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QUALITY OF LIFE OF PATIENTS WITH SEVERE KNEE OSTEOARTHRITIS IN HUNGARY: CROSS-SECTIONAL STUDY

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ABSTRACT. Introduction: Knee osteoarthritis (OA) is a chronic musculoskeletal disease that is associated with mortality, disability, and low quality of life. In Hungary, the number of patients diagnosed with severe knee osteoarthritis is dramatically increasing yearly. **Objective**: This study aims to assess the quality of life among patients with severe knee osteoarthritis who undergo knee replacement surgery after one month to assess their quality of life (QoL). **Material and Method**: Ten patients (6 female, 4 male, 70±4 years, 30.7±3.4 kg/m^2) with severe knee osteoarthritis were included from an orthopedic clinic in Pécs, Hungary. The SF-36 questionnaire (Hungarian version) was used to assess QoL of the patients one month prior to knee replacement surgery. **Results**: The participants with severe knee OA reported allow overall average of pain (40.95%), role limitations due to physical health (42.5%), and role limitations due to emotional problems (46.7%) that reduced their QoL. In addition, there are significant differences between women and men in some domains. Women had significantly lower physical functioning and role limitations due to emotional problems than men, by 42.8% (p=0.03) and 73.3% (P=0.005),

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respectively. Moreover, women had a higher feeling of pain than men; however, the differences was insignificant. **Conclusions**: Patients with severe knee osteoarthritis have low quality of life and severe pain during daily activities. Furthermore, women with severe knee OA had significantly higher pain and lower quality of life than men due to their emotional status. Further studies with large sample sizes are needed.

Keywords: *knee osteoarthritis, pain, quality of life, function.*

Introduction

Knee osteoarthritis (OA) is a very common chronic degenerative musculoskeletal disease (Felson et al., 2000; Midgley, 2021). The incidence of knee OA is increasing with age, obesity, occupation, gender (women are more affected than men) (Cui et al., 2020; Felson, 2006; Felson, Anderson, Naimark, Walker, & Meenan, 1988; Felson et al., 2000).Knee OAis characterized by cartilage breakdown, osteophyte formation, and joint space loss. Therefore, it increases the risk of knee pain, low quality of life (QoL), disability, and mortality (Felson, 2006; Felson et al., 2000). It has been found that 80% of patients with knee OA had movement limitation, and 25% of them were unable to achieve their daily life activities that negatively impacted their psychological status (Mahir et al., 2016).

It has been reported that the global prevalence of knee OA was 22.4% among the40 and over age group, while the global incidence of knee OA was 203 per 10,000 person-years among the 20 and over age group in 2020 (Cui et al., 2020). The prevalence and incidence were significantly higher among females than males (1.69 vs. 1.39, $p<0.001$, respectively) (Cui et al., 2020). In 2010, 185 of the examined knees in the southwestern part of Hungary had Kellgren-Lawrence ≥ 2(16.54%), and 20 of the examined knees had Kellgren-Lawrence ≥ 3 (2.9%) (Horváth et al., 2011). Another study found that the prevalence of knee OA in Hungary was 13.3% in 2010,where 2.9% of them had severe knee OA (Horváth et al., 2010).

Patients with severe knee OA have severe clinical and/or radiological symptoms, such as severe pain during activities and rest, depression, low activity level, low quality of life, stiffness, gait deformities, large osteophytes, joint enlargement, and joint space narrowing (Berger, Kean, Goela, & Doherty, 2012; Felson, 2006; Felson et al., 2000; Hall et al., 2017; Midgley, 2021; Rathbun, Yau, Shardell, Stuart, & Hochberg, 2017). For severe knee OA, knee replacement surgery is the optimal treatment to reduce pain and enhance the

quality of life (Biggs, Whatling, Wilson, Metcalfe, & Holt, 2019; Dieppe, Lim, & Lohmander, 2011; Escobar et al., 2017; Ferket et al., 2017; Nunez et al., 2009). In Hungary, the quality of life of patients with severe knee OA was not sufficiently investigated. One conference paper reported the quality of life (QoL) among Hungarian patients with severe knee OA before knee replacement surgery using four different questionnaires, including a homemade questionnaire, the Knee Society Score (KSS), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and the short form (SF-36) (Busa et al., 2019). However, the number of participants was not mentioned, and the reported results and methods were not well presented as it was a conference paper. As a result, insufficient data are available about the activity level of Hungarian patients with severe knee OA. Therefore, more information is required in this field to have clear information about their QoL, to identify the most challenging activities for patients with severe knee OA, and to identify if there are differences in QoL cross women and men.

Objectives

This cross-sectional study aimed to report QoL of patients with severe knee OA who undergoing knee replacement surgery after one month. Also, this study aimed to evaluate the gender differences in term of QoL. The results of this study could be important to therapist who work with patients with severe knee OA.

Materials and Methods

This is a cross-sectional study and part of a case serials study that was conducted between 2020 and 2021. The included participants had to continue the main study with one-year follow-up.

Participants

Ten-participants (four males, six females) on the waiting list for knee replacement surgery were included in this study, with an average age of 70±4 years and an average body mass index of 30.7±3.4 kg/m^2 (Table 1).

Table 1. Demographic data of the participants.

Domains	**Total N=10**
Age (year)	70.6 ±4.0
Body mass index (kg/m²)	30.7±3.4
Knee OA duration	More than four years
Using walking assistance	3 (1 male, 2 females)
Blood pressure	8 (2 males, 6 females)
Diabetes	3 (females)
Smoking	None
Employment	2 (1 male, 1female)
Marital-status	5 Married (3 males, 2 females) 5 Non-married (2 Divorced, 3 Widow)

The participants were recruited from the Department of Orthopedics (Clinical Center, University of Pécs, Hungary). The inclusion criteria were the presence of radiological and clinical symptoms of knee osteoarthritis, the Kellgren-Lawrence (K-L) scale ≥ 3 (Kohn, Sassoon, & Fernando, 2016),and pain during daily activities. Furthermore, the included participants had to be scheduled for knee replacement surgery within a month. The radiological symptoms were confirmed by the orthopedic surgeon at the orthopedic clinic. The exclusion criteria were to have one or more of the followings: an osteoarthritis in the hip or ankle, a knee replacement before, a knee surgery in the last five years, a hip and ankle injuries in the last five years, and cognitive problems. Ethical approval from the University of Pécs was granted and the consent form was signed from all participants before participation.

Procedure

The patients who met the inclusion criteria were contacted to participate in the study. Ten patients agreed to participate in this study. All the included participants were briefed about the study, and they were asked to sign the consent form. Then, each participant was asked to complete a Hungarian language SF-36 form one month before the surgery. The eight domains of the

short form (SF-36) were reported, including physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role and mental health (Brazier et al., 1992; Hayes, Morris, Wolfe, & Morgan, 1995; Ko et al., 2013; Ware Jr, 2000). Each question is scored from zero to 100. A low score indicates poor health status, and a high score shows better health status (Brazier et al., 1992; Hayes et al., 1995; Ko et al., 2013; Ware Jr, 2000).

Statistical analysis

SPSS software SPSS(SPSS Inc., Chicago, IL, USA, version 24) was used to calculate descriptive statistics and the multivariate analysis of MANOVA. In the multivariate analysis, all eight domains were dependent variables, and gender was an independent variable. The results were considered significant if the P value was less than 0.05. The other factors such as using walking assistance, diabetes, blood pressure, smoking, employment, and marital-status were not recorded because the outcomes were insignificant. The scoring was performed online via the online software Orthotool-kit (https://www.orthotoolkit.com/sf-36/).

Results

Ten patients had severe knee OA with a minimum of four years of knee OA and were ready for knee replacement surgery and completed the SF-36 form. The average of eight domains with standard deviation were calculated (Table 2). Based on the mean of the eight domains of the SF-36, the results show that three domains were less than 50%, including pain, role limitation due to physical activity, and role limitation due to emotional problems. The average reported pain was 40.95%, which was the lowest among the domains. The role limitation due to physical activity was the second lowest domain, with an average of 42.5%. In contrast, the overall mean of social functioning and emotional well-being were the higher domains.

In addition, the comparison of the eight domains according to gender showed that there are significant differences between women and men in two domains: physical functioning and role limitations due to emotional problems. Women significantly had lower physical functioning and role limitations due to emotional problems than men by 42.8% (p=0.03) and 73.3%, respectively. (p=0.005). Other differences were seen between women and men but the differences were insignificant. For instance, women reported lower role limitations

due to physical activity than men by 53.44%. In addition, women had lower average energy and emotional well-being domains than men by 24.46% and 22.5%, respectively.

Table 2. Mean and standard deviation of SF-36 domains in the included participants with comparison between the eight domains according to gender.

Domains	Overall Outcomes, N=10 (±SD)	Outcomes of males, N=4 (±SD)	Outcomes of females, N=6 (±SD)	P value
1) Physical functioning	52 (22.75)	70 (15.8)	40 (17.5)	**0.03***
2) Role limitations due to physical health	42.5 (37.36)	62.5 (47.8)	29.1 (34.9)	0.180
3) Role limitations due to emotional problems	46.71 (39.11)	83.3 (33.2)	22.2 (33.3)	**0.005***
4) Energy/fatigue	55.5 (13.63)	65 (11.54)	49.1 (10.8)	0.067
5) Emotional well-being	69.2 (16.34)	80 (18.18)	62 (10.5)	0.086
6) Social functioning	71.25 (27.67)	75 (28.8)	68.7 (27.6)	0.74
7) Pain	40.95 (23.94)	47.3 (26.2)	36.6 (21.9)	0.62
8) General health	52.5 (13.18)	52.5 (13.2)	52.5 (13.18)	1.00

Note: * Significant results.

Discussion

This cross-sectional study aimed to report the quality of life among Hungarian patients with severe knee OA who were ready for knee replacement surgery and the gender differences in term of QoL. This study is part of another study that evaluated the activity level before and one year after knee replacement surgery. The outcomes of this study found that there were significant impairments in some of the sub-scores of QoL. The Hungarian patients had low physical function and a high pain level, which reduced their ability to freely achieve their daily activities. However, the overall scores of social functioning and emotional well-being among participants were the highest in domains with less struggle.

The results of this study are similar to those of another studies that reported OoL using the SF-36 since these articles showed that OoL is impaired due to knee OA and that functional and pain scores were the lowest(Alkan, Fidan, Tosun, & Ardıçoğlu, 2014; Mahir et al., 2016; Saeed, Zulfiqar, Kaleem, Hafeez, & Ghauri, 2021). The impairment of quality of life could be correlated with pain severity and radiological severity (Alkan et al., 2014; Hannan, Felson, & Pincus, 2000; Muraki et al., 2012).

Furthermore, this study found differences in pain and emotional status in term of gender. The Hungarian women with severe knee OA had more severe pain and more functional limitations due to emotional problems than Hungarian men patients. Similar results were found in other published articles that showed that women with knee OA had higher pain and lower QoL than men with knee OA (Alkan et al., 2014; Cui et al., 2020; Muhammad, Azam, & Salam, 2018; Muraki et al., 2012; Tonelli, Rakel, Cooper, Angstom, & Sluka, 2011). Therefore, sex was a risk factor for the incidence and severity of knee OA.

For emotional status, this study found that Hungarian women with severe knee OA had lower emotional well-being and lower functional activity due to emotional problems than men. Similarly, other studies found that women with knee OA were more likely to have negative mood, anxiety, and depression than men with knee OA (Cui et al., 2020; Keefe et al., 2004; Tonelli et al., 2011). This could be due to the higher pain intensity and low activity level of women with knee OA (Tonelli et al., 2011). Another study conducted in Pakistan found that the role limitation due to emotional problems had a poor score (with an average response of 30%), which could be due to participant characteristics since most of the participants were overweight (Saeed et al., 2021). It is suggested that obesity could reduce QoL by more than 70% (Cui et al., 2020; Saeed et al., 2021) and increase the risk of disabilities (Batsis, Zbehlik, Barre, Mackenzie, & Bartels, 2014). Hence, obesity among patients with severe knee OA should be controlled, as it also reduces the QoL and physical activity level.

The limitations of this study

This cross-sectional study is a part of a case-series study with a small sample size. The data collection process was performed through the COVID-19 pandemic corona, and it was difficult to get in touch with more elderly individuals due to difficulties in reaching the hospital and putting their lives at risk. Furthermore, the included participants had to continue the main study with one-year follow-up; hence, the number of participants was low. Nevertheless,

the outcomes of this study could help the therapists in Hungary to understand the OoL and the most challenging activities among patients with severe knee OA. In addition, the results could be a basic for further studies regarding knee OA to be conducted in Hungary with larger sample size.

Conclusion

Knee OA is a global disabling disease that is associated with pain and low OoL. Hungarian patients with severe knee OA complain mainly of pain and role limitations due to physical health and emotional problems. Additionally, Hungarian women with severe knee OA had significantly lower physical functioning and role limitations due to emotional problems than Hungarian men. Hence, it is necessary to include intensive emotional-health care in the treatment strategy for women with severe knee OA in Hungary. Further studies with larger sample sizes are needed.

REFERENCES

Alkan, B. M., Fidan, F., Tosun, A., & Ardıçoğlu, Ö. (2014). Quality of life and self-reported disability in patients with knee osteoarthritis. *Modern rheumatology, 24*(1), 166-171.

Batsis, J. A., Zbehlik, A. J., Barre, L. K., Mackenzie, T. A., & Bartels, S. J. (2014). The impact of waist circumference on function and physical activity in older adults: longitudinal observational data from the osteoarthritis initiative. *Nutrition journal, 13*(1), 1-13.

Berger, M. J., Kean, C. O., Goela, A., & Doherty, T. J. (2012). Disease severity and knee extensor force in knee osteoarthritis: data from the Osteoarthritis Initiative. *Arthritis care & research, 64*(5), 729-734.

Biggs, P. R., Whatling, G. M., Wilson, C., Metcalfe, A. J., & Holt, C. A. (2019). Which osteoarthritic gait features recover following total knee replacement surgery? *PLoS One, 14*(1), e0203417. doi:10.1371/journal.pone.0203417

Brazier, J. E., Harper, R., Jones, N., O'cathain, A., Thomas, K., Usherwood, T., & Westlake, L. (1992). Validating the SF-36 health survey questionnaire: new outcome measure for primary care. *British medical journal, 305*(6846), 160-164.

Busa, M., Gunther, T., Mazzag, K., Vizsy, M., Boncz, I., & Molics, B. (2019). PMS6 Quality of Life of Patients Who Underwent Implantation of Knee Endoprosthesis. *Value in Health, 22*, S694-S695.

Cui, A., Li, H., Wang, D., Zhong, J., Chen, Y., & Lu, H. (2020). Global, regional prevalence, incidence and risk factors of knee osteoarthritis in population-based studies. *EClinicalMedicine, 29*, 100587.

