outcomes in lower extremity injury: A literature and systematic review. *Journal of Athletic Training*, 47(3), 339e357. <https://doi.org/10.4085/1062-6050-47.3.08>.
- Gribble, P.A., Hertel, J. (2003). Considerations for normalizing measures of the star excursion balance test. *Measurement in Physical Education and Exercise Science*, 7(2), 89-100. https://doi.org/10.1207/S15327841MPEE0702_3.
- Hegedus, E.J., McDonough, S.M., Bleakley, C., Baxter, D., Cook, C.E. (2015). Clinician-friendly lower extremity physical performance tests in athletes: A systematic review of measurement properties and correlation with injury. Part 2—the tests for the hip, thigh, foot and ankle including the star excursion balance test. *British Journal of Sports Medicine*, 49(10), 649e656. <https://doi.org/10.1136/bjsports-2014-094341>.
- Herrington, L., Hatcher, J., Hatcher, A., McNicholas, M. (2009). A comparison of Star Excursion Balance Test reach distances between ACL deficient patients and asymptomatic controls. *The Knee*, 16(2), 149e152. <https://doi.org/10.1016/j.knee.2008.10.004>.
- Munro, A.G., Herrington, L.C. (2010). Between-session reliability of the star excursion balance test. *Physical Therapy in Sport: Official Journal of the Association of Chartered Physiotherapists in Sports Medicine*, 11(4), 128e132. <https://doi.org/10.1016/j.ptsp.2010.07.002>.
- O’Sullivan, K., Murray, E., Sainsbury, D. (2009). The effect of warm-up, static stretching and dynamic stretching on hamstring flexibility in previously injured subjects. *Journal of BioMed Central*, 1471-2474/10/3. <https://doi.org/10.1186/1471-2474-10-37>.
- Panjan, A., Sarabon, N. (2010). Review of Methods for the Evaluation of Human Body Balance. *Sport Science Review XIX* (5-6), 146. <http://dx.doi.org/10.2478/v10237-011-0036-5>.
- Plisky, P.J., Rauh, M.J., Kaminski, T.W., Underwood, F.B. (2006). Star excursion balance test as a predictor of lower extremity injury in high school basketball players. *Journal of Orthopaedic and Sports Physical therapy*, 36(12), 911-919. <https://doi.org/10.2519/jospt.2006.2244>.
- Prakash, J., Irshad, A., Sonal, K., Kamran, A., Shalini, V., Tarun, K. (2017). Proprioception: An Evidence Based Narrative Review. *Res Inves Sports Med*. 1(2). RISM.000506. 2017. <https://DOI:10.31031/RISM.2017.01.000506>.
- Star Excursion Balance Test. (2017). Translating Research Evidence and Knowledge. Retrieved from: <https://exercise.trekeeducation.org/assessment/balance-testing/star-excursion-balance-test/>
- U.S. Department of Health & Human Services. (2012). National Heart, Lung, and Blood Institute. Classification of Overweight and Obesity by BMI, Waist Circumference, and Associated Disease Risks. Retrieved from: https://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmi_dis.htm

Wingood, M. (2019). The Star Excursion Balance Test is a reliable and valid outcome measure for patients with knee osteoarthritis. Retrieved from:
<https://www.physio-network.com/researchreviews/knee/the-star-excursion-balance-test-is-a-reliable-and-valid-outcome-measure-for-patients-with-knee-osteoarthritis/>

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*Received 2022 February 13; Revised 2022 March 20; Accepted 2022 March 22;
Available online 2022 May 5; Available print 2022 May 30.*

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ABSTRACT. The motor behavior of six football players aged 21 to 25 is investigated in this research. We examined the players using the HUBER® 360 platform and several functional tests such as the Stability test, Unipodal test, Stability limit test, Mobility restrictions test, and Upper and lower limb coordination test to obtain the information needed to avoid injuries while participating in performance sports. This study is relevant to footballers because injuries have a short-term detrimental impact on the health of the enhancers if they are discovered in time and a long-term negative impact if they are not detected. The preliminary testing on the HUBER® 360 equipment is specialized in defining the performance capacities of footballers and not only, by recognizing specific characteristics of the athletes, it is possible to correct them and thus improve sports performances. The data taken on such a group of football players are significant to the sport practiced as a professional, and so can be used to develop training methods and techniques for the sportsmen in question. Among those researched, it is discovered that corrective training sessions must be utilized, but it is also possible to specify which directions, positions, and speeds of movement must be avoided or used with caution.

Keywords: *football, balance, HUBER® 360, football injuries*

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REZUMAT. Evaluarea jucătorilor profesioniști de fotbal cu HUBER® 360 pentru evitarea accidentărilor. Acest studiu a investigat comportamentul motor a șase jucători de fotbal cu vârsta cuprinsă între 21 și 25 de ani. Jucătorii au fost examinați cu ajutorul platformei HUBER® 360 și a bateriei de teste funcționale, care conține testul de stabilitate, testul unipodal, testul limită de stabilitate, testul restricțiilor de mobilitate și testul de coordonare a membrelor superioare și inferioare pentru a obține informațiile necesare evitării accidentărilor din timpul practicării sportului. Această cercetare este relevantă pentru jucătorii de fotbal, deoarece accidentările pot avea efecte negative de lungă durată dacă carențele de instabilitate nu sunt detectate la timp. Testarea preliminară cu ajutorul dispozitivului HUBER® 360 specializat în definirea capacităților de performanță ale fotbaliștilor și nu numai, prin recunoașterea caracteristicilor specifice sportivilor, este posibilă corectarea acestora și astfel îmbunătățirea performanțelor sportive. Datele colectate asupra unui astfel de grup de jucători de fotbal au implicații importante pentru acest sport și, prin urmare, pot fi folosite pentru a dezvolta metode și tehnici de antrenament pentru jucătorii implicați. Printre cei cercetați, se constată că trebuie utilizate sesiuni de antrenament care să corecteze și să scadă riscul de accidentări, dar este de asemenea posibil să se precizeze în ce direcții, poziții și ce viteze de mișcare trebuie evitate sau utilizate cu prudență.

Cuvinte cheie: fotbal, echilibru, HUBER® 360, accidentări fotbal

Introduction

Football is one of the most popular sports, with a worldwide estimation of 200 million players' participation (Brophy et al., 2007). Football players pose an inherent risk of injury and are among the highest of all sports, particularly for adult male players (Junge et al., 2009). An injury can result in incomplete recovery, residual symptoms, withdrawal from sports, and the long-term degenerative joint process. In competitions, injuries are an important issue for sports clubs, especially in the situation where several athletes are unable to participate with all their team squad due to acute injuries, thus considerably decreasing the club's chance of success. This entails financial losses that increase with the withdrawal from the competition of one or two key athletes due to injuries (Anandacoomarasamy, 2005; Kissler & Bauer, 2010; Valle et al., 2017). There is consistent evidence in the literature to support the use of injury prevention strategies that include pre-season conditioning as well as balance programs that are continued throughout the playing season (Abernethy & Bleakley, 2007).

Material and method

The group of athletes investigated

The assessment with the help of the HUBER® 360 gadget is used for a group of 6 football players to acquire the essential information and to prevent injuries during the practice of football. They were informed about the investigations that are conducted with the specialized device in order to evaluate and build a recovery program using modern investigative techniques.

Table 1 shows the structure of the football group, which includes the specific elements of each subject analyzed, noting with F1 - F6 the football players who are part of the research group.

Table 1. The structure of the group of footballers under investigation

Subject	Sex	Age	Height [cm]	Weight [kg]
F1	Masculine	22	189	100
F2	Masculine	21	181	72
F3	Masculine	25	186	90
F4	Masculine	25	182	80
F5	Masculine	22	179	68
F6	Masculine	25	180	74

Due to the high incidence of injuries such as ankle sprains, investigations must be conducted using specialized equipment such as the HUBER® 360 to account for any potential disruptions or faults in the execution of movements by football players. Such assessments should be conducted at the start of the competitive season to allow for the detection of football players vulnerabilities utilizing safe and reliable methods. (Fabri et al., 2009; Haxhiu et al., 2015)

Motorized platform with multi-axial action

HUBER® 360 was the instrument used in this research. The HUBER® 360 is a device with an oscillating platform and two handles, as well as force sensors situated beneath the motorized platform and at the handle level (Fig. 1.a). You can view all the data recorded from the patient's evaluation on the tablet on which the software HUBER® 360 (Fig. 1.b) is integrated, you can export the evaluation in PDF format that can be transmitted to the subject, allows personalized configuration of recovery programs and tracking their progress. (Chattanooga, 2015, 2022)



Fig. 1 a. HUBER® 360 platform with a subject to investigate;
b. the tablet of the device with the subject's data

The gadget safely mobilizes joints in all planes of motion, and the feedback obtained on the screen assists the patient in improving strength and coordination of movements, exercising both superficial and deep muscles during this component of the program. Improved stability and self-confidence during movement execution can be accomplished with the help of balance games suited to the patient's physical condition. In the last stage, dynamic workouts are performed to enhance the tolerance to effort, as well as to improve the cardiovascular system and change the BMI. (Chattanooga, 2015, 2022).

Also with use of this platform, we can objectively assess the patient using a series of seven functional tests: Stability Test; Unipodal test; Stability limit test; Mobility restrictions test; Test of the strength of the hind limbs; Upper and lower limb coordination test.

The examination lasts 15 minutes. Three of the seven functional tests are based on the Romberg and Fukuda tests, and they examine balance, stability, and mobility limits, while the other two focus on quantifying force and assessing the subject's coordination abilities. We shall demonstrate the stability test and the mobility restriction test in this paper for the research of a group of football players.

- The stability test is done bipedally timed (inspired by the Romberg test) with both eyes closed and open, and it measures the position of the center of gravity, allowing you to assess your balance.. (Chattanooga, 2015)

- Test for mobility restrictions. This test will identify the patient's mobility limitations and, as a result, the amplitude of the platform on which the patient will be able to work. (Chattanooga, 2015)

Results and discussions

All six tests were completed on the HUBER® 360 gadget by the six athletes who play football as a performance sport. All of them were considered essential for the inquiry, but significant findings were obtained for the tests of stability and balance, thus the tests that emphasize this behavior of the sportsmen will be reported in this paper.

Test of stability with open eyes

Table 2 shows the results of the open-eyed stability test for the group of athletes, together with the evidential values for each researched subject and the related representations in figures 2 to 6. The minimum values are shown in red, while the highest values are highlighted in blue.

Table 2. Centralization of stability measurements with open eyes for footballers

Subject	Stability – length (eyes open) [mm]	Stability – area (eyes open) [mm ²]	Stability – speed (eyes open) [mm/s]
F1	935.08	535.28	18.70
F2	670.72	196.15	13.41
F3	917.19	390.17	18.34
F4	596.35	70.97	11.93
F5	496.83	253.20	9.94
F6	728.77	212.19	14.58

The stability test with eyes open displays the subject's center of gravity on the moving platform of the HUBER® 360. As the test is performed, the favorable attitude of a participant in comparison to the others for one of the recorded values is displayed in the tables for 15 minutes.

The registration data for sportsmen registrations can be found in Table 2 and Figures 2–7. We can deduce the following from them:

- The subject F5 not only has the shortest length of movement of the center of gravity during the 15-minute test, but also has the slowest speed of movement of the center of gravity.
- The subject F4 has the smallest surface in the movement of the subject's center of gravity, as well as the second smallest length and speed of movement of the subject's center of gravity.
- For all three measurements taken, the subjects F2, F3, and F6 show intermediate results.
- The subject F1 has the highest values for the researched parameters of length, area, and speed.

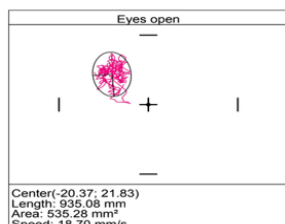


Fig 2. F1 Stability (eyes-open)

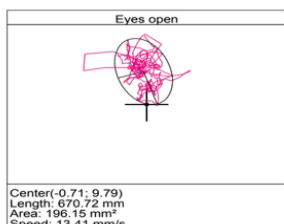


Fig 3. F2 Stability (eyes-open)

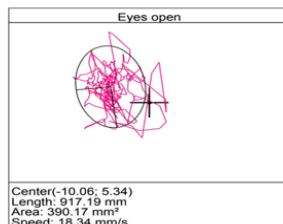


Fig 4. F3 Stability (eyes-open)

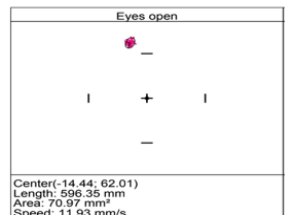


Fig 5. F4 Stability (eyes-open)

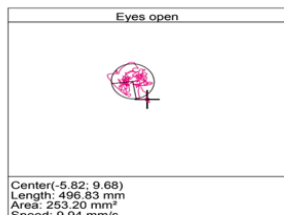


Fig 6. F5 Stability (eyes-open)

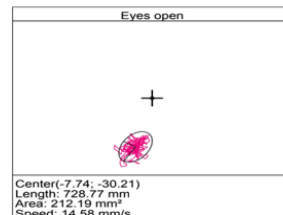


Fig 7. F6 Stability (eyes-open)

Test of stability with closed eyes

The stability test is carried out with the eyes closed, and the findings are displayed in Table 3, with the minimum values in red and the maximum values in blue for each group. The results of the tests are shown in figures 8 to 13 based on the visuals on the tablet.

Table 3. Centralization of stability measurements with closed eyes for footballers

Subject	Stability – length (eyes closed) [mm]	Stability – area (eyes closed) [mm ²]	Stability – speed (eyes closed) [mm/s]
F1	1679.74	1085.41	33.59
F2	1293.82	241.66	25.88
F3	1417.79	417.84	28.36
F4	933.25	324.81	18.66
F5	576.25	292.52	11.52
F6	621.06	195.55	12.42

Table 3 and numbers 8 to 13 from the football players' closed-eyed stability test highlight the following points:

- With his eyes closed, subject F1 displays the maximum values of three sizes observed in the stability test, indicating that this player from the analyzed group has significant instability and requires well-directed training to improve this aspect.

- The subject F5 has the shortest length of movement and the slowest speed of movement of the center of gravity, indicating that his centre of mass is robust.
- The subject F4 has the smallest surface in the movement of the subject's center of gravity, as well as the third smallest length of movement and third lowest speed of movement, indicating that he is stable.
- Subjects F2, F3, and F6 exhibit intermediate levels for all three assessments, indicating that they need to improve their steadiness.