Dieppe, P., Lim, K., & Lohmander, S. (2011). Who should have knee joint replacement surgery for osteoarthritis? *Int J Rheum Dis, 14*(2), 175-180. doi:10.1111/j.1756-185X.2011.01611.x

Escobar, A., Garcia Perez, L., Herrera-Espineira, C., Aizpuru, F., Sarasqueta, C., Gonzalez Saenz de Tejada, M., . . . Bilbao, A. (2017). Total knee replacement: Are there any baseline factors that have influence in patient reported outcomes? *J Eval Clin Pract, 23*(6), 1232-1239. doi:10.1111/jep.12765

Felson, D. T. (2006). Osteoarthritis of the knee. *New England Journal of Medicine, 354*(8), 841-848.

Felson, D. T., Anderson, J. J., Naimark, A., Walker, A. M., & Meenan, R. F. (1988). Obesity and knee osteoarthritis: the Framingham Study. *Annals of internal medicine, 109*(1), 18-24.

Felson, D. T., Lawrence, R. C., Dieppe, P. A., Hirsch, R., Helmick, C. G., Jordan, J. M., . . . Zhang, Y. (2000). Osteoarthritis: new insights. Part 1: the disease and its risk factors. *Annals of internal medicine, 133*(8), 635-646.

Ferket, B. S., Feldman, Z., Zhou, J., Oei, E. H., Bierma-Zeinstra, S. M., & Mazumdar, M. (2017). Impact of total knee replacement practice: cost effectiveness analysis of data from the Osteoarthritis Initiative. *BMJ, 356*, j1131. doi:10.1136/bmj.j1131

Hall, M., Bennell, K., Wrigley, T., Metcalf, B. R., Campbell, P., Kasza, J., . . . Hinman, R. S. (2017). The knee adduction moment and knee osteoarthritis symptoms: relationships according to radiographic disease severity. *Osteoarthritis and Cartilage, 25*(1), 34-41.

Hannan, M. T., Felson, D. T., & Pincus, T. (2000). Analysis of the discordance between radiographic changes and knee pain in osteoarthritis of the knee. *The Journal of rheumatology, 27*(6), 1513-1517.

Hayes, V., Morris, J., Wolfe, C., & Morgan, M. (1995). The SF-36 health survey questionnaire: is it suitable for use with older adults? *Age and ageing, 24*(2), 120-125.

Horváth, G., Koroknai, G., Ács, B., Than, P., Bellyei, Á., & Illés, T. (2010). Prevalence of knee osteoarthritis in Hungary. Study conducted in a representative Hungarian population. *Orvosi Hetilap, 151*(4), 140-143.

Horváth, G., Koroknai, G., Ács, B., Than, P., Bellyei, Á., & Illés, T. (2011). Prevalence of radiographic primary hip and knee osteoarthritis in a representative Central European population. *International orthopaedics, 35*(7), 971-975.

Keefe, F. J., Affleck, G., France, C. R., Emery, C. F., Waters, S., Caldwell, D. S., . . . Wilson, K. (2004). Gender differences in pain, coping, and mood in individuals having osteoarthritic knee pain: a within-day analysis. *Pain, 110*(3), 571-577.

Ko, Y., Lo, N. N., Yeo, S. J., Yang, K. Y., Yeo, W., Chong, H. C., & Thumboo, J. (2013). Comparison of the responsiveness of the SF-36, the Oxford Knee Score, and the Knee Society Clinical Rating System in patients undergoing total knee replacement. *Qual Life Res, 22*(9), 2455-2459. doi:10.1007/s11136-013-0376-y

Kohn, M. D., Sassoon, A. A., & Fernando, N. D. (2016). Classifications in brief: Kellgren-Lawrence classification of osteoarthritis. *Clinical Orthopaedics and Related Research®, 474*(8), 1886-1893.

Mahir, L., Belhaj, K., Zahi, S., Azanmasso, H., Lmidmani, F., & El Fatimi, A. (2016). Impact of knee osteoarthritis on the quality of life. *Annals of physical and rehabilitation medicine, 59*, e159.

Midgley, J. (2021). Osteoarthritis and obesity; conservative management, multi-morbidity, surgery and the implications of restricted access to knee or hip replacement: a literature review. *Int J Orthop Trauma Nurs, 40*, 100840. doi:10.1016/j.ijotn.2020.100840

Muhammad, A., Azam, M. J., & Salam, A. (2018). Impact On Quality Of Life In Patients With Knee Osteaoarthritis In Faisalabad. *Journal of University Medical & Dental College, 9*(3), 49-52.

Muraki, S., Akune, T., Oka, H., Ishimoto, Y., Nagata, K., Yoshida, M., . . . Yoshimura, N. (2012). Incidence and risk factors for radiographic knee osteoarthritis and knee pain in Japanese men and women: A longitudinal population-based cohort study. *Arthritis & Rheumatism, 64*(5), 1447-1456.

Nunez, M., Lozano, L., Nunez, E., Segur, J. M., Sastre, S., Macule, F., . . . Suso, S. (2009). Total knee replacement and health-related quality of life: factors influencing long-term outcomes. *Arthritis Rheum, 61*(8), 1062-1069. doi:10.1002/art.24644

Rathbun, A. M., Yau, M. S., Shardell, M., Stuart, E. A., & Hochberg, M. C. (2017). Depressive symptoms and structural disease progression in knee osteoarthritis: data from the Osteoarthritis Initiative. *Clinical rheumatology, 36*(1), 155-163.

Saeed, A., Zulfiqar, T., Kaleem, M., Hafeez, M., & Ghauri, M. W. (2021). Health related quality of life in patients with grade III knee osteoarthritis. *Rawal Medical Journal, 46*(3), 580-580.

Tonelli, S. M., Rakel, B. A., Cooper, N. A., Angstom, W. L., & Sluka, K. A. (2011). Women with knee osteoarthritis have more pain and poorer function than men, but similar physical activity prior to total knee replacement. *Biol Sex Differ, 2*, 12. doi:10.1186/2042-6410-2-12

Ware Jr, J. E. (2000). SF-36 health survey update. *Spine, 25*(24), 3130-3139.

Declarations

Ethics approval and consent to participate: Ethical approval was obtained from the University of Pecs research ethics committee (8343/2020, date of approval is July 2020). All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication: Informed consent was obtained from all subjects involved in the study.

Availability of data and materials: Data sharing does not apply to this article as no datasets were generated or analyzed during the current study.

Competing interests: The authors declare that they have no competing interests (financial and nonfinancial).

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Authors' contributions: With the submission of this manuscript, I would like to confirm that all authors of this paper have directly participated in the planning, execution, and analysis of this study. All authors of this paper have read and approved the final version submitted, and they have no conflicts of interest.

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SEBT AND YBT DYNAMIC BALANCE TESTS

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ABSTRACT. A fundamental role in movement control is given by proprioceptive information from a multitude of mechanoreceptors that are integrated and processed by the human brain. Understanding proprioception and the test method, such as the threshold for detecting passive movement and reproducing joint position, are used to assess proprioception. The origin of the methods, test apparatus and procedures or protocols used in each approach are compared and discussed. Instability of a lower limb joint is a risk factor for these areas. Therefore, the development of proprioception can play an important role in injury prevention. The Star Excursion Balance Test (SEBT) is a dynamic postural control task that has gained notoriety in clinical and research settings, it is able to provide objective measures to differentiate deficiencies and improve dynamic postural control related to lower limb joint injuries. The clinical application of the SEBT led to the development of the Y Balance Test (YBT), both SEBT and YBT involve similar movements that are deemed to measure and challenge dynamic balance.

Keywords*: proprioception, Star Excursion Balance Test, Y Balance Test*

REZUMAT. ***Testele de echilibrare dinamică SEBT şi YBT.*** Un rol fundamental în controlul mişcării este dat de informaţiile proprioceptive de la o multitudine de mecanoreceptori care sunt integraţi şi procesaţi de creierul uman. Înţelegerea propriocepţiei şi a metodei de testare, cum ar fi pragul de detectare a mişcării pasive şi de reproducere a poziţiei articulare, sunt utilizate pentru a evalua propriocepţia. Se compară şi se discută originea metodelor, a aparatelor de testare şi a procedurilor sau protocoalelor utilizate în fiecare abordare.

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Instabilitatea unei articulații inferioare a membrelor este un factor de risc pentru aceste zone. Prin urmare, dezvoltarea propriocepției poate juca un rol important în prevenirea leziunilor. Testul de echilibru al excursiei Stelare (SEBT) este o sarcină dinamică de control postural care a câștigat notorietate în setările clinice și de cercetare, este capabil să ofere măsuri obiective pentru a diferenția deficiențele și pentru a îmbunătăți controlul dinamic postural legat de leziunile articulare ale membrelor inferioare. Aplicarea clinică a SEBT a condus la dezvoltarea testului de echilibru Y (YBT), atât SEBT, cât și YBT implică mișcări similare care se consideră că măsoară și provoacă echilibrul dinamic.

Cuvinte-cheie: *propriocepție, Testul de echilibru Stea, Testul de echilibru Y*

Introduction

Postural control can be classified as static or dynamic. This is a complex process that requires central sensory processing, visual, vestibular, and somatosensory pathway information, as well as a resultant efferent response, which controls the recruitment of specific motor units (Bressel, Yonker, Kras & Heath, 2007).

Balance is the key to all functional movements. Any impairment of balance will decrease performance and increase the risk of injury and fracture as a result of daily activities. Thus, balance is of key clinical relevance for any rehabilitation program or prophylactic rehabilitation program (Zazulak, Cholewicki & Reeves, 2008).

There are many methods for assessing balance, but the number of tests for assessing dynamic balance is very small. The standardized test present for the clinical examination of balance focuses on static balance, while many daily activities require dynamic balance (Butler, Lehr, Fink, Kiesel & Plisky, 2013).

The central nervous system generates a movement plan. Feedback and feed-forward control mechanisms play vital roles in controlling movement and performing tasks such as SEBT and YBT. Stimulation of mechanoreceptors located in the skin, ligaments, muscles and joints, provides related feedback through the spinal pathways in terms of movement and position of joints in different segments of the body during movement (Winter, Patla & Frank, 1990). The motoneuron activation pattern is fine-tuned by feedback from these mechanoreceptors, which act either monosynaptically or through inhibitory interneurons and provide a corrective response to action.

The anatomical-functional substrate of the exercises is represented by the stimulation of the proprioceptive function of the organism, respectively of its capacity to transmit the position of the body and its segments, to analyze the respective information and to react (consciously or unconsciously) to the

stimulation, through a movement proper. The information needed by the nervous system to assess posture, body balance and coordination is provided by receptors located in the muscles and joints, the vestibular apparatus and the visual analyzer (Prakash et al., 2017). Muscle and joint receptors are stimulated by movements of the musculoskeletal system. The vestibular apparatus provides information about the position of the whole body and is stimulated when the vertical posture of the body changes. The visual analyzer helps to orient the head and body in the environment. In this context, it is obvious that in case of injury to the joints and ligaments, the proprioceptors located at these levels are also damaged, which means that the information transmitted to the central nervous system is affected. As a result, the joint is suffering. Although the vestibular apparatus intervenes to balance the position of the body and the joint, over time stability, position control and joint functional capacity are lost. Loss of sense of position puts the joint at additional risk of injury. In these circumstances, the intervention of specialists in medical recovery is required, and the rehabilitation program must include, in essence, proprioceptive re-education.

Topic addressed

According to the literature, neuro-muscular reprogramming after a sprain is based on two theories whose principles complement each other: Freeman's (1965) theory and Thornard's (1996) theory.

According to Freeman's (1965) theory, after an acute sprain, the articular receptors (proprioceptors) are differentiated. As a result, proprioceptive information can no longer be transmitted or is partially transmitted to the central nervous system, which alters muscle reactions in feedback. Therefore, the knee muscles (hamstrings) contract to counteract the lesion movement and to position the knee joint at physiological amplitude.

Thornard (1996) showed by EMG recordings that normal muscle responses to stimuli appeared after 60 ms, while movement in the injured areas appeared first, after 20 ms. In this context, proprioceptive re-education in feedback has been rethought in feed-forward, which means that in re-education all proprioceptive information must be used to create motor schemes of anticipation in the central nervous system.

Therefore, in order for neuromuscular reprogramming to be as effective as possible, the two theories should be combined in order to require coordination and anticipation of muscle contractions. In order to implement such re-education, all proprioceptive information involved in the knee protection mechanism should be stimulated. We appreciated that an effective way to stimulate the proprioceptive system would be sports-specific exercises to "bombard" the CNS with motor experiences similar to those that athletes practice in sports.

Given the diversity of sports gestures of the researched subjects, we appreciated that jumping would be the common element in the sports practice of the subjects included in the research.

This test, known in the international literature as the Star Excursion Balance Test (SEBT), is a dynamic test commonly used by clinicians and researchers to assess dynamic balance and detect postural control deficits. At the same time, it identifies the pathological conditions in the lower limb and the effects of interventions through exercise programs. The test is also predictable, as it identifies people at high risk of injury consisting of injuries to the lower limb. Basically, the test is a useful tool to check both the primary and secondary prophylactic effects of injury prevention.

In this context, to which is added the fact that the literature considers it one of the best tools for measuring the dynamic balance of the lower extremity, we considered that it can be applied by us to monitor the performance of research subjects.

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 has shown that previous contact distances were different when comparing the two tests. Therefore, the two tools may not be directly comparable.

Star Excursion Balance Test (SEBT) is a simple, reliable and cost-effective test that is quick to administer and accessible in clinical settings to assess the dynamic balance of the lower limbs (Gribble & Hertel, 2003). SEBT can monitor the progress of rehabilitation, assess deficiencies after injury and can identify athletes at high risk of lower limb injuries. SEBT requires neuromuscular features, such as lower limb coordination, balance, mobility, and strength (Plisky et al., 2009).

In this test, balance is maintained on one lower limb and with the other lower limb it must reach along marked lines in eight different directions, which causes the subject's postural control, strength, range of motion and proprioceptive abilities (Lee, Kang, Lee & Oh, 2015). The distance reached in each direction is measured separately and interpreted as a representation of the dynamic equilibrium, providing an alternative for the evaluation of the dynamic equilibrium.

SEBT normative values (table 1) can provide objective measures to differentiate deficits and improvements in dynamic postural control related to lower limb joint injuries and has the potential to prevent the possibility of lower limb joint injury (Plisky, Rauh, Kaminski & Underwood, 2006).

Table 1. Data on the normal values of the Star Excursion Balance Test (Star Excursion Balance Test, 2017)

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

SEBT is a promising test of postural control that is used to assess physical performance, but also to detect deficiencies in dynamic postural control due to musculoskeletal injuries (e.g., chronic ankle instability), to identify high-risk athletes for injuries to the joints of the lower limbs, as well as during the rehabilitation of orthopedic injuries in healthy subjects (Gribble, Hertel & Plisky, 2012).

SEBT can be framed as a diagnostic tool in clinical practice and research (Star Excursion Balance Test, 2017). SEBT can be administered quickly and easily, the physiotherapist can determine if the patient has or has returned to normal levels of dynamic balance, it can also be used in physical training. It can be used to identify athletes who have not fully rehabilitated or normalized their dynamic balance after an injury (Plisky et al., 2006).