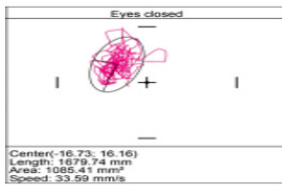


Fig 8. F1 Stability (eyes-closed)

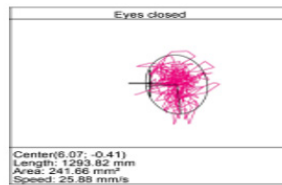


Fig 9. F2 Stability (eyes-closed)

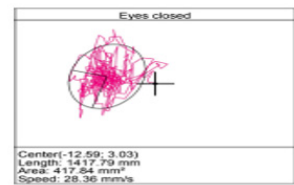


Fig 10. F3 Stability (eyes-closed)

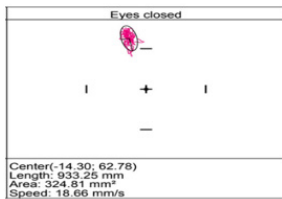


Fig 11. F4 Stability (eyes-closed)



Fig 12. F5 Stability (eyes-closed)

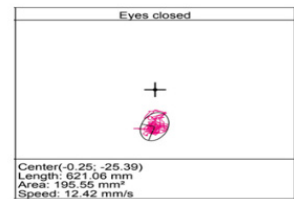


Fig 13. F6 Stability (eyes-closed)

Unipodal Test

The unipodal test is performed on the platform with a single leg, and the length of the distance from the equilibrium state, or the area generated by the center of the weights, is measured for 30 seconds. The measurements are taken with both feet on the platform, and the findings are given in Table 4 with illustrations in Figures 14–19.

Table 4. Unipodal Test – left and right

Subject	Unipodal left length [mm]	Unipodal left area [mm ²]	Unipodal right length [mm]	Unipodal right area [mm ²]
F1	1858.91	1214.99	1291.30	982.95
F2	3211.13	18290.95	3037.24	5489.84
F3	2668.41	707.13	2604.16	1502.60
F4	1899.83	5531.00	1708.12	712.99
F5	1577.26	1931.00	1478.08	2480.49
F6	1688.69	549.90	1716.75	689.84

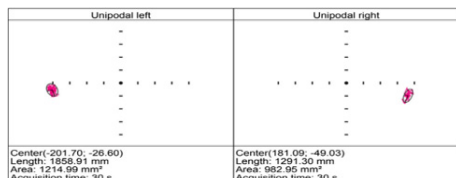


Fig 14. F1 unipodal - left and right

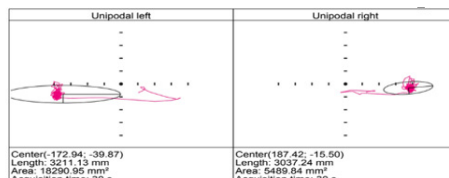


Fig 15. F2 unipodal - left and right

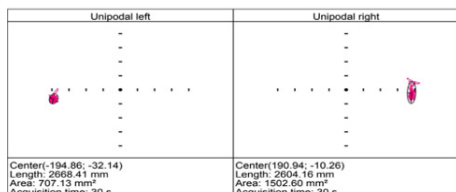


Fig 16. F3 unipodal - left and right

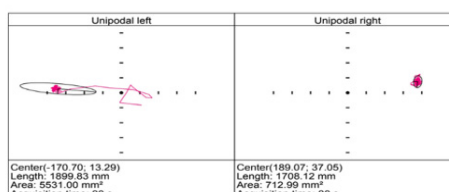


Fig 17. F4 unipodal - left and right

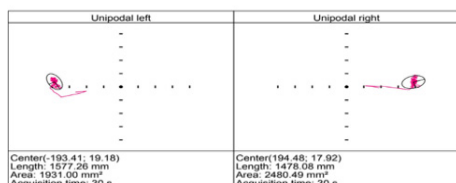


Fig 18. F5 unipodal - left and right

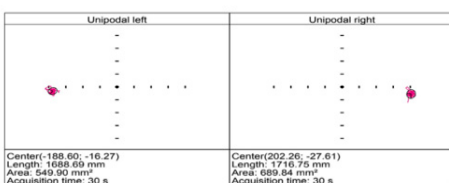


Fig 19. F6 unipodal - left and right

In the unipodal test on the both legs situations given by Table 4 and Figures 14-19, the recommendations are:

- In this test, the F2 football player has the highest values with both legs, therefore it must be cautious with the left leg to avoid injury during the competition.
- F1 shows the lowest value in length on the right foot and intermediate on the left one, so he has good stability on the right leg.
- F5 shows the smallest value in length on the left foot and intermediate values on the others, so he has good stability on the right leg.
- F6 shows the smallest surface in the movement of the center of gravity of the subject on both legs and intermediate values on the others parameters, so he has good stability on both legs.
- F3 and F4 subjects show intermediate values for all measurements made, so it is considered that they need to train more to improve their abilities.

Stability limit test

Table 5 shows the results of the stability limit test for the group of footballers, along with the evidential values for each researched subject and the related representations in pictures 20 to 25. The minimum values are shown in red, while the highest values are highlighted in blue.

Table 5. Centralization of stability limit test for footballers

Subject	Limits of stability 1	Limits of stability 2	Limits of stability 3	Limits of stability 4	Limits of stability 5	Limits of stability 6	Limits of stability 7	Limits of stability 8
F1	139	228	263	277	206	267	273	0
F2	88	149	212	190	167	201	215	156
F3	105	167	237	213	206	246	253	266
F4	136	221	233	174	153	188	257	238
F5	142	212	275	179	136	231	257	199
F6	171	242	288	116	125	111	203	219

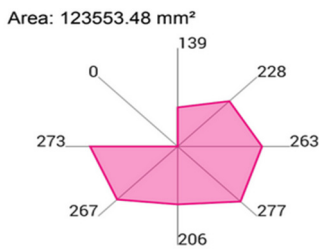


Fig 20. F1 stability limit test

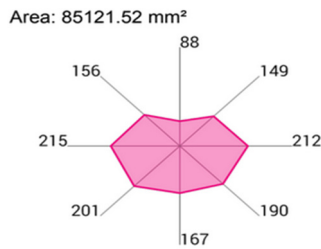


Fig 21. F2 stability limit test

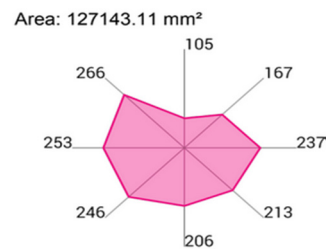


Fig 22. F3 stability limit test

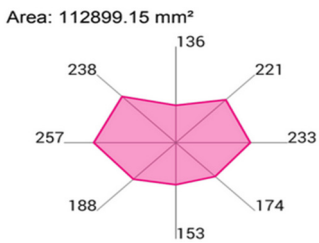


Fig 23. F4 stability limit test

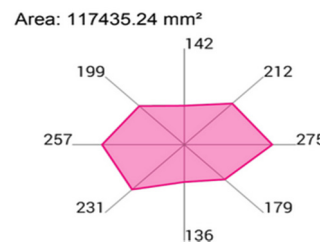


Fig 24. F5 stability limit test

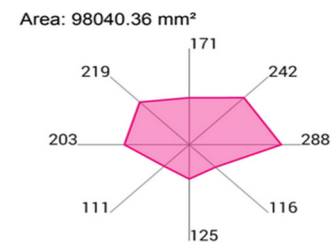


Fig 25. F6 stability limit test

The recordings in the figures corresponding to the stability limit test are made in the front direction – direction 1 – and the sequence is in direct rotation of the clockwise motion, as shown in table 5. As a result of this finding, all components of the footballers group perform as follows:

- F1 footballer has greater stability for the following directions: rear-right, rear, rear-left and left. Regarding the front-left direction, it can be a device error or an athlete distraction. The rest of the results are in the medium range.
- F2 footballer has the smallest values for front, front-right and right directions and medium for the other directions. These values could be due to the reduced mobility of the talocrural joint.
- F3 footballer has good results for rear and left-rear directions. Considering the results for all the athletes in the group, he can improve the stability for front and front-right direction.
- F4 and F5 footballers, compared to the other athletes in the group, have medium results.
- F6 footballer has big differences between the front and rear directions, the results from the front direction being greatest and from the rear being lowest; these values could indicate an imbalance between anterior and posterior calf muscles.

Mobility restriction

The amplitude of the platform's movement is explored according to the indications provided by the gadget specialized in testing the subjects on the platform, for which the subject is able to perform. The platform motion is graded on a scale of one to ten. The smallest amplitude of the platform movement is "1," and the largest amplitude is "10," at which the subject can engage while maintaining his balance or doing particular activities that can be highlighted in eight different directions.

The device recordings for subjects F1–F6 will be provided centrally in table 6, and the results recorded by the device will be presented in figures 26–28 for the footballers group tested with mobility restrictions.

Table 6. Centralization of measurements of restrictions on the mobility

Subject	Mobility restriction 1	Mobility restriction 2	Mobility restriction 3	Mobility restriction 4	Mobility restriction 5	Mobility restriction 6	Mobility restriction 7	Mobility restriction 8
F1	10	10	10	10	10	10	10	10
F2	10	10	10	10	10	10	10	10
F3	10	10	10	10	10	10	10	10
F4	10	10	10	10	10	10	10	10
F5	10	10	10	10	10	10	10	3
F6	3	10	3	10	10	6	0	10

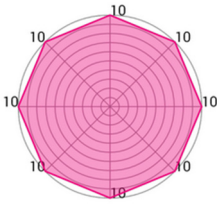


Fig 26. F1,F2,F3,F4
mobility restriction

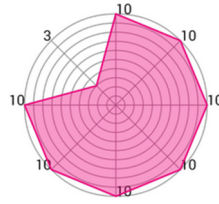


Fig 27. F5
mobility restriction

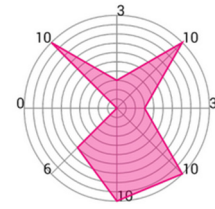


Fig 28. F6
mobility restriction

The status of footballers is relatively straightforward to present based on the analysis of table 6.

- On all eight investigation directions, the subjects F1, F2, F3, and F4 have the best behavior. They act the same way in all eight directions in relation to the support surface, therefore it will not destabilize and will remain stable.
- Subject F5 has one restriction on the front-left direction.
- The subject F6 has 4 restrictions, the most severe in the left direction.

Upper and lower limb coordination test

The subject is positioned on the platform with his hands on the handles, and the footballer must push with the same power on both handles while maintaining his balance on the platform in the upper and lower limb coordination test. Different visuals emerge on the monitor screen, and the person being studied must pay attention to the given commands and carry them out according to the specifications.

This test is particularly crucial for football players because it takes their whole attention in order to react to the opponent's movements and changes of direction - in this case, the screen of the device's display.

This dynamic test was found to be tough for individuals F1, F3, F4, and F6, who were only able to complete the activities for around 30 seconds, achieving level 0 (see figure 29). On the other hand, footballer F5 achieved level 8 and he was able to complete the activities for around 99 seconds, which shows he has the best coordination between lower and upper limbs, on the second place is footballer F2 who managed to complete the activities in around 124 seconds achieving level 6.



Fig 29. F1, F3, F4, and F6 upper and lower limb coordination test



Fig 30. F2 upper and lower limb coordination test

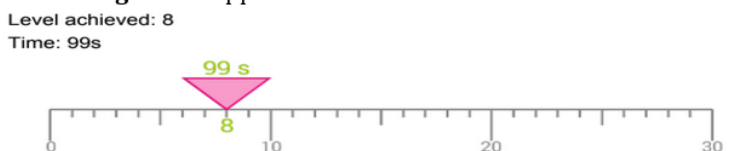


Fig 31. F5 upper and lower limb coordination test

Conclusion

The study describes the results of a preliminary test conducted on six athletes who participate in football as a competitive sport. The testing of performance footballers with the HUBER® 360 platform is particularly important because, by using the device's 6 possible tests, those characteristics of the footballers that make them vulnerable at certain competitive moments and predispose them to accidents, can lead to recovery periods over a long period, or can even take them out of the practice of their favorite sport, which is harmful to both athletes and to the sports clubs they belong.

The premises of the investigation tests of the athletes and the methods of selecting the investigated group are:

- Athletes that participate in competitive football are medically healthy.
- Every subject in this group, from F1 to F6, is fit and healthy and able to play football.
- Each member of the group expresses a desire to participate in performance sports and is eager to enhance his performance.

- Each member of the group agreed to the anticipated testing with the HUBER® 360 equipment to detect their weaknesses and to avert the coming accidents with specific, well-targeted trainings based on the test results.

The following conclusions can be drawn from the tests performed on athletes and described in Chapter 3 of this paper:

- **Stability with open and closed eyes.** There are no significant differences between athletes, but given that subject F5 has the lowest results, it's recommended to improve its performances, especially the speed of execution, to avoid injury in the future.
- **Unipodal Test.** The differences being significant between F2 and the other participants for this study, will be necessary an improvement of unipodal support for F1, F3, F4, F5 and F6.
- **Stability Limit Test.** It could be recommended, for F2 subject, stretching for posterior calf muscles to increase mobility at the ankle joint.
- The **Mobility Restriction Test** shows that the subject F6 has to improve his mobility of the talocrural joint.
- **Coordination Test.** F1, F3, F4 and F6 need dynamic training to increase the coordination between upper and lower limbs. These workouts will help increase the adaptability to unexpected situations during competitions.

The recommendation would be for athletes to practice training that follows spontaneity during matches for improving the personal and team results.

Authors' Contribution

All authors have equally contributed to this study and should be considered as main authors.

REFERENCES

- Abernethy, L., & Bleakley, C. (2007). Strategies to prevent injury in adolescent sport: A systematic review. In *British Journal of Sports Medicine* (Vol. 41, Issue 10). <https://doi.org/10.1136/bjism.2007.035691>
- Anandacoomarasamy, A. (2005). Long term outcomes of inversion ankle injuries * Commentary. *British Journal of Sports Medicine*, 39(3). <https://doi.org/10.1136/bjism.2004.011676>