In an attempt to improve the reliability and utility clinic, the Y Balance Test protocol has been developed that addresses some of the limitations of traditional SEBT. Thus, the test procedure was modified to allow the participant to lift the heel off the ground. In addition, the original position was changed at the distal end of the longest finger to improve repeatability. Based on the reduction in the number of directions, the Y Balance test continues the efficiency of the SEBT. This device comprises a position platform consisting of three arms of different materials extending in the anterior, posteromedial and posterolateral direction (Fig. 1).

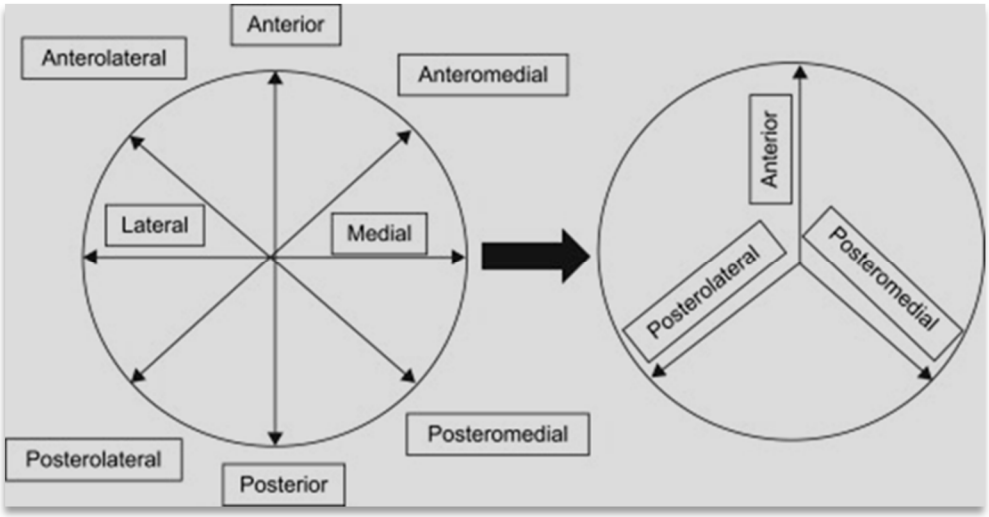

Fig. 1. Y Balance Test (Weingroff, 2013)

The clinical application of SEBT led to the development of the Y Balance (YBT) test. Plisky and collaborators (2009) used a Y, which signifies the directions of execution A, PM and PL, which in turn led to the development of YBT. It sits on a plastic center plate raised 2.5 cm from the ground and pushes a rectangular block with the foot along a length of 1.5 m, from a plastic tube, in each of the 3 directions. The touch distance is recorded as the point at which the indicator block is pushed by the position foot. Each arm of the device is marked in 5 mm increments. The participant pushes a coverage indicator along the device with the foot of his touching member and stays over the measuring tape after performing the test.

In order to make valid comparisons of the distances of reach of the SEBT between individuals or groups, normalized distances of the length of the lower limbs must be reached. This recommendation is based on the length of the lower limbs, measured from the anterosuperior iliac creast to the median ankle, being correlated with the performance of performance in each direction.

The Y test was developed to perfect the long process of performing the Star Excursion balance test. As such, most of the supportive research for the Y test is based on the investigations performed in the balance test on the Star race (fig. 2). However, the Y test not only proved to have a high level of test reliability, but also a sensitive indicator of the risk of injury among athletes (Shaffer et al., 2013).

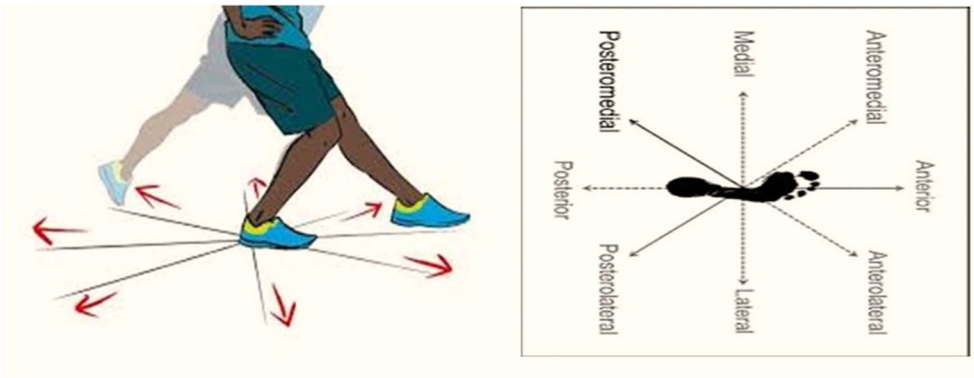

Fig. 2. Star Excursion Balance Test (Adiguzel, 2020)

The Y test is a simple test used to measure dynamic equilibrium. It was developed to standardize the modified star race test, to improve practicality and to make it commercially available. Since then, the Y test has become an extremely popular test due to its simplicity and reliability (Alnahdi, Alderaa, Aldali & Alsobayel, 2015).

YBT also requires endurance and coordination, which can increase its sensitivity to injury prevention. In addition, each direction of touch activated the position of the muscles of the lower limbs. In the anterior direction the medial and lateral vastus in the posterolateral direction, the femoral biceps and the anterior tibia and in the posteromedial direction. The Y test requires the athlete to balance on one leg, reaching simultaneously, as far as possible, with the other leg in three separate directions: anterior, posterolateral and posteromedial. Therefore, this test measures the endurance, stability and balance of the athlete in different directions.

The composite score of the Y test is calculated by summing the three directions of touch and normalizing the results to the length of the lower limb, while the asymmetry is the difference between touching the right and left limb.

Although the injury or surgery does not appear to have any impact on the test's performance in athletes, the test has been shown to have strong relationships with the knee flexor and the strength of the hip abductor. Although little research has been done on the Y test and the risk of athletic injury, most of the hypotheses regarding the risk of injury are drawn from research on the star race balance test, due to its great resemblance to the Y test.

For example, it has been suggested that an anterior asymmetry of more than 4 cm during the star stroke balance test was predicted to predict who is at risk for lower limb injury. Further research has also shown that the poor performance of the star stroke balance test is related to chronic instability of the knee.

Balance, otherwise known as 'postural control', can be defined statically as the ability to maintain a support base with minimal movement and as dynamic as the ability to perform a task while maintaining a stable position. In a chaotic sports environment, the ability to maintain a stable position is vital not only for the successful application of skill, but also for reducing the risk of injury. As a result, it can be of great interest to test and monitor the dynamic stability of an athlete.

In contrast, feed-forward controls have previously been described as anticipatory actions that occur before sensory detection, and feedback and feed-forward control may vary between SEBT and YBT, resulting in differences in touch distances in the Forward direction. YBT asks the participant to sit in an elevated position on a center plate while pushing a sliding block. In SEBT, the participant puts downward pressure through the touching leg only at the end of the direction of execution.

The SEBT balance test and the Y balance test (YBT) (table 2) have three common coverage directions: anterior (ANT), posteromedial (PM) and posterolateral (PL). Research has shown that performance on the ANT execution direction of SEBT differs from that on YBT.

Table 2. Mean distance vs Relative distance

Direction	Mean distance				Relative distance			
	P value		Effect size		P value		Effect size	
	Affected	Healthy	Affected	Healthy	Affected	Healthy	Affected	Healthy
A	0.001	0.006	1.52	0.84	<0.001	0.005	1.39	0.85
P	0.001	0.041	1.03	0.58	0.001	0.029	1.04	0.63
M	0.001	0.002	1.40	1.00	<0.001	0.002	1.30	0.98
L	<0.001	<0.001	1.37	1.59	0.003	<0.001	0.94	1.54
AL	0.011	0.005	0.76	0.86	0.012	0.006	0.74	0.83
AM	0.356	0.077	0.25	0.49	0.002	0.009	1.00	0.79
PL	0.001	0.830	1.18	0.06	<0.001	0.833	1.18	0.06
PM	0.050	0.013	0.55	0.74	0.064	0.018	0.52	0.69

In the touch direction A, participants receive visual feedback from the touch foot and can observe the marked touch distance. In the PM and PL directions, visual awareness is reduced and therefore the inability of the participants to perform as in the A direction. However, during the YBT, participants were able to reach similar distances to the SEBT, due to their contact with the sliding block. Another possible reason for running distances observed in the PM and PL directions refers to the location of the cover leg on the sliding block of the YBT.

Participants were instructed not to place the foot above the tube and to place the plantar surface of the touching foot on the medial side of the sliding block. This leads to their support being kept closer to their center of gravity during the YBT than along the SEBT measuring bands, reaching similar distances in the PM and PL directions. In the A direction, the foot was placed on the side of the sliding block, the center of gravity was shifted and the touch distances were reduced compared to the SEBT.

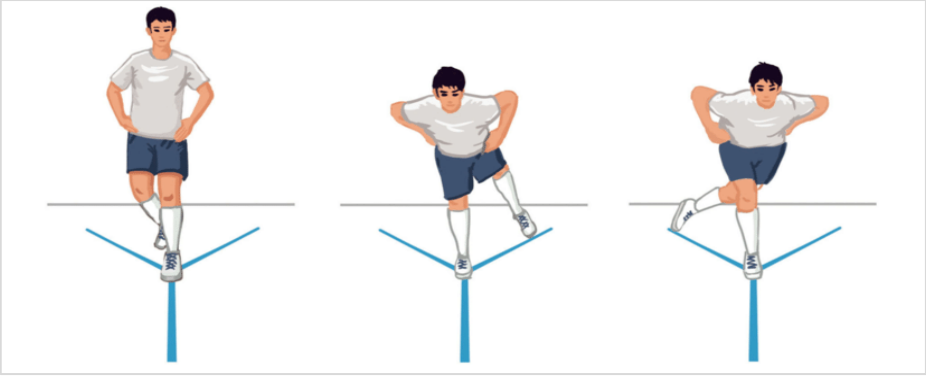

Fig. 3. Y balance test-YBT (Guo et al., 2021)

Increasing the stability of the knee through static proprioceptive exercises also determines the maintenance of the body in the situation when it is or is not subject to attempts to unbalance. By increasing the instability during the exercises, a better stability of the neuromuscular system is obtained. Therefore, the effect of these exercises is to improve the perception of body positions as a whole, by activating static proprioceptive receptors in the joints (static mechanoreceptors such as Ruffini corpuscles) and slow muscle fibers that have a dominant endurance component.

The protocol can be established by reference to the training sessions for a period of 4 weeks. The period may be preceded by one week dedicated to testing the subjects studied (initial testing) and followed by one week during which the final testing is performed.

The proprioception programs were based on the following principles:

- preparation / heating of the structures that were to be requested through walking exercises and active stretching of the adductor muscles, hamstrings, quadriceps and sural triceps, with a duration of 10-12 minutes;
- symmetrical exercise of the lower limbs;
- stressing the knees with the legs bent; the flexion angle of the calves on the thighs was varied.

However, its purpose is common: it applies both to the prevention of injuries and to the re-education / reintegration of sports after an injury. The effect is to increase the stability of the knee.

Proprioceptive exercises are of two types: static and dynamic.

We mention that proprioceptive reeducation through static exercises is most frequently used in reeducation programs applied to the studied pathology; some authors even call it the classic form of therapeutic intervention.

It is important to understand that each time the test is performed, it must be done in a consistent environment so that it is protected with a surface that is not affected by wet or slippery conditions. If the environment is not consistent, the reliability of repeated tests at subsequent data may be substantially impaired and may result in worthless data.

Before starting the test, it is important to make sure that you have the following items:

✓ Reliable and consistent test installation (minimum 2x2 meters).
✓ Test coordinator.
✓ Y balance test kit, or sticky tape and a measuring tape.
✓ Performance record sheet.

Participants must warm up thoroughly before the start of the test. The heaters must correspond to the biomechanical and physiological nature of the test. In addition, sufficient recovery (3-5 minutes) is required after heating and before the start of the test.

Warm-up exercises play a key role in preventing musculoskeletal injuries. Thus, by increasing the local temperature, there is an increase in the flexibility of these structures by up to 20%. In addition, adequate heating increases cardiovascular parameters and achieves the mental preparation of the subject for the exercises to be performed. As a result, the whole body is prepared for intense physical activity. For these reasons, the subjects benefit from a warm-up program. It runs for 10-12 minutes and is composed of walking and stretching exercises. Stretching exercises can consist of dynamic stretches performed during the practice of knee-specific movements.

Based on the notions of anatomy, according to which most of the muscles that control the movements of the knee are at the level of the thighs and only a few at the level of the leg, we applied stretching exercises located to these muscle groups to the researched subjects. Thus, the four muscles of the anterior thigh (the right femur, the vastus intermedia, the vastus lateralis, the vastus medialis) were targeted, which together make up the quadriceps muscle, with a major extensor role of the knee. Stretching was also applied to the muscles of the posterior thigh (femoral biceps, semimembranosus, semitendinosus, gracilis and tailor), as well as to the calf muscles (gastrocnemius, popliteal, plantar).

Due to the large volume of the thigh muscles, compared to other muscle groups that act on the knee joint, muscle pain occurs less frequently in these muscle groups. Attention is paid to the symmetrical, balanced load of the anterior and posterior thigh muscles, as it is known that the quadriceps muscle is stronger but less flexible than the posterior thigh muscles, and the tendency of practitioners and subjects is to stretch the posterior thigh muscles. The effects of this unbalanced approach are felt immediately by intense, persistent pain, but also at a distance by the installation of chronic fatigue and decreased strength of the posterior thigh muscles, so we avoided inducing these unwanted effects.

Researched subjects may perform 10-minute stretching exercises as part of the recovery program. Also, as in any other exercise program, it is taken into account that progression is an important condition in ensuring the success of a stretching program. The progression was gradual, moving from an easier task to a more difficult one. The level of working speed also varies. The intensity of the stretches was controlled by monitoring the associated pain.

Using a pain scale from 0 to 10, the initial stretching of a certain muscle group is considered easy when, performed on a certain muscle group, it is associated with a mild pain, located only in one point (intensity from 1 to 3 on the pain scale). The extension is moderate, when the subject feels an increased or medium pain in the stretched muscle (intensity between 4 and 6 on the pain scale) and becomes intense when the pain intensity is between 7 and 10 on that scale. Usually, the pain dissipates as the duration of the stretch prolongs.

Researchers' studies have shown that more intense stretches compared to lighter ones produce more significant increases in flexibility and musculoskeletal endurance. Stretches can be performed at various angles of the hip and knee and up to the full stroke of the movement to ensure an elongation, respectively a progressive increase in muscle flexibility.

Remember that the warm-up can be structured efficiently and strategically and the content or exercises should reproduce in the most accurate way those of the session for which the athletes are preparing.

To plan for effective warm-up, the test coordinator must first understand the mental, physiological, and biomechanical requirements of the training or sports session before attempting to prepare the athlete for these precise requirements. In most circumstances, these requirements are identified during the needs analysis. For example, if you are planning a warm-up for a maximum of one repetition test, then you may want to consider the mental, physiological, and biomechanical requirements of that session. For mental training, the coordinator can encourage athletes to rest well and bring self-motivational music to listen to while testing takes place - as it has been repeatedly shown to improve performance. The coordinator can adopt a warm-up routine with physiological

requirements such as high strength exercises, endurance, long rest. Regarding biomechanical training, stretching, dynamic movements and exercises similar to those performed during the warm-up program would be appropriate.