- Brophy, R.H., Backus, S.I., Pansy, B.S., Lyman, S., & Williams, R.J. (2007). Lower extremity muscle activation and alignment during the soccer instep and side-foot kicks. *Journal of Orthopaedic and Sports Physical Therapy*, 37(5).
<https://doi.org/10.2519/jospt.2007.2255>
- Chattanooga. (2015). *Integrated functional assessment*. [Http://International.Chattgroup.Com/Huber360/Assessment.Php](http://International.Chattgroup.Com/Huber360/Assessment.Php).
<http://international.chattgroup.com/huber360/assessment.php>
- Chattanooga. (2022). *HUBER 360*. <https://Www.Chattanoogarehab.Com/Huber-360-15-0011-Int>.
- Fabri, S., Duc, A., Constantinides, A., Pereira-durif, Y., Marc, T., & Lacaze, F. (2009). Predictives evaluations of the sprain ankle. Fifty-eight cases report. *Journal de Traumatologie Du Sport*, 26(3). <https://doi.org/10.1016/j.jts.2009.06.003>
- Haxhiu, B., Murtezani, A., Zahiti, B., Shalaj, I., & Sllamniku, S. (2015). Risk Factors for Injuries in Professional Football Players. *Folia Medica*, 57(2).
<https://doi.org/10.1515/folmed-2015-0033>
- Junge, A., Engebretsen, L., Mountjoy, M.L., Alonso, J.M., Renström, P.A.F.H., Aubry, M.J., & Dvorak, J. (2009). Sports injuries during the Summer Olympic Games 2008. *American Journal of Sports Medicine*, 37(11).
<https://doi.org/10.1177/0363546509339357>
- Kisser, R., & Bauer, R. (2010). Sport injuries in the European Union. *Injury Prevention*, 16(Supplement 1). <https://doi.org/10.1136/ip.2010.029215.752>
- Valle, X., Alentorn-Geli, E., Tol, J.L., Hamilton, B., Garrett, W.E., Pruna, R., Til, L., Gutierrez, J.A., Alomar, X., Balius, R., Malliaropoulos, N., Monllau, J.C., Whiteley, R., Witvrouw, E., Samuelsson, K., & Rodas, G. (2017). Muscle Injuries in Sports: A New Evidence-Informed and Expert Consensus-Based Classification with Clinical Application. *Sports Medicine*, 47(7). <https://doi.org/10.1007/s40279-016-0647-1>

THE BIG INTERNATIONAL FENCING COMPETITION AT THE YEAR OF THE FIRST OLYMPIC GAMES

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*Received 2022 March 1th; Revised 2022 March 09; Accepted 2022 April 10;
Available online 2022 May 5; Available print 2022 May 30.*

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ABSTRACT. Due to the proximity of the dates, in 1896 fencers had to make a choice, where to go to compete, at this time an amateur Olympics event or for grand prize at World Expo in Budapest. The best fencers had chosen the second opportunity. According to Carpathian experts, the Keresztessy fencing system was the best in the whole world, so the audience couldn't wait to be successful on the competition. This was the first time when the Carpathian and Italian fencing styles were compared. The belief in the invulnerability of Carpathian athletes was shattered when no one of them came to the top of the podium as a result of the competition. At the first major international competition Carpathian fencers were forced to their knees.

Keywords: *Keresztessy, Italo Santelli, fencing styles, Millenial contest*

Introduction

One month later at the end of the first Olympic games, the largest international fencing competition of the year was held in the Carpathian. The best fencers of the age preferred to choose the competition in the Carpathian, which featured valuable prizes, then the 'nameless' Olympic Games. This also shows well the difficult situation of the Olympic Games in the initial time.

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Even then, fencing was one of the oldest sports activities, with a long tradition throughout the Carpathian Basin. For centuries, it has been an important part of combat military activity and preparation, and then in the 19th century, duel-based fencing also appeared in the Carpathian Basin, which can be considered a forerunner of the sport of fencing.

The first fencing masters came from abroad. The first public fencing school was opened by master Biassini in 1824 in Cluj-Napoca. Only then did the National Fencing Institute open in Pest in 1825, headed by elder Fridrich. Biassini, Ignacz Clair, Ferenc Fridrich, Lui Chappon, Nándor Martinengo created the unstructured system of fencing schools in the Carpathian Basin, and thanks to them and their students, duel-fencing started to be popular across the Carpathian Basin. During the 19th century clubs opened in a row, and a Carpathian style appeared. József Keresztessy has been a fencing assistant since the age of 13, he studied from almost the every Carpathian master, and he created his own style which became dominant in the Carpathian by the end of the 19th century. This style matched white the Italian style, which presented by fencing masters of Scula Magistrale.

Experts at the time believed that the Carpathian Keresztessy style was the most effective in swordsmanship, so organizers had made the largest international fencing competition of the year the millennium events (1896) at the time, with they wanted to prove their leadership in swordsmanship. In fact, it was the first international sports competition for Carpathian Basin competitors, which concluded with important lessons and triggered a change in the Carpathian Basin fencing society, which resulted in the creation of a new style that later became dominant in international fencing life.

Materials and Methods

The research examined and compared the speciality of the dominant fencing style of the age. The research performed a descriptive and an exploratory study to analyze the historical events highlighted the 1896 international fencing competition by the contemporary press.

As you explore the history of 19th-century sport and culture, you must find all the clues that indirectly give you an insight into the past and the sporting events of that time. When working on this topic, the research will focus primarily on exploring the history of sports through the following methods:

Archial research is the most difficult part of the job since accessing the matrial preserved in the Hungarian State Archives is rather difficult because the decisions of the Ministry of the Interior were destroyed in 1956.

Searching for museum collections attempts to replace the data of all regulations, decisions, official reports that have been destroyed in archival materials or which are impossible to search. By locating and mapping the documents in the library of the Physical Education and Sports Museum in Budapest, we can get an authentic picture of everything that happened during the research period. The exhibited material contains rich treasures of sports history, unfortunately these memories are also scattered, as these memories and values are usually part of separate exhibition materials. The material of the Hungarian Museum of Physical Education and Sport is the starting point of my research, because fortunately there is a lot of material about the 19th century sports life.

Lexicons, encyclopedias are collections of information that can be general, comprehensive, or thematic. Although they do not provide detailed information, headings and brief explanations are important points in the research.

Sport-related monographs, as well as sports memos and diaries, usually contain a lot of important information, but their most important feature is subjectivism, so this analysis requires duplication of work, to verify the authenticity of the information.

Since the 1800s, contemporary newspapers have published columns on the most important aspects of social life, including information on sporting events. The 1896 Millennium is a series of events well documented by the newspapers.

There is a strong correlation between sport and its determinants, often a biography hides information that is relevant to the history of sport: We know from the life of Gaetano Biassini that he had working as a fencing teacher in Cluj-Napoca for 6 years, when his fencing school was opened in 1924.

The modern trend in historiography is the introduction of age through biography. The period under investigation is decisive for the work of several prominent personalities. For example, József Keresztessy is the epitome of 19th-century Carpathian fencing.

Result

The Keresztessy Style

In Middle Europe, the contemporary famous fencing styles were present in sports life thanks to the foreign masters' appearance (Friedrich, Chapon, Barbesetti, Clair). Keresztessy created his own style by summarizing and simplifying these styles; that we can call Keresztessy style. His fencing essentially was the one that Friedrich's fought and Chapon described in his comprehensive

work. This wrist-fencing that was extended by the French and was accepted by the Germans – in contrary to the Italian, later trendy fencing that used lower arm movements – was really complicated. Keresztessy simplified it, poured Hungarian soul into it. This fencing style, soaked by the personality of Keresztessy, was called the Hungarian fencing, then in the following generation it still existed, but later it stayed as a nice memory (Siklóssy, 1928).

The Keresztessy's fencing was built on active defence at that time (defence and quick retort). It took the dynamism needed for the retort from the wrist, waited for the attack motionless, typically in fencing base-standing. Stepping back was considered cowardice, which did not fit into the knight's mentality. 'It seems like that by our nature, we do not sympathies nor with the French, neither the Italian retrograding, circling, squatting or side-jumping defensive and attacking fencing style. We barely step back even in the dagger fencing, indeed, we see virtue in not giving up the standing. In the sword fencing, we just need a huge attack to make us leave our position.' (Porzso, 1887) It meant that they tried to defend every attack by the sword with the least amount of movements; this is how using the wrist to move the sword and a high level of defence could be developed. 'The Hungarian fencers defend everything and perform art during conscious, hedged, quick retors.' (Vészi, 1896a) According to Keresztessy 'the legs fence as the hands do', he emphasized strongly the leg. His school was characterised by simplicity and clearness. (Szabó, 2017) József Keresztessy had died in 1895. The style that he created influences the Carpathian fencers' styles in these decades.

His son, Sándor Keresztessy continued his work and had been a teacher since 1869. First in the National Gymnastics Club, later he was a master at the Ludovika, in the years of 1890 he had his own fencing room. He was a member of the jury at the huge international competitions in 1895-1896, when he was already older than 50.

One of his favourite students was Lajos Vay, who took the József Keresztessy-room and the guard. His pupils also participated in the outstanding fencing contests in 1895 and 1896. He is considered as the heritor of the Keresztessy-system. (Gáspár, 1908)

József Keresztessy gave fencing master certification only to three masters in his life. Besides the two mentioned above, Mihály Bély was the last one whose certificate was signed by Keresztessy. As a real all-around sportsman, he did many sports, among them skiing, high jump, football, etc. He also took part in the Millennial Competition in the master category. These three men can be seen as the successors of Keresztessy.

Italian style

After 1868 a new Italian fencing style was formed, which Keresztessy could not meet. Then Giuseppe Radaelli became the head of the Military Cavalry Fencing School in Milan, and he created his school the Scuola Magistrale. As a consequence of united Italy (1870) the school moved to Rome. The masters from this school spread his technique all around Europe. "His appearance meant revolution when he made extraordinary changes in sword fencing as he made the elbow to the cornerstone of control. Before that, people fought with stiff arms, but by this, fencing became easier and more secure (Soproni, 1975). The essence of his school was that the newly-developed light sword was controlled not from the wrist, but from the elbow as the blade is the continuation of the arm; this gave bigger space to the leg-techniques. (Nagy, 1907) In his style, the first defense line in attacks and protection was the leg; during attacks, the leg 'jumps' towards, while when it defences it 'jumps' back. One of the weapons of this fencing was the swiftness, the leg movements were quick and diversified (Adorján, 1896).

In contrary to the Keresztessy style, Italians liked to stab with the curved-blend swords. Instead of stiff standing, the quick legwork made diversity possible for the Italian fencers. As a result of their flexible, fast and multifarious movements they performed attacker, almost aggressive fencing. "They could attack with marvellous braveness and strength, and the opponent is lost who could be attacked by them. But they do not have a defensive system at all; or if they do, it is just because their strong muscles in their legs so they can jump back from cuts and stabs efficiently" (Vészi, 1896a).

Due to its spectacularity and effectiveness, it could spread all over Italy; furthermore, it conquered the whole world. As part of the new, modern sports movement, there started to be international competitions more often to allow the Italian masters and amateurs to prove their system's superiority. They took part in numerous contests (fencing academies, competitions with a prize, etc.), and following them the most successful Italian fencers got invitations, job offers to the sports clubs, schools. Italian masters started to work in many cities: In Vienna: Barbasetti, Della Santa, Franceschini, in Prague: Santelli Horatia, in Trieste: Tagliapietra, in Paris: Conte, in Berlin: Schiavonni, in Frankfurt: Gazzera, in Mainz: Tagliabo, in Hamburg: Galante, in Buenos Ayres: Pini, also in London there was one, in Philadelphia there were two, in New York there were three Italian masters. In the area of the Kingdom of Hungary there was Santelli, Toricelli, Gennari in Budapest, Armentani in Szeged, Majone in Kosice, Piacenti in Targu Mures, Biase Erncesto started to teach in Fiume (Nagy, 1907).

“Although the list above seems to be an army of virtuous Italian masters and teachers, Italy fully provided with many great masters. . . The development and the fame of Italian fencing are exactly caused by the huge number of its fencers. In every city and village, there is at least one good master and 10-15 excellent fencers. They consider it a shame if someone cannot fence. Being a first-class fencer is a big honour. But duels are rare so the fencing-fever has nothing to do with this barbarous tradition. They fight for art and their nation’s glory. The result is: To conquer the world” (Nagy, 1907).

The International Fencing Competition four weeks later than the first Olympic Games

In 1896, Millennium events were held around the Carpathian Basin. The center of the events included the exhibition and programs in Budapest.

The Exhibition hosted many sports competitions and congresses. There was chess, shooting contest, regatta on the Danube, athletics competition, gymnastics ceremony, cycling and international fencing races too (Kőváry, 1897).

These international competitions can be seen as the age’s world championship because at that time there were no international associations leading the sports life. The Olympic Movement had also started this time, and the first Modern Olympic Games were held between 6-15 April 1896; where the Carpathian and the Italian fencers did not participate because the date of the Budapest Contest was too close and they had to decide which one to take part on. It describes the struggles of the Olympic Games well, that the best fencers chose the Millennial Contest instead of the Olympics in Athen.

Antecedents of the Millennial Fencing Competition

According to the contemporary view ‘our weapon is the sword’ (Halász, 1896a), so in fencing, the organisers wanted to prove the superiority of the Hungarian sword. It is proved, that the contemporary writings bond together the importance of the sword and the fate: ‘Our ancients got our homeland by weapons, their descendants were able to keep it by weapons and to bloom it with peace.’ (Füzesséry, 1896f) The dagger fencing was not really important for the organisers mentality at that time, it was traditionally considered French.

The Italian fencing’s fame was spreading, they also got invited besides the French fencers to the Millennial Events in 1896.

From the Carpathian side, there was a serious preparation for the Millennial Competition.

The Hungarian Athletic Club organised the I. National Fencing Competition in 1895, where they could estimate the number of the fencers and their potential. Already in this event, the deficiency of the Carpathian fencing appeared. The students of the Keresztessy School met with fencers who used Italian style: Ámon Gregurics, Baron Jenő Bothmer. Gregurics won the masters' sword fencing, while he won the second place in dagger fencing; Zsiga Halász won it who was the student of Keresztessy. Jenő Bothmer did not participate with the masters, but he won against Zsiga Halász so he deserved the gold medal from Budapest (Balogh, 1895).

Gregurics and Bothmer started to learn the Italian style from Luigi Barbasetti in a Military Fencing School in Vienna. Barbasetti came from the Scuola Magistale, Rome in 1894 to Vienna and started his teaching activity. He was the outstanding figure of the International Competition in Prague in 1895, after that, the leading of the Vienna fencing life got into his hands. (Nick, no date)

In 1895 the backwardness of the Keresztessy-school was still not obvious. Zsiga Halász won the masters' dagger fencing without getting any stabs. His pupil, Gyula Iványi won the amateur's competition, the national gold medal and the Silver Cup from the Secretary of Defense. In their success it may have contributed that they had met with the Italian style before, they already knew it a bit. Zsiga Halász was fencing with local masters while he was in Genova, but in the last two decades he was the follower only of the Keresztessy-school. Iványi was fighting against Italians during his fencing-study tour in 1894, for example against Rossi, the pupil of Radelli, and against Giroladini who was widely liked before 1896.