Alternatively, if the coordinator designs a field-based heater for a short and fast technical session for football, then the heater should be specially designed for that session and therefore may look very different from the previous test example. Mental training can be very different, because the mental training of players can be stimulated by competing with other players. Physiologically, if the technical session requires high workloads, with short recovery periods and thus a high cardiovascular demand, then the warm-up should aim to produce similarly or even reproduce the intensities to which athletes will be exposed. From a biomechanical point of view, the movements adopted should have biomechanical similarities with the movements that will be predominant during the technical session. This may include long strokes, changes of direction, jumps and twisting movements.

With his hands firmly placed on his hips, the athlete must then be instructed to slide forward as far as possible with his right foot and return back to the starting vertical position.

Touch distances should be recorded to the nearest 0.5 cm.

They should then repeat this with the same foot for a total of three successful touches. After completing three successful touches with the right foot, then they are allowed to repeat this process with the left foot.

Once the athlete has made three successful touches with each foot, they can then move on to the next test direction.

The test coordinator should record the reach of each attempt to calculate the composite score.

With the test completed and all performance recorded, the test coordinator can then calculate the test performance scores using any or all of the following equations:

- Absolute touch distance (cm), the sum of the three touches;
- Relative (normalized) touch distance (%) = Absolute touch distance / limb length x 100;
- Compound touch distance (%) = Sum of the 3 touch directions / 3 times limb length x 100.

Conclusion

The results suggest that both SEBT and YBT can be used clinically to measure dynamic balance, performance scores in a certain direction of execution should not be used alternately between SEBT and YBT. As the administration of SEBT and YBT

protocols varies in the literature, the detailed specific methodology should be carefully observed by physicians, physiotherapists and researchers when interpreting dynamic equilibrium scores. Further research is needed to establish normative values for SEBT and YBT and to determine the limits of dynamic equilibrium testing.

A difference was observed on the distance A between SEBT and YBT, without differences on the PM and PL directions. Achieving the values set for SEBT in sports, healthy populations and those with injuries to the joints of the lower limbs cannot replace the values of YBT performance. It is important to note that there are differences between these assessment tools although it is not established whether one test is more clinically appropriate than the other.

The Star Trip Balance Test (SEBT) is a widely accepted method of assessing dynamic postural stability. The Y Balance Test (YBT) is a commercially available device for measuring balance that uses three (anterior, posteromedial and posterolateral) of the eight SEBT directions and has been supported as a method of assessing dynamic balance. The claimed benefits of YBT are that it takes less time to complete testing and has a standard protocol and high reliability. To date, no study has compared the achievement of achievement in these tests in a healthy population.

Both SEBT and YBT involve similar movements that are considered, measuring and causing dynamic equilibrium. Despite the similarity between the tests, so far no researcher has evaluated performance in both tests in the same group of participants.

REFERENCES

Adiguzel, S.N. (2020). Education of star excursion balance performance among young male athletes. *African Educational Research Journal*. Retrieved from: https://www.researchgate.net/figure/The-Star-Excursion-Balance-Test-SEBT_fig1_341219448.

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).

Bressel, E., Yonker, J.C., Kras, J., Heath, E.M. (2007). Comparison of Static and Dynamic Balance in Female Collegiate Soccer, Basketball, and Gymnastics Athletes. *Journal of Athletic Training*;42(1):42-46.

Butler, R.J., Lehr, M.E., Fink, M.L., Kiesel, K.B., Plisky, P.J. (2013). Dynamic balance performance and noncontact lower extremity injury in college football players: an initial study. *Sports Health*. 2013; 5(5): 417-422). https://doi:10.1177/1941738113498703.

Freeman, M.A.R., Dean, M.R.E., Hanham, I.W.F. (1965). The etiology and prevention of functional instability of the foot. *The Journal of Bone and Joint Surgery*, 47B (4), 678-685.

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:10.1207/S15327841MPEE0702_3.

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).

Guo, Z., Huang, Y., Zhou, Z., Leng, B., Gong, W., Cui, Y., Bao, D. (2021). The Effect of 6-Week Combined Balance and Plyometric Training on Change of Direction Performance of Elite Badminton Players. Frontiers in Psychology. 12. 684964. 10.3389/fpsyg.2021.684964. Retrieved from: https://www.researchgate.net/figure/Y-balance-test-YBT_fig4_352285619.

Lee, D.K., Kang, M.H., Lee, T.S., Oh, J.S. (2015). Relationships among the Y balance test, Berg Balance Scale, and lower limb strength in middle-aged and older females. *Revista Brasileira de Fisioterapia*.19(3):227-234). https:// DOI:10.1590/bjpt-rbf.2014.0096.

Prakash, J., Irshad, A., Sonal, K., Kamran, A., Shalini, V., Tarun, K. (2017). Proprioception: An Evidence Based Narrative Review. *Research & Investigations in Sports Medicine*, 1(2). RISM.000506. 2017. https://DOI:10.31031/RISM.2017.01.000506).

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:10.2519/jospt.2006.2244.

Plisky, P.J., Gorman, P.P., Butler, R.J., Kiesel, K.B., Underwood, F.B., Elkins, B. (2009). The reliability of an instrumented device for measuring components of the star excursion balance test. *North American Journal of Sports Physical Therapy*;4(2):92-9).

Star Excursion Balance Test. (2017). Translating Research Evidence and Knowledge. Retrieved from: https://exercise.trekeducation.org/assessment/balance-testing/star-excursion-balance-test/).

Shaffer, S.W., Teyhen, D.S., Lorenson, C.L., Warren, R.L., Koreerat, C.M., Straseske, C.A., Childs, J.D. (2013). Y-balance test: a reliability study involving multiple raters. *Military Medicine*;178(11):1264-70. https://doi.org/10.7205/MILMED-D-13-00222.

Thornard, J.L., Bragard, D., Williams, P.A., Plaghki, L. (1996). Stability of the braced ankle: A biomechanical investigation. *American Journal of Sports Medicine*, 24: 356-361.

Weingroff, C. (2013). Y Balance vs Star Excursion. Retrieved from https://charlieweingroff.com/2013/04/y-balance-vs-star-excursion/

Winter, D.A., Patla, A.E., Frank, J.S. (1990). Assessment of balance control in humans. *Medical Progress through Technology*. 1990;16:31-51).

Zazulak, B., Cholewicki, J., Reeves, N.P. (2008). Neuromuscular control of trunk stability: Clinical implications for sports injury prevention. *Journal of the Academy Orthopaedic Surgeons*, 16: 497-505, 2008). https://DOI:10.5435/00124635-200808000-00011.

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TRAINING EFFECTS ON BODY COMPOSITION AND STRENGTH OF JUNIOR HANDBALL PLAYERS

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ABSTRACT. Introduction: Coaches and fitness trainers strive through various testing methods to identify appropriate short-term training techniques to achieve the greatest improvements in athletic performance in the shortest possible time. Therefore, studies are needed to evaluate the effects of handball-specific training on selected physical fitness (speed, agility, explosive power, and explosive arm strength) and physiological variables (body fat, body mass, capacity, maximal heart rate, anaerobic endurance) of handball players. The main aim of this study was to develop a complementary strength training program for the development of physical training of professional handball players at junior level, as well as the selection of a test methods to assess fitness. **Materials and methods**: The research was conducted over a period of 12 months, and during this time a complementary strength training program was applied on an experimental group. The experimental group was represented by 16 junior I athletes from the SCM Politehnica Timișoara handball club, and the control group consisted of 16 junior I athletes from the CSM Resita handball club. The tests aimed the evaluation of the following parameters: body composition and strength before and after training for both groups. **Results and discussions**: The results obtained show a slight progress of the experimental group in front of the control group in terms of body composition, but an important progress in terms of strength. Conclusions: The study validated that through the modern means of training applied, substantial contributions are made to the increase of sports performance.

Key words*: junior handball players, body composition, training, strength*

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REZUMAT. ***Efectele antrenamentului asupra compoziției corporale şi puterii la jucătorii juniori de handbal.*** **Introducere***:* Antrenorii şi preparatorii fizici se străduiesc prin diverse procese de încercare, să identifice tehnici de antrenament adecvate de scurtă durată pentru a obține cele mai mari îmbunătățiri ale performanţei sportive într-un timp cât mai scurt. Prin urmare, este nevoie de studii care să evalueze efectele antrenamentului specific handbalului asupra aptitudinilor fizice selectate (viteză, agilitate, putere explozivă, forţa explozivă a braţului) şi variabilelor fiziologice (ţesutul adipos, masa corporală, capacitatea, ritmul cardiac maxim, anduranţa anaerobă) a jucătorilor de handbal masculin. Principalul scop al acestui studiu a fost de a elabora un program de antrenament de forţă complementar pentru dezvoltarea pregătirii fizice a handbaliştilor profesionişti la nivel de juniori, precum şi selectarea unei baterii de teste pentru evaluarea pregătirii fizice. **Materiale şi metode***:* Cercetarea s-a desfăşurat pe o perioadă de 12 luni de zile, perioadă în care au fost aplicate mijloacele de antrenament pentru grupa experimentală. Grupa experimentală a fost reprezentată din 16 sportivi juniori I din cadrul clubului de handbal SCM Politehnica Timişoara, iar grupa de control a fost formată din 16 sportivi juniori I din cadrul clubului de handbal CSM Reşiţa. Prin intermediul testelor s-a urmărit evaluarea următorilor parametrii: compoziţia corporală şi forţa înainte şi după antrenament pentru ambele grupuri. **Rezultate şi discuţii:** Rezultatele obţinute au arătat un uşor progres al grupului experimental comparativ cu grupul de control în ceea ce priveşte compoziţia corporală, dar un progres important în ceea ce priveşte forţa. Studiul a validat că prin mijloacele şi moderne de antrenament aplicate, se aduc contribuţii substanţiale la creşterea performanţelor sportive.

Cuvinte cheie*: jucători de handbal juniori, compoziţie corporală, antrenament, forţă*

Introduction

In handball, the ability to perform is acquired in a relatively long period of time, through an effort that is often not easy, the road to performance being often difficult. The "human material" plays an important role in the performance, but without a training aimed at optimizing the process of physical training of handball players, which ultimately ensures the efficiency of the activity is more difficult to achieve (Balasubramanian, 2014; Marques, van den Tillaar, Vescovi & González-Badillo, 2007; El-Din, Zapartidis & Hassan, 2011). That is why the use of scientific methods to eliminate the hazard in the handball players training, the application of the latest news in the field, are landmarks from which any coach must start in order to streamline the training process

(Póvoas, Seabra, Ascensão, Magalhães, Soares, & Rebelo, 2012; Nikolaidis, & Ingebrigtsen, 2013; Wagner, Finkenzeller, Würth, von Duvillard, 2014; Hermassi, Chelly, Fieseler, Bartels, Schulze, Delank, Shephard, & Schwesig, 2017).

Coaches and fitness trainers strive through various testing methods to identify appropriate short-term training techniques to achieve the greatest improvements in athletic performance in the shortest possible time. Therefore, studies are needed to evaluate the effects of handball-specific training on selected physical fitness (speed, agility, explosive power, and explosive arm strength) and physiological variables (body fat, body mass, capacity, maximal heart rate, anaerobic endurance) of handball players (Cardoso Marques, & González-Badillo, 2006; Gertjan, Gløsen, & van den Tillaar, 2008).

Conducting specific tests in handball and developing a training strategy customized to the positions and individualized to the players is a necessity given that the FRH does not have a database, test methods and training methodology by age, gender, level of training in order to streamline the technical-tactical actions at the modern game level. Testing must precede, accompany and complete the training process so that the coach knows where the players are physically related to international standards, but also to the initial values of testing.

The main aim of this study was to develop a complementary strength training program for the development of physical training of professional handball players at junior level, as well as the selection of a test methods to assess fitness.

Materials and methods

The research was conducted over a period of 12 months, and during this time a complementary strength training program was applied on an experimental group. During these months we tried to observe if the training influence the specific parameters of physical training of the experimental group. The final test was performed under the same conditions and using the same tests as the initial test. Subjects who participated in the personal research were divided into two groups (experimental and control groups).

The experimental group was represented by 16 junior I athletes aged between 16-18 years, from the handball club SCM Politehnica Timişoara. In addition to the training program, which included specific traditional means of handball training, it was applied an additional training program to increase strength and endurance. The number of workouts planned during a week was 6 / week with a day off.

The complementary training is detailed in table 1.

Table 1. Training program

Day	Movement
Day 1	Dumbbell chest press 3x10 reps
	Dumbbell biceps 3x10 reps
	Triceps 3x10 reps
	Inclined dumbbell press 3x10 reps
	EZ bar curl 3x10 reps
	Bodyweight pushups 3x10 reps
	90° leg raises 20 rep x 4 series
Day 2	Front squat 3x12 reps
	Heel raises 3x12 reps
	Leg extension 3x12 reps
	Leg press 3x8 reps
Day 3	Neck strain exercises 3x12 reps
	Seated pushups 3x12 reps
	Wide grip tractions 3x12 reps
	Seated dumbbell shoulders 3x12 reps
	Dumbbell push press 3x12 reps
	Knee to chest raise 10x4 series
Day 4	Incline chest press 3x10 reps
	Tractions 3x10 reps
	Sitting triceps 3x10 reps
	Triceps rope pulldown 3x10 reps
	Proprioceptive pushups 3x20 reps
Day 5	High bar squats 3x12 reps
	Forward lunge 3x12 reps
	Adductions and abductions of the lower limbs 3x12 reps
	Jumping at different heights 3x10 reps
	Candle raises 10x4 series
Day 6	Seated dumbbell shoulders 3x10 reps
	Shoulder plate rotation 3x10 reps
	Cable face pull 3x10 reps
	Pushups 3x10 reps
Day 7	Rest

The control group consisted of 16 junior I athletes aged between 16-18 years, from the CSM Resita handball club. The tests aimed the evaluation of the following parameters: body composition and strength. Body composition tests measured the weight, body fat index (body fat BF) and body mass index (BMI). The strength tests assessed 1RM for squats, deadlifts and bench press. The effect of the training was achieved with the Wilcoxon statistical test which determines the magnitude of the differences between the results obtained by a group of subjects before and after an action (test, retest).

Results and discussions

Assessment of body composition parameters following initial and final testing of the both groups are listed in Table 2.

Table 2. Comparison of pre-test and post-test changes of body composition of groups

Variables	Group	Pre-test	Post-test	Progress
Weight (kg)	EG	83.25±10.74	82.37±9.68	-0.88
	CG	80.87±7.21	80.75±6.67	0.12
Body Fat (%)	EG	18.82±2.14	18.43±1.97	-0.39
	CG	19.21±1.85	19.26±1.8	-0.05
Body mass index (kg/m^2)	EG	24.91±3.17	25.65±3.11	0.74
	CG	25.3± 2.49	25.47±2.48	0.17

Statistical processing of body composition results highlighted the following:

- Weight- In EG the lowest value at the initial test is 65 kg, and the highest value is 97 kg, the amplitude being 32 kg. The final test shows a slight weight loss of up to 3 kg. The initial mean is 83.25 kg, and the final mean is 82.37 kg. The standard deviation represents the average deviation value from the mean and this is 10.74 kg at the initial test, respectively 9.68 kg at the final one. The difference between the values obtained before and after training is not statistically significant as z = -0.492, p = 0.623> 0.05. The size effect r = 0.12 <0.5 shows a small difference between the two tests.