Károly Fodor was also the representative of the international fencing in Hungary. He started to learn from Clair, then Sztrákay and Zsiga Halász were also his masters. In 1887 he looked for Austrian and German fencing masters. In 1888 he ended up with Italian and Swiss masters. His students also participated in the Millennial Contest.

Besides organising competitions, they sent the best fencers to international challenges to collect information about the opponents.

Thus there were Budapest-Vienna fencing matches already in 1895, also directly before the Millennial competition on 28th March in the Fencing Academy in Vienna, where the best fencers of the sport attended and they fought mostly with the military fencing school's followers (Barbasetti school). (Halász, 1896c) This is how Oszkár Fery, Ervin Mészáros, Gyula Kerékgyártó from the HAC, the Gáspár brothers from Lord Arlow's school, Alajos Bay from the Fodor-Rákossy school could travel abroad; Bódog Balogh, Zsiga Halász and Gyula Iványi also participated in the academy (Füzesséry, 1896a).

Also, the HAC invited Barbasetti to Budapest at the beginning of 1896. He was fighting with his opponents one by one successively. With dagger he fought with Kerékgyártó, Kálmán Lakner, Lord Arlow master, using sword he fought with Oszkár Fery, Bódog Balofg and with Iványi. Iványi succeeded to do three cuts on the arms to prove the high level of the Kersztessy fencing school. But he achieved apparent superiority against a tired opponent (Füzesséry, 1896e). Zsiga Halász could not take part in the meeting due to his illness.

It is well illustrated that the most successful fencers participated in many competitions at that time already and tried to earn foreign experiences. By their previous experiences, they had seen the greatness of the Italian style, but they did not recognise the deficiency of their old style. As Halász wrote about the 1896 competition: 'As we can see, the followers of the Italian style prove the most conspicuously that a lot of running does not make sense, because if they are willing to fight for two hits with relatively little moves for a horribly long time and they do not touch each other during this; the leg-work is very incomprehensible because it is just a waste of energy and it tires the lungs.' (Halász, 1896b) For this reason, the Carpathian fencers used the older, Keresztessy school in the Millennial competition.

It is typical of the belief in the supremacy of the Carpathian school that Lajos Vay (the trainer of the Keresztessy Guard) only asked the foreign opponents for friendly practicing just at the last moment before the competition; he only noticed then the greatness of the opponent's knowledge.

The Millennial International Fencing Contest

The Millennial International Fencing Contest was opened on 13 May 1896, the matches were between 14-20 and there was a fencing academy on the 20th of May. From the 140 participants, 232 application arrived in the master and the amateur categories in sword and dagger fencing. Although the opening ceremony was in the Casino of the HAC, the competition was held in the area of the Exhibition in the Hall of Feasts. (Füzesséry, 1896f) The participants were divided into masters and amateurs.

Among the competitors were all the Carpathian fencers who could be considered, who had already proved their suitability. So among the 85 amateurs were Menotti Réthy, Gyula Iványi, Ervin Mészáros; among the masters: Ámon Gregurich, Lajos Vay, Lord Gusztáv Arlow, Károly Chappon, Zsiga Halász, Mihály Bély and Jenő Bothmer. The Austrian, Czech, Polish, Moravian, Spanish delegates represented their countries (Rákosi, 1896), there was the world-famous French dagger-fencer master, the left-handed Lucien Merignac, and three outstanding amateur and the three most excellent masters Italo Santelli, Giuseppe Nadi and

Angelo Torricelli fought for Italy's glory (Füzesséry, 1896f). Miklós Horthy, a naval officer (a student of Toricelli) came from Pola to the contest. He participated very well as an amateur in dagger-fencing. (He was later the Governor of Hungary (1920-1944) (Ottlik, 1934).

According to the rules of the fight, the results were judged by the jury. A clean hit scored 1 point (touché). Four hits meant winning. During sword fencing, it was allowed to stab under the headline until the line of the waist. They had to stop after every hit. (Füzesséry, 1896d) The jury of the competition consisted Carpathian and Italian masters as well. The jury's president was Ferenc Kiss Kisbaári, who was helped by others, from the Carpathian side: Sándor Keresztessy, from the Italian side Commendator Gelli and Barbasetti Luigi (Füzesséry, 1896c).

The competition started with classification according to the order used at that time (during the classification they did not count the given and gotten scores, only the beauty of the movements was observed), from where only the best could go to the next round, which had already been counted in a straight knockout system (until four hits).

After the four days long competition the jury announced who was awarded 1st to 2nd and 3rd class. Among the amateurs, Gyula Iványi, Ervin Mészáros, Oszkár Fery, Jenő Metzler and Kornél Gáspár received gold, among foreigners Bordi Emilio, Florencz; Calabresi Eduardo, Milan; Geccertni Santi, Florenz; Galli Francesco, Florenz; Ottó Gellinek, Premzyl; Gusztáv Kuchta, Vienna-Újhely; Oszkár Mayer, Vienna-Újhely; Minas Alberto, Trieste; Müller Camillo, Vienna; Pál Orbán, Vienna-Újhely; Piacenti Marco, Florenz; Baron Ferenc Pongrácz, Vienna-Újhely; Raus Frigyes, Lemberg; Baron Frigyes Reichlin-Meldégg, Vienna-Újhely; József Schlechta, Vienna-Újhely; György Szarvassy, Vienna-Újhely; knight John Trankwelli Umlauf, Vienna-Újhely; noble Béla Zulawski, Vienna-Újhely (Porzsolt, 1896). All of the masters received the first-class status, so they all took part in the straight-knockout phase.

"Two fencing modes faced each other in the race, the more serious, strong-cut, stiff warlike-fencing with the heavier weapon and "the more agile, rhapsodic, more prick and pinch Italian mode' with a lighter weapon 'in which the flexible and elastic feet also have an important role to play, and the fencers also seem to accompany their cuts with heated exclamations" (Rákosi, 1896).

First, there was the amateur sword-fencing competition featuring 24 first-class and 44 second-class fencers, "which was run with great discomposure. . . the atmosphere became lively and excited". The strongly patriotic audience was very disappointed by the fact that the best of their forces were successively defeated by the Italians in their unusual but undeniably successful fencing. "By the third round, it was obvious that the foreigners would win because Galli was

the only Italian who lost and from the best Hungarians only Fery, Iványi and Pórtreleky stayed in. . . ' During the third round Iványi defeated Pórtreleky, Piacenti won against Fery. 'By the fourth round the two best Italians, Ceccherini and Piacenti met and Ceccherini went towards from them to the best four with Müller Dr. , Iványi and Ceni Cino. Finally, the best Hungarian and the best Italian fencer, Ceccherini stayed in the fight for the first place. The excitement reached its peak; the Italian attacked with lightning speed and Iványi's pre-cuts failed against them. The Italian cuts, due to their light, flexible sword, fell several times flat (invalid cutting surface), which avoided the jury's attention. After several clashes, they stood like this: Ceccherini got one hit, Iványi got three (so the Italian fencer led). Baranyi representative, member of the jury tried to draw the jury's attention to the articles of the competition rules concerning flat cuts and asked for their application, which the jury acknowledged too late. Other fierce clashes led again to hits on both sides. Finally, the jury warned Ceccherini who did not think about defending, and in the next attack he waited for Iványi's offensive, a side cut; the cut bounced off the defence and hit Ceccherini's side, who attacked back with a head cut. The debate broke out again, with some saying that the Italian had got the cut earlier, so his head cut was too late, while the others thought that Ceccherini had cut back after a clear defence. The mood was so excited that the president of the jury put an end to the fight for that day, also because of the overrunning time. After the audience had left, the jury decided that Ceccherini was the winner. On the following day, Müller Dr. won the third, Ceni Cino the fourth place" (Füzesséry, 1896b).

The first cold shower was followed by the masters' competition. There the followers of the Keresztessy school: Vay, Bély, Halász already fall out in the first round, but to tell the truth, their opponents knew the Italian fencing as Bothmer and Gregurics. At the second round, Lord Arlow loses against the Italian Nadi, but during the match, a heated debate ensued following a hit by Nadi. Barbasettin and Nadi both left the piste and after the jury's decision, they could follow the fencing in the afternoon with cool heads. (Vészi, 1896b) Already in the second round, Italo Santelli appears with his chivalry manners and acts, who always said if he got hit. In the third round, he defeated Nadi Guisuppe, who was considered as a possible winner among the masters. Thus Jenő Bothmer, Ámon Gregurics and Santelli went to the final and Santellini 'after an interesting match won against Gregurics quickly. But it was more difficult against Baron Jenő Bothmer. The Lieutenant with Hercules's strength defended with astonishing perseverance, and Italo was barely able to access it. The match was as heated and strong, that they had to have a break after every hit. Bothmer got the first cut, but in the next round Italo. . . then Bothmer again. . . in the fourth one Italo. . . then Bothmer. . . and again Italo got hit by the sword. The audience

and the jury breathlessly waited for the final hit. . . Bothmer was about to hit and lifted his arm when Italo Santelli suddenly stretched out his arm and won with a beautiful breast stab. '(Vészi, 1896b) 'Italo Santelli won as he wanted' (Füzesséry, 1896b), and with this, he made it obvious that the Italian fencing style, the lighter sword, the sports-like fencing is superior in contrary to the war-like Keresztessy style. This also brought a decisive turn in the history of universal fencing.

After these, the amateur competitions took place where the disappointment and despondency were felt on the Carpathian fencers. There was no Carpathian among the best fours at all. In the amateur category, the Italians won all the places: Piacenti Marco (Florence) won, Ceni Cino (Florence) was the second, the third was Minas Alberto (Trieste) and Galli Francesco (Florence) was the fourth.

The last was the masters' dagger contest, where the "amazing' Lucien Merignac won. 'He faced with excellent opponents but did not get any hits; however, he stabbed his opponent every time with such security and ease that he won the undivided admiration of the audience. Indeed, he was far above the other fencers. Merignac was a tall, thin man; also left-handed which contributed his superiority a lot' (Füzesséry, 1896b).

Discussion

After the Millennial Contest

The Carpathian fencers forced to their knees. The Keresztessy fencing system, which until then was considered perfect, lost against the Italian one.

But the best masters did not accept their subordinate position, and therefore they learnt the – proven – more efficient fencing. For this purpose, the Hungarian Athletic Club first hired the best Italian, the winner Italo Santelli as their trainer. They invited many Italians to the Carpatian, whose education fell on fertile soil. Consequently, masters - besides Santellini - arrived: Torcelli, Gennari, Armentani to Szeged, Majone to Kosice, Piacenti to Targu Mures, Biase Ernesto to Fiume. (Nagy, 1907)

The conscientious work had started, whereupon the Carpathian active, defender, 'pre-cut' technique set blends into the Italian system. This is how the new style was born, which 12 years after the Millennial Contest introduced itself at the Olympics; where five out of the best six fencers were Carpathian. (*Fechtschule in 16th-century Germany: Excerpt from the secret history of the sword*, 2010) Carpathian fencers won not only individually, but they defeated the Italians in team too.

In addition to the talent of Carpathian athletes, masters who were not born in Carpathian contributed to this success, they created here, in this atmosphere a sports culture that became determinative in national and international sports life.

Conclusion

The period between 1896 and 1908 illustrate well that in a sport the creation of a new atmosphere, a new culture, over a generation, but still able to change the position and the role of the nation's athletes in the world. Such was Italo Santelli and the Italian masters, who brought a new movement culture into the life of the Carpathian fencing. Such was the community of the Charpathian fencers, who were able to learn from their defects and provided an environment for Carpathian sport to change and develop.

REFERENCES

- Adorján, S. (1896). A világ folyása. *Ország-Világ*, 17(41), 651.
- Balogh, H. (1895). Vívás, box. *Sport-Világ*, 2(16), 5–6. *Fechtschule in 16th-century Germany: Excerpt from the secret history of the sword* 2010. Retrieved 15 December 2019 from :
<https://fechtschule.wordpress.com/2010/03/13/fechtschule-secret-history/>
- Füzesséry, Á. (1896a). A millenáris vívó-verseny. *Sport-Világ*, 3(12), 9.
- Füzesséry, Á. (1896b). A milleniumi nemzetközi vívóverseny. *Sport-Világ*, 3(21), 5–6.
- Füzesséry, Á. (1896c). A milleniumi nemzetközi vívóverseny - első nap. *Sport-Világ*, 3(20), 4–5.
- Füzesséry, Á. (1896d). Az ezredéves országos kiállítás alkalmával 1896. évi május hó Budapeseten rendezendő nemzetközi vívóverseny szabályzata, *Sport-Világ*, 3(8), 5.
- Füzesséry, Á (1896e). Barbasetti a M. A. C. -ban, *Sport-Világ*, 3(2), 4.
- Füzesséry, Á (1896f). Millenium - A millenáris nemzetközi vívóverseny, *Sport-Világ*, 3(19), 5.
- Gáspár, K (1908). Gróf Vay Lajos, *Nemzeti Sport*, 6(35), 3.
- Halász, Z (1896a). A bécsi-magyar vívóversenyéről, *Sport-Világ*, 3(15), 12.
- Halász, Z (1896b). A bécsi-magyar vívóversenyéről, *Sport-Világ*, 3(18), 6–7.
- Halász, Z (1896c). A bécsi osztrák-magyar vívómérkőzés, *Sport-Világ*, 3(14), 11.
- Kőváry, L (1897). *A millenium lefolyásának története és a millenáris emlékéalkotások*. Atheneumr. Budapest.
- Nagy, B. (1907). A nagyvilág vívóművészete, *Nemzeti Sport*, 5(1), 3–4.

Nick, F. (n. d.). *Luigi Barbasetti*. Available at:

<https://www.britannica.com/biography/Luigi-Barbasetti>.

Ottlik, G. (1934). A sportember, *Budapesti Hírlap*, 54(258), 3.

Porzsolt, J. (1887). Kitérés a törvívásban, *Herkules*, 4(16), 5–6.

Porzsolt, K. (1896). Sport - nemzetközi vívóverseny. Az ítélet, *Fővárosi Lapok*, (138), 8.

Rákosi, J. (1896). Nemzetközi vívóverseny, *Budapesti Hírlap*, 16(134), 4.

Siklóssy, L. (1928) . *A magyar sport ezer éve*. Stephaneum. Budapest.

Soproni, J. (1975). A vívásról, *Képes Sport*, 22(25), 18.

Szabó, G. (2017). Úri lelkét beléöntötte, *Nemzeti Sport*, 115(29), 2.

Vészi, J. (1896a). A nemzetközi vívóverseny - a nagy akadémia, *Pesti Napló*, 47(140), 8–9.

Vészi, J. (1896b). Mesterek kardversenye - A nemzetközi vívóversenyek ötödik napja, *Pesti Napló*, 47(138), 4.