In CG the lowest value at the initial test is 68 kg, and the highest value is 92 kg, the amplitude being of 24 kg. The final test shows a slight weight loss of up to 1 kg. The initial mean is 80.87 kg, and the final mean is 80.75 kg. The standard deviation is 7.21 kg at the initial test, respectively 6.67 kg at the final test. The difference between the values obtained in both tests is not statistically significant as z = -0.057, p = 0.95> 0.05. The size effect r = 0.01 <0.1 shows a very small difference between the two tests.

- BF - In EG the lowest value at the initial test is 15.2 %, and the highest value is 21.6 %, the amplitude being of 6.4 %. The final test shows a slight decrease up to 0.3 %. The initial mean is 18.82%, and the final mean is 18.43 %. The standard deviation is 6.4 % at the initial test, respectively 6.3 % at the final test. The difference between the values obtained before and after training is not statistically significant as z = -0.697, p = 0.486> 0.05. The size effect r = 0.17 <0.5 shows a small difference between the two tests.

In CG the lowest value at the initial test is 16.9 %, and the highest value is 22.3%, the amplitude being of 5.4 %. The final test shows a slight increase up to 0.1 %. The initial mean is 19.21%, and the final mean is 19.26 %. The

standard deviation is 1.85 % at the initial test, respectively 1.8 % at the final test. The difference between the values obtained in tests is not statistically significant as z = -0.170, p = 0.86> 0.05. The size effect r = 0.04 <0.1 shows a very small difference between the two tests.

- BMI - In EG the lowest value at the initial test is 20.2 kg/m^2 and the highest value is 29.7 kg/m^2, the amplitude being of 9.5 kg/m^2. The final test shows a slight increase up to 0.74 kg/m^2. The initial mean is 24.91 kg/m^2, and the final mean is 25.65 kg/m^2. The standard deviation is 3.17 kg/m^2, at the initial test, respectively 3.11 kg/m^2 at the final test. The difference between the values obtained before and after training is not statistically significant as z = -0.641, p = 0.522> 0.05. The size effect r = 0.16 <0.5 shows a small difference between the two tests.

In CG the lowest value at the initial test is 20.8 kg/m^2, and the highest value is 28.9 kg/m^2, the amplitude being of 8.1 kg/m^2. The final test shows a slight increase up to 0.17 kg/m^2. The initial mean is 25.3 kg/m^2 and the final mean is 25.47 kg/m^2. The standard deviation is 2.49 kg/m^2, at the initial test, respectively 2.48 kg/m^2 at the final test. The difference between the values obtained in tests is not statistically significant as z = -0.339, p = 0.73> 0.05. The size effect r = 0.08 <0.1 shows a very small difference between the two tests.

The training progress between groups for body composition is presented in Figure 1.

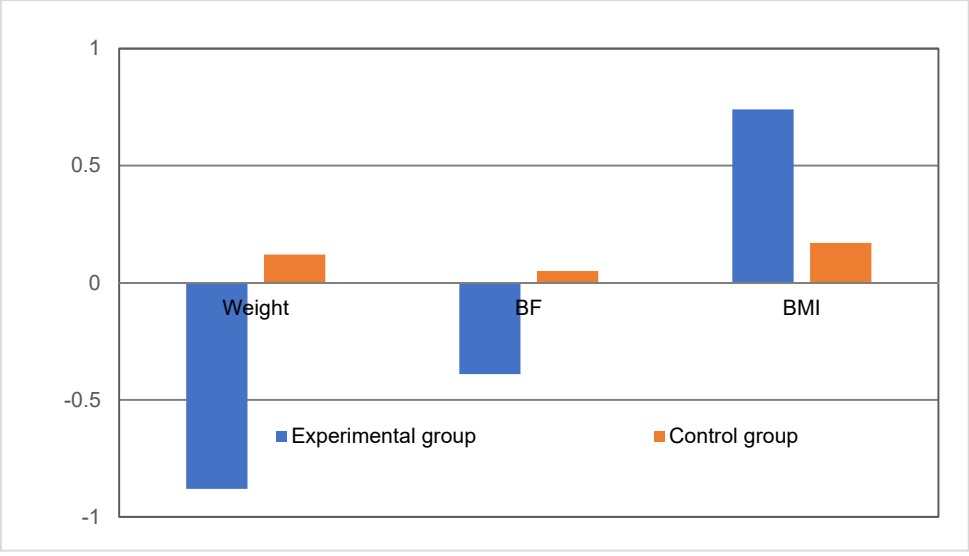

Fig. 1. Progress differences of body composition between the two groups

In the case of weight, the mean value for the experiment group is 0.88 lower and for the control group with 0.12. The difference in progress between the two groups is 0.76 kg in favor of the experimental group.

In the case of BF, the mean value for the experiment group is 0.39% lower, while for the control group it is 0.05% higher. The difference in progress between the two groups is 0.44% in favor of the experimental group.

In the case of the body mass index, the average value for the experiment group is higher by 0.74 and for the control group by 0.17. The difference in progress between the two groups is 0.57 kg in favor of the experimental group.

The results of strength tests for both groups are listed in table 3.

Table 3. Comparison of pre-test and post-test changes of strength of groups

Variables	Group	Pre-test	Post-test	Progress
Squats (1RM)	EG	85.93±7.57	94.37±7.93	8.44
	CG	88.12±7.14	87.5±6.58	-0.62
Deadlifts (1RM)	EG	75.62±5.12	82.81±6.57	7.19
	CG	75.31±7.04	76.25±6.58	0.94
Bench press (1RM)	EG	76.56±5.97	85.62±5.43	9.06
	CG	75.31±6.7	76.56±5.39	1.25

Statistical processing of strength results highlighted the following:

- Squats - In EG the lowest value at the initial test is 75 kg 1 RM, and the highest value is 100 kg 1RM, the amplitude being of 25 kg. The final test shows an increase up to 5 kg. The initial mean is 85.93 kg, and the final mean is 94.37 kg. The standard deviation is 7.57 kg at the initial test, respectively 7.93 kg at the final test. The difference between the values obtained before and after training is statistically significant as $z = -2.584$, $p = 0.01<0.05$. The size effect $r = 0.64>0.5$ shows big difference between the two tests.

In CG the lowest value at the initial test is 75 kg 1 RM, and the highest value is 100 kg 1 RM, the amplitude being of 25 kg. The initial mean is 88.12 kg 1RM and the final mean is 87.5 kg 1RM. The standard deviation is 7.04 kg at the initial test, respectively 6.58 kg at the final test. The difference between the values obtained in tests is not statistically significant as $z = -0.309$, $p = 0.757> 0.05$. The size effect $r = 0.07 <0.1$ shows a very small difference between the two tests.

- Deadlifts - In EG the lowest value at the initial test is 65 kg 1 RM, and the highest value is 80 kg 1RM, the amplitude being of 15 kg. The final test shows an increase up to 15 kg. The initial mean is 75.62 kg, and the final mean is 82.81 kg. The standard deviation is 5.12 kg at the initial test, respectively 6.57 kg

at the final test. The difference between the values obtained before and after training is statistically significant as z = -2.981, p = 0.003<0.05. The size effect r = 0.74>0.5 shows big difference between the two tests.

In CG the lowest value at the initial test is 65 kg 1 RM, and the highest value is 80 kg 1 RM, the amplitude being of 15 kg. The initial mean is 75.31 kg 1RM and the final mean is 76.25 kg 1RM. The standard deviation is 7.04 kg at the initial test, respectively 6.58 kg at the final test. The difference between the values obtained in tests is not statistically significant as z = -0.588, p = 0.556> 0.05. The size effect r = 0.13 <0.5 shows a small difference between the two tests.

- Bench press - In EG the lowest value at the initial test is 60 kg 1 RM, and the highest value is 85 kg 1RM, the amplitude being of 15 kg. The final test shows an increase up to 10 kg. The initial mean is 76.56 kg, and the final mean is 85.62 kg. The standard deviation is 5.97 kg at the initial test, respectively 5.43 kg at the final test. The difference between the values obtained before and after training is statistically significant as z = -3.705, p = 0.001<0.05. The size effect r = 0.92>0.5 shows big difference between the two tests.

In CG the lowest value at the initial test is 65 kg 1 RM, and the highest value is 85 kg 1 RM, the amplitude being of 20 kg. The initial mean is 75.31 kg 1RM and the final mean is 76.56 kg 1RM. The standard deviation is 6.7 kg at the initial test, respectively 5.39 kg at the final test. The difference between the values obtained in tests is not statistically significant as z = -0.467, p = 0.640> 0.05. The size effect r = 0.11 <0.5 shows a small difference between the two tests.

The training progress between groups for strength is presented in Figure 2.

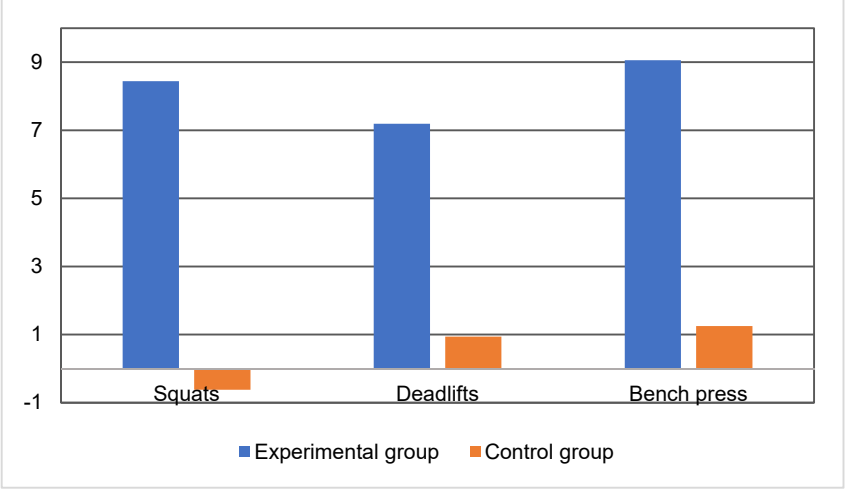

Fig. 2. Progress differences of strength between the two groups

The mean value for 1RM squats in the experiment group is 8.44 higher, and for the control group it is 0.62 lower. The difference in progress between the two groups is 9.06 kg in favor of the experimental group.

In the case of 1RM deadlifts, the mean value for the experiment group is higher by 7.19 at the final test, while for the control group it is higher by only 0.94. The difference in progress between the two groups is 6.25 kg in favor of the experimental group.

For 1RM bench press, the mean value for the experiment group is higher by 9.06 and for the control group by 1.25. The difference in progress between the two groups is 7.81 kg in favor of the experimental group.

Conclusions

The results obtained show a slight progress of the experimental group in front of the control group in terms of body composition, but an important progress in terms of strength.

The study validated that through the modern means of training applied, substantial contributions are made to the increase of sports performance.

The practical implications of the study are the tactical approach to the matches, given a very good physical preparation. The theoretical implications of the study are that the study highlights a common phenomenon in Romania in general, and in handball in particular, when specific physical training is not in line with the requirements of the game.

REFERENCES

Balasubramanian C.M. (2014). *Effect of handball specific aerobic training on selected physical fitness and physiological variables of male handball players* – PhD thesis, Annamalai University.

Marques, M.C., van den Tillaar, R., J. D., & Juan José González-Badillo. (2007). Relationship Between Throwing Velocity, Muscle Power, and Bar Velocity During Bench Press in Elite Handball Players, *International Journal of Sports Physiology and Performance,* 2(4):414–22.

El-Din, H., Zapartidis, I., & Hassan, I., (2011). A comparative study between talented young Greek and German handball players in some physical and anthropometric characteristics, *Biology of Sport,* 28: 245-248.

Póvoas, SCA, Seabra, AFT, Ascensão, AAMR, Magalhães, J, Soares, JMC, & Rebelo, AMC. (2012). Physical and physiological demands of elite team handball, *J Strength Cond Res*, 26: 3365–3375.

Nikolaidis, P. T., & Ingebrigtsen, J. (2013). Physical and Physiological Characteristics of Elite Male Handball Players from Teams with a Different Ranking, *Journal of Human Kinetics*, 38: 115–124.

Wagner, H., Finkenzeller, T., Würth, S., von Duvillard, SP. (2014). Individual and team performance in team-handball: a review. *J Sports Sci Med*, 13(4):808-16.

Hermassi, S., Chelly, M., Fieseler, G., Bartels, T., Schulze, S., Delank, K.-S., Shephard, R., & Schwesig, R. (2017). Effects of In-Season Explosive Strength Training on Maximal Leg Strength, Jumping, Sprinting, and Intermittent Aerobic Performance in Male Handball Athletes. *Sportverletzung Sportschaden,* 31(03), 167–173.

Cardoso Marques, M. A., & González-Badillo, J. J. (2006). In-Season Resistance Training and Detraining in Professional Team Handball Players, *The Journal of Strength and Conditioning Research,* 20(3): 563.

Gertjan, E., Gløsen, T., & van den Tillaar, R. (2008). Effect of Specific Resistance Training on Overarm Throwing Performance, *International Journal of Sports Physiology and Performance*, 3(2):164–75.

Tillaar, R. V. D., Roaas, T. V., & Oranchuk, D. (2020). Comparison of effects of training order of explosive strength and plyometrics training on different physical abilities in adolescent handball players, *Biology of Sport*, 37(3): 239–246.

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THROWING PROCEDURES USED AT THE EUROPEAN U17 BEACH HANDBALL CHAMPIONSHIPS – STATISTICAL ANALYSIS

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ABSTRACT. Beach handball started as a leisure sport, with the main purpose of maintaining the physical training of handball players during the summer, after the end of the internal competitions. **The purpose of the research.** The purpose of this research has been to investigate the change of throwing preferences through beach handball-specific technical procedures, to the first three teams in the initial phase of competitions (games during the groups phase), from two consecutive editions of the European Beach Handball Championship U17 - 2019 and 2021. **Materials and methods**. The study was carried out by viewing the video recordings of the first six games of the national teams ranked on the first three places of the respective editions, at the end of the competitions. After viewing the match records, observation sheets were completed which contained the quantitative values of all throwing procedures (throw and goal). The SPSS Statistics 17 program was used to interpret the data obtained. Calculations were made for descriptive statistics, obtaining the following indices: minimum, maximum, mean, standard deviation, variance and range. **Results**. The 1st place at the 2019 edition had the efficiency of finalizing at the goal through the spinshot procedure of 82.18% (DS=10.53), and the team ranked on the 1st place in 2021, had the efficiency of the same procedure of 72.95% (DS=6.22). The teams ranked 2nd in the two editions mentioned above of BH EC had an average efficiency of 87.5% (DS=14.67) in 2019 and 75.65% (DS=4.27) in 2021. The teams ranked 3rd had an average efficiency of 92.1% (DS=8.74) in 2019 and 72.86% (DS=3.9) in 2021. The 1st place in 2019 had the efficiency of finalizing at the goal through the inflight

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procedure of 81.94% (DS=11.08), and in 2021, the team ranked on the 1st place had the average efficiency of 35.08% (DS=20.59). The teams ranked 2nd in the two editions of BH EC, had an average efficiency of 78.05% (DS=17.65) in 2019 and 58.08% (DS=17.05) in 2021. The teams ranked 3rd had an average efficiency of 64.58% (DS=8.23) in 2019 and 68.45% (DS=24.14) in 2021. **Conclusions**. The trend identified by us for the 3 teams on the podium, from the U17 BH EC 2019 and 2021 editions, highlighted the fact that the share of goal throws by two points increased compared to that of goal throws capitalized by one point.

Keywords: *Beach handball, throws, goals, European Championship U17*

Rezumat. ***Procedee de aruncare la poartă folosite la Campionatele Europene U17 de Beach Handball – Analiză statistică.*** Beach Handball-ul a început ca un sport de loisir, având ca principal scop menținerea pregătirii fizice a jucătorilor de handbal în timpul verii, după încheierea competițiilor interne. **Scopul cercetării.** Scopul aceste cercetări a fost să investigăm schimbarea preferințelor de aruncare la poartă prin procedeele tehnice specifice Beach Handball-ului, la primele trei echipe în faza inițială a competițiilor (jocurile din grupe), de la două ediții consecutive a Campionatului European de Beach Handball U17 – 2019 și 2021. **Materiale și metode**. Studiul a fost efectuat prin vizualizarea înregistrărilor video a primelor șase jocuri ale echipelor naționale clasate în final pe primele trei locuri ale ediţiilor respective. În urma vizualizării înregistrărilor meciurilor s-au completat fișe de observație care au conținut valorile cantitative ale tuturor procedeelor de aruncare (aruncare și gol). Pentru interpretarea datelor obținute s-a utilizat programul SPSS Statistics 17. S-au efectuat calcule pentru statistică descriptivă, obținându-se următorii indici: minimum, maximum, mean, standard deviation, variance and range. **Rezultate**. Locul 1 la ediția din 2019 a avut eficiența finalizării la poartă prin procedeul spinshot de 82.18% (DS=10.53), iar în anul 2021, echipa clasată pe locul 1 de 72.95% (DS=6.22). Echipele clasate pe locul 2 la cele 2 ediții ale CE BH au avut eficiența medie de 87.5% (DS= 14.67) în 2019 și de 75.65% (DS= 4.27) în 2021. Echipele clasate pe locul 3 au avut Eficiența medie de 92.1% (DS= 8.74) în 2019 și de 72.86% (DS= 3.9) în 2021. Locul 1 din 2019 a avut eficiența finalizării la poartă prin procedeul aeriană (inflight) de 81.94% (DS=11.08), iar în anul 2021, echipa clasată pe locul 1 a avut eficiența medie de 35.08% (DS=20.59). Echipele clasate pe locul 2 la cele 2 ediții ale CE BH, au avut eficiența medie de 78.05% (DS= 17.65) în 2019 și de 58.08% (DS= 17.05) în 2021. Echipele clasate pe locul 3 au avut eficiența medie de 64.58% (DS= 8.23) în 2019 și de 68.45% (DS= 24.14) în 2021. **Concluzii**. Trendul identificat de noi pentru cele 3 echipe de pe podium, de la edițiile CE BH U17 din 2019 și 2021, a evidențiat faptul că ponderea aruncărilor la poartă de două puncte a crescut comparativ cu cea a aruncărilor la poartă valorificate cu un punct.

Cuvinte cheie: *Handbal pe plajă, aruncări, goluri, Campionatul European U17*

Introduction

Beach handball started as a leisure sport, with the main purpose of maintaining the physical training of handball athletes during the summer, after the end of the internal competitions. Over time, beach handball has reached clear structure and regulations (van den Linder et al., 2004; Belka et al., 2015; Zapardiel, 2018).

The European Beach Handball Championships were organized for the first time in 2008, the next editions being held every two years. The last edition has taken place in 2021 in Bulgaria. In 2018, beach handball was introduced during the Youth Olympic Games, representing a first step towards achieving the Olympic dream (Zapardiel & Paramio, 2018).

The purpose of the game is, as in the game of handball, to score goals in the opponent's goal using throws. The difference between the two sports games is given by the reward of two points given for some goal-throwing procedures used in beach handball. These procedures are specified by the rules of the game (FRH.ro, 2010): spinshot, inflight, the specialist player's throw, throwing from 6 meters and the goalkeeper's throw (direct goal). Classic throws (jumping, in support, running, standing) are rewarded with 1 point.

Statistical studies have been conducted on the goal-throwing procedures used in important beach handball competitions. Thus, at the World Championships in Cadiz, a comparative study was conducted between the teams in the first places and those in the last places (Konig et al., 2009). The best-ranked teams used a 50% spinshot in most of the matches, and the teams in the last places used this procedure in a percentage of 25%, focusing on 1 point throws in a percentage of 32% -39%.

And at the 2010 World Championships in Antalya, the spinshot was the most used finalizing procedure for the best performing teams (Gehrer & Posada, 2010).

In 2013, after the European Beach Handball Championship held in Randers, Denmark, the throwing procedures used were analyzed and a balance was found regarding their use by the teams participating in this competition (Tezcan, 2013). In contrast, at the 2017 European Championships, held in the Croatian city of Zagreb, the difference in the classification of the procedures was huge, the spinshot being the most commonly used technical procedure. (Zapardiel, 2018).

The purpose of the research

The purpose of this research was to investigate what were the technical procedures of throwing at the goal used and what was the efficiency

of these throws to the teams ranked in the first three places at the U17 Beach Handball EC, in 2019 and 2021 editions.

Materials and methods

The study was conducted by viewing video recordings of the first six games (group games) of the women's national teams ranked in the top three of the U17 European Beach Handball Championships in 2019 and 2021. These teams were *de facto* subjects of the study as follows: 2019 edition – Spain (1st place), Hungary (2nd place), Germany (3rd place); 2021 edition – Hungary (1st place), Netherlands (2nd place) and Spain (3rd place). The 2019 U17 European Beach Handball Championship took place in Poland and was attended by 14 teams. The 2021 edition was held in Bulgaria, with 15 national youth teams participating.

The selection of the teams ranked in the first three places at the end of the competitions was based on the fact that the result obtained by them could illustrate the pattern of tactical preferences for goal completion chosen up to the upper stages of each edition.

After viewing the recordings of the matches from the two editions, observation sheets were completed which contained the numbers of all the throwing procedures (throwing and goal). The variables recorded in the observation sheets were: spinshot throws (SpS_Throws), spinshot goals (SpS_Goals), inflight throws (Inf_Throws), inflight goals (Inf_Goals), specialist goals (SpC_Goals), specialist throws (SpC_Throws), direct goal (DiG_Goals), direct throws (DiG_Throws), 6m goals (6mT_Goals), 6m throws (6mT_Throws), one point throws (OneP_Throw), one point goals (OneP_Goals).

The SPSS Statistics 17 program was used to interpret the data obtained. Calculations were made for descriptive statistics, obtaining the following indices: minimum, maximum, mean, standard deviation, variance and range. After obtaining them, we analyzed the values only from a ascertaining point of view between the two editions of U17 BH EC.

Based on these, the efficiency of the gate completion (Perc) was calculated for each technical procedure used according to the following formula:

$$\eta = \frac{G}{S} \times 100$$

η = the efficiency of the gate completion for each process
G = the number of successful throws (goals) for each procedure
S = the number of throws for each procedure

In order to analyze the efficiency of the teams from the perspective of the number of points accumulated in each match at U17 BH EC, the share of points obtained from 1-point procedures (OnP) and 2-point procedures (SpS, Inf) was calculated relative to the maximum number of possible points from total throws:

$$\eta p = \frac{G_1 + 2 * G_2}{S_1 + 2 * S_2} \times 100$$

η_p = gate completion efficiency calculated for the number of points obtained/possible
G_1 = the number of successful throws (goals) from the procedures which are capitalized by 1 point
S_1 = the number of throws for procedures capitalized by one point
G_2 = the number of successful throws (goals) from the procedures which are capitalized by 2 points
S_2 = the number of throws for the procedures capitalized by 2 points

Results

The analysis of the data recorded in the observation sheets was done taking into account the throwing procedures used by the team players, the total number of throws at the goal, the number of goals and the number of points scored.

Table 1. Descriptive statistics for the spinshot throw used by the six teams.

Ranking		Year	N	Range	Min.	Max.	Mean	Std. Deviation	Variance	Total
I	SpS_Perc	2019	6	29	71	100	82.18	10.53	110.79	
		2021	6	15	64	79	72.95	6.22	38.75	
	SpS_Throws	2019	6	3	7	10	8.50	1.05	1.10	51
		2021	6	5	9	14	12.00	1.79	3.20	72
	SpS_Goals	2019	6	3	5	8	7.00	1.26	1.60	42
		2021	6	5	6	11	8.83	1.94	3.77	53
II	SpS_Perc	2019	6	33	67	100	87.50	14.67	215.34	
		2021	6	12	71	83	75.65	4.27	18.22	
	SpS_Throws	2019	6	2	4	6	5.00	1.10	1.20	30
		2021	6	12	12	24	16.50	4.46	19.90	99
	SpS_Goals	2019	6	3	3	6	4.33	1.03	1.07	26
		2021	6	9	9	18	12.50	3.51	12.30	75
III	SpS_Perc	2019	6	17	83	100	92.06	8.74	76.38	
		2021	6	12	68	80	72.86	3.90	15.18	
	SpS_Throws	2019	6	4	3	7	5.33	1.51	2.27	32
		2021	6	3	18	21	19.67	1.21	1.47	118
	SpS_Goals	2019	6	3	3	6	4.83	1.17	1.37	29
		2021	6	3	13	16	14.33	1.21	1.47	86

The 1st place in 2019 had the efficiency of finalizing at the goal through the spinshot procedure of 82.18% (DS=10.53), and in 2021, the team ranked on the 1st place had the average efficiency of 72.95% (DS=6.22). The teams ranked 2nd in the two editions of BH EC, had an average efficiency of 87.5% (DS=14.67) in 2019 and 75.65% (DS=4.27) in 2021. The teams ranked 3rd had an average efficiency of 92.1 % (DS=8.74) in 2019 and 72.86% (DS=3.9) in 2021.

Table 2. Descriptive statistics for the inflight throw used by the six teams.

Ranking		Year	N	Range	Min.	Max.	Mean	Std. Deviation	Variance	Total
	InF_Perc	2019	6	33	67	100	81.94	11.08	122.72	
		2021	6	56	0	56	35.08	20.59	423.99	
	InF_Throws	2019	6	2	4	6	5.33	1.03	1.07	32
I		2021	6	6	3	9	7.50	2.35	5.50	45
	InF_Goals	2019	6	2	3	5	4.33	0.82	0.67	26
		2021	6	5	0	5	3.00	1.90	3.60	18
	InF_Perc	2019	6	40	60	100	78.05	17.65	311.63	
		2021	6	48	33	82	58.08	17.05	290.70	
	InF_Throws	2019	6	4	1	5	3.00	1.41	2.00	18
II		2021	6	8	3	11	6.00	2.76	7.60	36
	InF_Goals	2019	6	2	1	3	2.17	0.75	0.57	13
		2021	6	7	2	9	3.67	2.73	7.47	22
	InF_Perc	2019	6	25	50	75	64.58	8.23	67.69	
		2021	6	67	33	100	68.45	24.14	582.65	
	InF_Throws	2019	6	6	3	9	5.67	2.42	5.87	34
III		2021	6	6	1	7	3.67	1.97	3.87	22
	InF_Goals	2019	6	4	2	6	3.67	1.63	2.67	22
		2021	6	5	1	6	2.50	1.87	3.50	15

The 1st place in 2019 had the efficiency of finalizing at the goal through the inflight procedure of 81.94% (DS=11.08), and in 2021, the team ranked on the 1st place had the efficiency of 35.08% (DS=20.59). The teams ranked 2nd at the two editions of BH EC, had an efficiency of 78.05% (DS=17.65) in 2019 and 58.08% (DS=17.05) in 2021. The teams ranked 3rd had an efficiency of 64.58% (DS=8.23) in 2019 and 68.45% (DS=24.14) in 2021.

Table 3. Descriptive statistics for the throw of the specialist player used by the six teams.

Ranking		Year	N	Range	Min.	Max.	Mean	Std. Deviation	Variance	Total
I	SpC_Perc	2019	6	33	67	100	83.61	13.60	184.95	
		2021	6	33	50	83	72.72	12.48	155.64	
	SpC_Throws	2019	6	2	3	5	4.17	0.98	0.97	25
		2021	6	11	3	14	7.67	4.13	17.07	46
	SpC_Goals	2019	6	3	2	5	3.50	1.05	1.10	21
		2021	6	9	2	11	5.83	3.54	12.57	35
II	SpC_Perc	2019	6	40	60	100	93.33	16.33	266.67	
		2021	6	40	60	100	72.50	14.29	204.21	
	SpC_Throws	2019	6	4	1	5	2.67	1.37	1.87	16
		2021	6	2	3	5	3.50	0.84	0.70	21
	SpC_Goals	2019	6	2	1	3	2.33	0.82	0.67	14
		2021	6	1	2	3	2.50	0.55	0.30	15
III	SpC_Perc	2019	6	50	50	100	77.78	25.09	629.66	
		2021	6	90	10	100	68.61	30.74	944.91	
	SpC_Throws	2019	6	1	2	3	2.50	0.55	0.30	15
		2021	6	4	1	5	3.83	1.60	2.57	23
	SpC_Goals	2019	6	2	1	3	2.00	0.89	0.80	12
		2021	6	4	1	5	3.17	1.47	2.17	19

The 1st place in 2019 had the efficiency of finalizing at the goal through the specialist player's throw of 83.61% (DS=13.60), while in 2021, the team ranked on the 1st place had the efficiency of 72.72% (DS=12.48). The teams ranked 2nd at the two editions of BH EC, had an efficiency of 93.33% (DS=16.33) in 2019 and 72.50% (DS=14.29) in 2021. The teams ranked 3rd had an efficiency of 77.78% (DS=25.09) in 2019 and 68.61% (DS=30.74) in 2021.

Table 4. Descriptive statistics for the goalkeeper's throw used by the six teams.

Ranking		Year	N	Range	Min.	Max.	Mean	Std. Deviation	Variance	Total
I	DiG_Perc	2019	6	0	0	0	0.00	0.00	0.00	
		2021	6	100	0	100	33.33	51.64	2666.67	
	DiG_Throws	2019	6	0	0	0	0.00	0.00	0.00	0
		2021	6	1	0	1	0.67	0.52	0.27	4
	DiG_Goals	2019	6	0	0	0	0.00	0.00	0.00	0
		2021	6	1	0	1	0.33	0.52	0.27	2
	DiG_Perc	2019	6	0	0	0	0.00	0.00	0.00	
		2021	6	100	0	100	16.67	40.82	1666.67	
	DiG_Throws	2019	6	0	0	0	0.00	0.00	0.00	0
		2021	6	1	0	1	0.17	0.41	0.17	1

Ranking		Year	N	Range	Min.	Max.	Mean	Std. Deviation	Variance	Total
II	DiG_Goals	2019	6	0	0	0	0.00	0.00	0.00	0
		2021	6	1	0	1	0.17	0.41	0.17	1
	DiG_Perc	2019	6	0	0	0	0.00	0.00	0.00	
		2021	6	50	0	50	8.33	20.41	416.67	
	DiG_Throws	2019	6	0	0	0	0.00	0.00	0.00	0
		2021	6	2	0	2	0.33	0.82	0.67	2
III	DiG_Goals	2019	6	0	0	0	0.00	0.00	0.00	0
		2021	6	1	0	1	0.17	0.41	0.17	1

The 1st place in 2019 had the efficiency of finalizing at the goal by scoring from goal to goal through the goalkeeper's throw of 0% (DS=0.00), and in 2021, the team ranked on the 1st place had the efficiency of 33.33% (DS=51.64). The teams ranked 2nd in the two editions of BH EC, had an efficiency of 0% (DS=0.00) in 2019 and 16.67% (DS=40.82) in 2021. The teams ranked 3rd had an efficiency of 0% (DS=0.00) in 2019 and 8.33% (DS=20.41) in 2021.

Table 5. Descriptive statistics for the 6 meter throw used by the six teams.

Ranking		Year	N	Range	Min.	Max.	Mean	Std. Deviation	Variance	Total
I	6mT_Perc	2019	6	20	80	100	87.22	9.98	99.63	
		2021	6	50	50	100	77.78	25.09	629.66	
	6mT_Throws	2019	6	1	5	6	5.17	0.41	0.17	31
		2021	6	3	1	4	2.50	1.38	1.90	15
	6mT_Goals	2019	6	1	4	5	4.50	0.55	0.30	27
		2021	6	1	1	2	1.67	0.52	0.27	10
II	6mT_Perc	2019	6	33	67	100	90.28	15.29	233.86	
		2021	6	100	0	100	50.00	54.77	3000.00	
	6mT_Throws	2019	6	1	3	4	3.33	0.52	0.27	20
		2021	6	3	0	3	1.50	1.05	1.10	9
	6mT_Goals	2019	6	2	2	4	3.00	0.63	0.40	18
		2021	6	3	0	3	1.17	1.33	1.77	7
III	6mT_Perc	2019	6	50	50	100	75.83	15.94	254.17	
		2021	6	50	50	100	91.67	20.41	416.67	
	6mT_Throws	2019	6	1	4	5	4.17	0.41	0.17	25
		2021	6	3	2	5	3.17	1.33	1.77	19
	6mT_Goals	2019	6	2	2	4	3.17	0.75	0.57	19
		2021	6	4	1	5	3.00	1.55	2.40	18

The 1st place in 2019 had the efficiency of finalizing at the goal by scoring through 6 meter throws of 77.78% (DS=25.09), and in 2021, the team ranked on the 1st place had the efficiency of 87.22% (DS=9.98). The teams ranked 2nd in the two editions of BH EC, had an efficiency of 50% (DS=54.77) in 2019 and 90.28% (DS=15.29) in 2021. The teams ranked 3rd had an efficiency of 91.67% (DS=20.41) in 2019 and 75.83% (DS=15.94) in 2021.

Table 6. Descriptive statistics for the one-point throw used by the six teams.

Ranking		Year	N	Range	Min.	Max.	Mean	Std. Deviation	Variance	Total
I	OnP_Perc	2019	6	10	65	75	71.36	3.89	15.11	
		2021	6	33	67	100	92.06	13.69	187.53	
	OnP_Throws	2019	6	8	11	19	15.67	2.66	7.07	94
		2021	6	6	1	7	3.50	2.07	4.30	21
	OnP_Goals	2019	6	6	8	14	11.17	1.94	3.77	67
		2021	6	5	1	6	3.17	1.83	3.37	19
II	OnP_Perc	2019	6	19	57	76	66.93	7.87	61.90	
		2021	6	13	88	100	97.92	5.10	26.04	
	OnP_Throws	2019	6	3	14	17	15.83	1.47	2.17	95
		2021	6	7	1	8	4.00	2.53	6.40	24
	OnP_Goals	2019	6	5	8	13	10.67	2.07	4.27	64
		2021	6	6	1	7	3.83	2.23	4.97	23
III	OnP_Perc	2019	6	11	78	89	82.14	4.40	19.35	
		2021	6	100	0	100	33.33	51.64	2666.67	
	OnP_Throws	2019	6	2	18	20	18.67	0.82	0.67	112
		2021	6	1	0	1	0.33	0.52	0.27	2
	OnP_Goals	2019	6	2	14	16	15.33	1.03	1.07	92
		2021	6	1	0	1	0.33	0.52	0.27	2

The team on the 1st place in 2019 had the efficiency of finalizing at the goal by one-point throws of 71.36% (DS=3.89), and in 2021, the team ranked on the 1st place had the efficiency of 92.06% (DS=13.69). At the same time, the teams ranked 2nd in the two editions of BH EC, had an efficiency of 66.93% (DS=7.81) in 2019 and 97.92% (DS=5.10) in 2021. The teams ranked 3rd had the efficiency of 82.14% (DS=4.40) in 2019 and 33.33% (DS=51.64) in 2021.

Table 7. Descriptive statistics on the efficiency of the throws at the goal of the six teams.

Ranking		Year	N	Range	Min.	Max.	Mean	Std. Deviation	Variance
I	Eff	2019	6	5.30	77.78	83.08	80.33	2.31	5.33
		2021	6	8.00	62.96	70.97	66.28	3.50	12.27
II	Eff	2019	6	17.66	70.91	88.57	79.00	6.23	38.79
		2021	6	15.22	64.44	79.66	73.32	5.27	27.75
III	Eff	2019	6	9.38	75.00	84.38	78.68	3.48	12.14
		2021	6	13.72	68.42	82.14	75.70	5.50	30.24

In the beach handball game, goals scored with 2 points can be decisive in the evolution of a team during a competition or towards winning it.

From table no. 7 we notice a decrease in the efficiency of the goals scored by 2 points from one competition to another. This situation may indicate that in the competitive course of the three teams, a higher number of throws was allowed, followed by a decrease in the efficiency of completion, but with a higher average goals per game than in the 2019 edition.

The team on the 1st place in 2019 had the efficiency of the goals scored by 2 points of 80.33% (DS=2.31), and in 2021, the team ranked on the 1st place had the efficiency of 70.97% (DS=3.50). At the same time, the teams ranked 2nd in the two editions of BH EC, had an efficiency of 79% (DS=6.23) in 2019 and 73.32% (DS=5.27) in 2021. The teams ranked 3rd had efficiency of 78.68% (DS=3.48) in 2019, and 75.70% (DS=5.50) in 2021.

Conclusions

The trend identified by us for the three teams on the podium, from the U17 BH EC editions in 2019 and 2021, highlighted the fact that the share of goal throws by two points increased compared to that of goal throws capitalized by one point.

The two spectacular goal-scoring procedures, spinshot and inflight, had a higher share of use during the 2021 edition of U17 BH EC compared to the 2019 edition. The average goals scored was higher per match, but close values of the standard deviation can be seen, both to the total throws at goal and the goals scored, this indicating a coherent strategy during the first stages of U17 BH EC.

The specialist player is the only one who benefits from 2 points for each goal scored, regardless of the procedure chosen by them. We notice a decrease in its efficiency from one edition to another from the results obtained,

but the number of throws on goal and the number of goals scored are higher in the 2021 edition, this fact indicating a greater involvement during the games.

Goalkeepers in the beach handball game can score much faster and more goals compared to those in the handball game, the ball being put back into play immediately after the goal is scored or if the shot is missed by the opponents. We noticed an increase in goal throws, goals scored and their efficiency from one edition to another, the goalkeepers being much more involved in the game, the attacks of their own team starting with them.

The efficiency of 1-point throws increased at U17 BH EC edition in 2021 compared to the 2019 edition, but a decrease in these throws at goal during the games can be observed from the results, the teams preferring to score goals in the 2-point procedures.

The obtained results indicate a qualitative increase of the beach handball game from one edition to another of the U17 European Beach Handball Championship, by increasing the efficiency of the goal-scoring actions capitalized by 2 points.

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REFERENCES

Bulka, K., Safar, M., Weisser, R., & Chadimova, J. (2015). Beach Handball and Beach Volleyball as means leading to increasing physical activity of recreational sportspeople - Pilot Study. *Journal of Sports Science,* no. 3, p. 165-170.

Gehrer, A., & Posada, F. (2010, November). Statistics from the 4th Beach Handball World Championship 2010 in Antalya. *EHF Periodical Web*.

Gruic, I. (2011). Situational efficiency of team in female part of tournament in the World Beach Handball Championship in Cadiz. *6th International Scientific Conference on Kinesiology - Proceedings Book*, (pp. 524-528). Cadiz.

Konig, O., Mimaridis, I., & Gehrer, A. (2010, November). World Games Kaoshiung 2009 Beach Handball Tournament: Statistical Analysis. *EHF Periodical Web*.

Tezcan, B. (2013, October). 2013 YAC European Beach Handball Championships qualitative analysis. *EHF Periodical Web*.

Van Linder, T., Gehrer, A., & Trespidi, M. (2004, September). Beach Handball is leaving childhood. *EHF Web Periodical*, pp. 55-67.

Zapardiel, J. (2018, January). Beach Handball European Championship Analysis Zagreb 2017. *EHF Web Periodical.*

Zapardiel, J., & Paramio, E. (2018, August). Methodological proposal for technical-tactical practice in Beach Handball. *EHF Periodical Web.*

FRH. (n.d.).
https://frh.ro/documente/regulamente/REGULAMENT%20HANDBAL%20PE%20PLAJA.pdf Regulamentul jocului Handbal pe plajă, Ediția 01 Martie 2010.

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THE DYNAMIC OF THE SOCIO-AFFECTIVE RELATIONS IN A ROMANIAN RURAL HANDBALL SCHOOL TEAM

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ABSTRACT. Introduction: It is human nature to interact with the other. Interpersonal relationships appear as an invisible connection beyond the spoken words and the informational content of the communication. Starting from the age peculiarities of the students, from their motor possibilities, but also from the personality of each one, taking into account the affinities in the relationship with the others, the teacher can form a group in which to obtain performance with a rural school team. **Objectives:** 1) identifying the types and meanings of relationships between group members (acceptance, rejection, indifference relationships) and 2) identifying gender influences on the dynamics of relationships between target group members. **Methods:** The sociometric test was applied on the handball team of the Romanian rural school, 28 students, 14 14 boys and 14 girls), of different ages, between 11 and 14 years old. The average age of the group is 12.89 years, 13 years for boys and 13.64 years for girls. **Results:** Male subjects received more positive choices than rejections compared to female subjects. 3 subjects (2 boys and a girl) are the most popular. Most members of the group, 14, are in zone B (Liked more than disliked), 8 b and 6f. Another 7 (1b and 6f) are in zone C (Disliked more than liked). None are in zones E (Rejected) and F (Neglected). **Conclusions**: The first positive elections were aimed at members of the same gender. Male subjects focused their first positive choices more on same-sex subjects, but most girls focused more on male subjects. The rejection options are oriented towards the other gender. There is at the group level an individualized acceptance according to the personality, qualities and sports abilities of each member of the group.

Keywords: *socio-affective relation, handball, Group Dynamics, personality, sociometric*

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REZUMAT. ***Dinamica relațiilor socio-afective într-o echipă de handbal de la o școală rurală românească*. Introducere.** Stă în natura omului să interacționeze cu celălalt. Relațiile interpersonale apar ca o conexiune invizibilă aflată dincolo de cuvintele rostite și de conținutul informațional al comunicării. Plecând de la particularitățile de vârstă ale elevilor, de la posibilitățile motrice ale acestora, dar și de la personalitatea fiecăruia, ținând cont și de afinitățile în relaționarea cu ceilalți, profesorul poate alcătui un grup în care să obțină performanță cu o echipă școlară din mediul rural. **Obiective.** 1) identificarea tipurilor și sensurilor relațiilor dintre membrii grupului (relații de acceptare, respingere, indiferență) și 2) identificarea influențelor genului asupra dinamicii relațiilor dintre membrii grupului vizat. **Metode**. Testul sociometric a fost aplicat pe echipa re handbal a școlii din mediul rural românesc, 28 de elevi, 14 14 băieți și 14 fete), de vârste diferite, cuprinse între 11 și 14 ani. Media vârstei grupului este de 12,89 ani, 13 ani pentru băieți, respectiv 13,64 ani pentru fete. **Rezultate.** Subiecții de gen masculin au primit mai multe alegeri pozitive decât respingeri în comparație cu subiecții de gen feminin. 3 subiecți (2 băieți și o fată) sunt cei mai populari. Cei mai mulți membri ai grupului, 14, sunt în zona B (Liked more than disliked), 8 b și 6f. Alți 7 (1b și 6f) sunt în zona C (Disliked more than liked). Niciunul nu e în zonele E (Rejected) și F (Neglected). **Concluzii.** Primele alegeri pozitive au fost orientate către membrii de același gen. Subiecții de gen masculin și-au orientat primele alegeri pozitive mai mult către subiecții de același gen, însă cele mai multe fete s-au orientat mai mult către subiecții de gen masculin. Opțiunile de respingeri sunt orientate către genul celălalt.. Există la nivelul grupului o acceptare individualizată în funcție de personalitatea, calitățile și abilitățile sportive ale fiecărui membru al grupului.

Cuvinte cheie: *relație socio-afectivă, handbal, Group Dynamics, personalitate, sociometrie*

INTRODUCTION

It is human nature to interact with each other. Interpersonal relations represent an invisible connection beyond spoken words and the informational content of the communication.

Within the formal educational environment, in school, between the social actors (teacher/student, student/students), many relations – developed during the classes – exist/coexist. It represents an environment where students relate to one another in social interactions depending on personal needs and necessities (Waluyo et al., 2019; Neculau, 1983). The group represents both a setting and a means for training the social actor (the student) and a therapeutic tool (Neculau, 1981, 2007).

From a systemic perspective, sports groups are considered small social groups. They are analysed as complex, adaptative and dynamic systems (Arrow et. colab., 2000). The interactions between the group members and the group with other groups lead to three group dynamics: local dynamics – regarding the internal activities of the group; global dynamics – regarding the emerging properties of the group; and contextual dynamics – regarding the group being placed in a concrete context modelling the group from the standpoint of composition, coherence and behaviours of its members (Rusu, 2012).

The insight into school sports groups represents an elaborate endeavour, given the particularities of sports activities (Carron & Hausenblas, 1998). The group climate is both formal and informal, and teachers must consider several aspects when organising and conducting lessons with the school's representative team. These aspects include the small number of members, the educational nature of the purposes and group objective, the particularities of the members (related to selection in a sports branch). Teachers should also take into account the formality provided by the school regulations and the standards serving as criteria for assessing individual and group behaviours, the direct, face-to-face interactions of the group members, a certain formal and informal group structure, with the distribution of role and status structures of the educators and the educated, emerging processes and states as a result of the interaction between members (cohesion, identity, satisfaction, etc), group identity in relation with other groups (Neculau, 2003, 2007).

In this study, we analysed the representative handball team of a Romanian rural middle school in Iași County, including students from all four study levels. The training sessions were carried out after the teaching activities, for an hour, once a week, in the outdoor school field, during the academic year, except for the holidays and unfavourable weather (cold/and or rainy).

Understanding the relations between students, the way a collective is formed and the attainment of performance (mostly in sport) represents a challenge to which we tried to respond. We chose to analyse the dynamics of relating processes between the members of a mixed representative handball team from the Romanian rural area.

The teaching profession involves many responsibilities (some of the hardest – forming and counselling students). A physical education teacher's activity is special and different from that of the other teachers. This teacher provides freedom of movement to students and teaches them to play in a team. Starting from the age particularities of students, from their motor possibilities and every student's personality, also considering the affinities when interacting with the others, a teacher may make up a group where performance is possible (Gutierrez et al., 2016).

The research objectives focused on: 1) identifying the types and meanings of the relations between the group members (relations of acceptance, rejection, indifference) and 2) identifying gender influences on the dynamics of the relations between the members of the targeted group.

As a working hypothesis, we propose to determine potential gender and age difference in the acceptance and rejection relations between the members of the targeted group.

Material and methods

The sample of subjects included 28 students of the 5th-8th grades within a Romanian rural middle school, in Iași County (north-east of the country). They make up the representative handball school team. Because this school has a reduced number of students, the group is heterogeneous, including children of both genders (14 boys and 14 girls), of different ages, between 11 and 14 years old (8 students (5 b and 3 g – 28.57%) are 14 years old, 11 students (5 b and 6 g – 39.29%) are 13 years old, 7 students (3 b and 5 g – 25%) are 12 years old, while 2 students (1 b and 1 g – 7.14%) are 11 years old. The mean group age is 12.89 years old (13 years old for boys and 13.64 years old for girls).

The research place and procedure

We carried out the research study throughout the academic year 2019-2020. We applied the designed tool in February 2020, in a classroom, immediately after the finalisation of a practice. We obtained the participation consent from both the school administration and students and their parents; then, the subjects filled out the sociometric test. Each student filled out the questionnaire; they received support in understanding the instructions (e.g., when expressing their choices, to write down only the initials of the persons selected and/or rejected). We asked the subjects to rank their choices, and we categorised all answers. We introduced the information in the *GroupDynamics, Inc*. software database. Thus, we were able to present and analyse them.

Moreno (1941, 1960) introduced sociometry in group dynamics analysis by investigating the nature, configuration and intensity of interpersonal relations within a group and the phenomena emerging based on them: communication, collaboration, influence, etc (Vajarim, 2012). Several studies have used this tool in the field of education (Bansal, 2014,;Waluyo et al., 2019) and group formation (Gutierrez et al., 2016; Parker et al., 2020), identifying the influence of variables (such as, gender, age, type of activity, etc.) on sociometric status and social

acceptance, academic self of group members (English, 2017, Underwood, 1959), social intelligence (Lozovina et al., 2014), participation in the group to obtain performance (Lucius & Kuhnert, 1996), self-perception (Ingles et al., 2017) and group perception towards a member (Bahar, 2010; Bakkaloglu, 2010; Cannon, 1954); group cohesion (Barile et al., 2016).

Studies related to sociometric status in sports groups identify influences on the psychosocial climate among group members (hierarchy, group perception of a particular member - acceptance / rejection among teammates, leader / captain) (Vierimaa & Cote, 2016, Ungureanu-Dobre, 2017), on group cohesion (Sopa, 2014; Tohănean et al., 2011), participation in sports (Gadzic & Vuckovic, 2009), obtaining group performance (Lucius, 1997), in formal environments of influence (Vojvodic & Jovanovic, 2014) and informal (Erickson & Cote, 2016).

The sociometric test included several questions concerning the students' options related to collaboration with their classmates in highly diverse situations. The questions are grouped into pairs, and each concern the same situations for which they have to express choices and rejections. In the first part, we collected identification data: initials of the first and last name, age, gender, school, sport practised. In the second part, we formulated six questions: three of them concerned the listing in order of three names of colleagues selected, rejected and indifferent, as well as three other questions concerning potential choices, rejections and indifferent positions of one's person by three colleagues in the activities to the school's representative handball team.

The data obtained after applying the designed sociometric test were processed using the software *GroupDynamics – rev.1.0*. The female subjects are represented by pink, while the males by blue. The distribution of subjects is illustrated by a sociogram, within the concentric circles delimiting the social status areas, as follows. Area A – "Popular", area B – "Liked more than disliked", area C – "Disliked more than liked", area D – "Controversial", area E – "Rejected", area F – "Neglected". The sociogram is the Graph developed by the software featuring the choices among subjects. Each choice represents an arrow connecting the "source"-subject (the one who made it) with the "target"-subject (the one selected). The choice is mutual when two students choose each other. The subjects may be moved around in the Graph to allow the extraction of connections. The green arrows show the positive choices, while the red arrows – the negative choices (rejection). The thicker line represents the first choice, the thinner line – the second choice, the dotted line – the third option, while the arrow indicates direction – from whom to whom.

Results

The first question of the test (*If you were to choose, whom would you prefer as teammates in the school's representative team? List, in order, 3.*) concerned the expression of the subjects' preferences in the positive choices of the other colleagues for activities within the representative team.

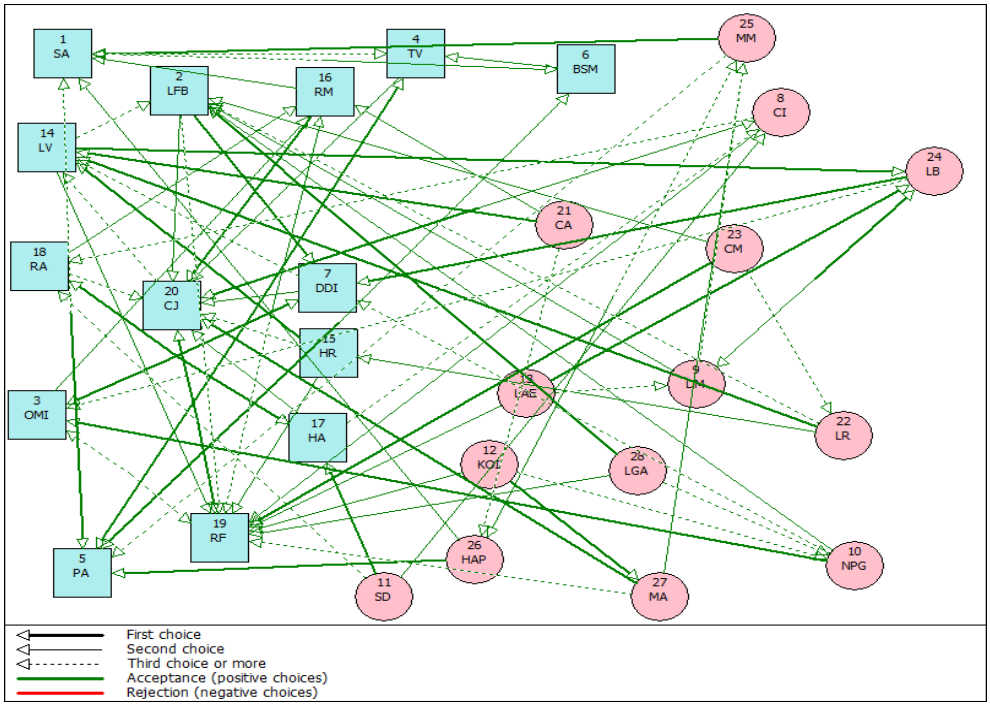

Figure 1. Diagram of positive choices of subjects for the first question of the test

Figure 1 shows that the first options in the positive choices of the subjects, regardless of their gender, concerned mostly the male subjects, most of them CJ and PA (4 each), while LB (female) received most of them, namely 3. The male subjects oriented their first positive choices mostly towards those of the same gender. Only one boy – LV – chose a girl first, LB. Most girls had mainly boys as their first choice; in a few cases, they preferred female colleagues (LB and MA). Most positive choices – regardless of the option (the first, the second, the third) – were received by the subject CJ, male.

The second question concerned the identification of preferences for the rejection of the subjects (*List, in the order of preference, 3 of the colleagues you would not want in the school's representative team.*). The results show that the

first rejection option tends to regard the other gender, boys towards girls and girls towards boys (see Fig. 2). It does not mean that there were no rejections as first options within the same gender. Most first rejection options were received by KOI, a female subject: 4 from boys and one from girls. In addition, HR, a male subject, received 3 first rejection options from boys and one from girls. On the contrary, LFB – a male subject – received 3 first rejection options from the girls. SD and CI – both girls – received 2 rejection options from the boys.

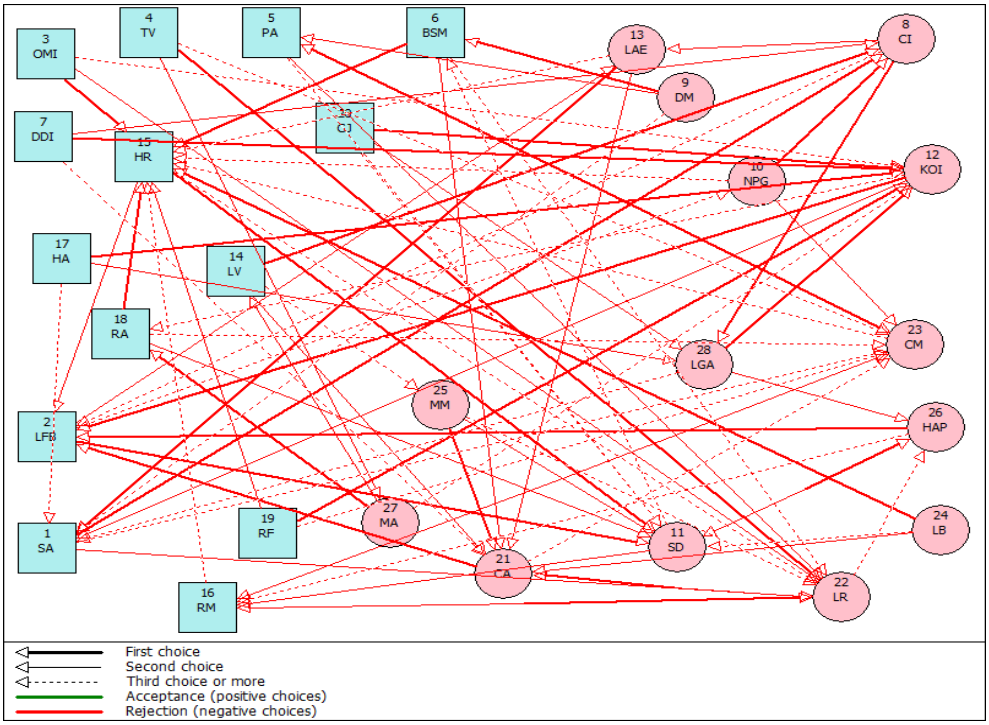

Figure 2. Diagram of subject rejections for the second test question

The third question – also concerning acceptance (*Who of your colleagues do you believe prefer to attend school sports competitions with you?*) – sought to identify the potential choices made by the colleagues concerning the subject. Figure 3 shows that the dominant preferences come from subjects of the same gender. LB (a female subject) received most of the possible choices as a first option (3) from subjects of the same gender, while the male subject LV also received three from boys. In addition, the Graph shows several first positive choices from the girls towards the boys (HAP towards BSM, MA towards RF) and only one from the boys towards the girls (RM towards MA).

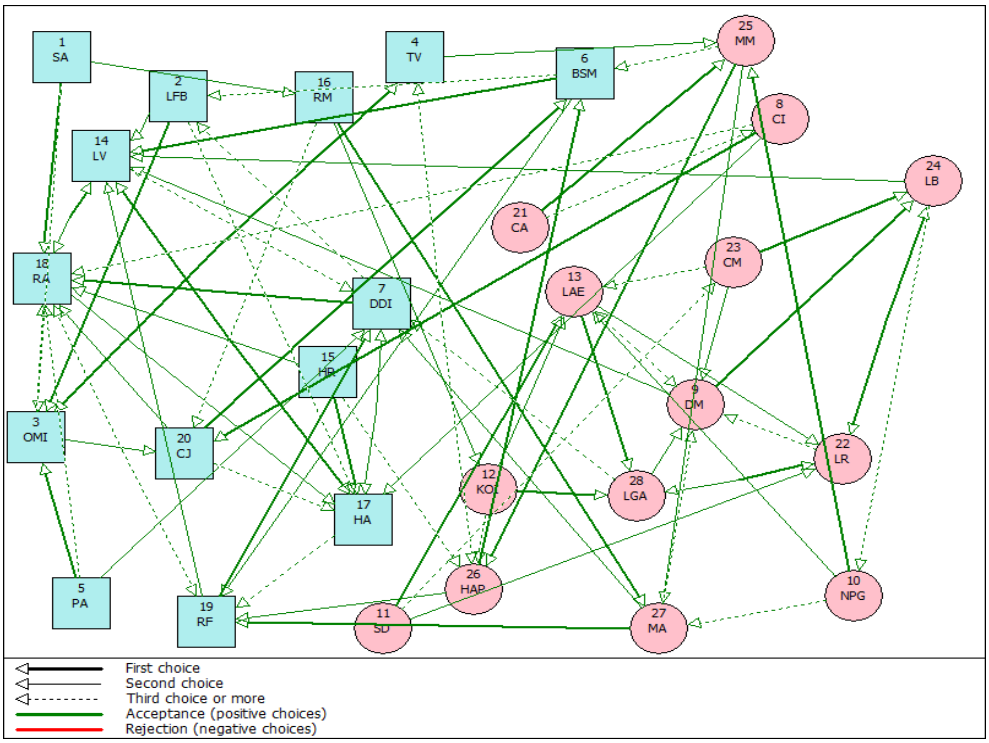

Figure 3. Diagram of positive choices of subjects for the third question of the test

Question 4 (*Choose 3 colleagues, in order, who do not prefer you.)* sought to identify the negative preferences towards the subject filling out the test (see Fig. 4). The results obtained highlight the following aspects: two female subjects (NPG) and two male subjects (DDI and RF) did not receive any rejection from the other colleagues. By corroborating the information in the sociogram, three of them (NPG, DDI and LB) are part of the central area of the popular subjects (i.e., of the leaders). Several subjects received 3 first rejection options each from the others (from both genders), but it is worth noting that rejection also came from the other gender. Hence, the male subjects CJ and BSM received 3 first rejection options each (2 from girls and one from boys). At the same time, TV (a boy) also received 3 first rejection options, but 2 are from boys and one from girls. Several female subjects – CI, HAP and SD – received a first rejection option each from boys and one each from girls.

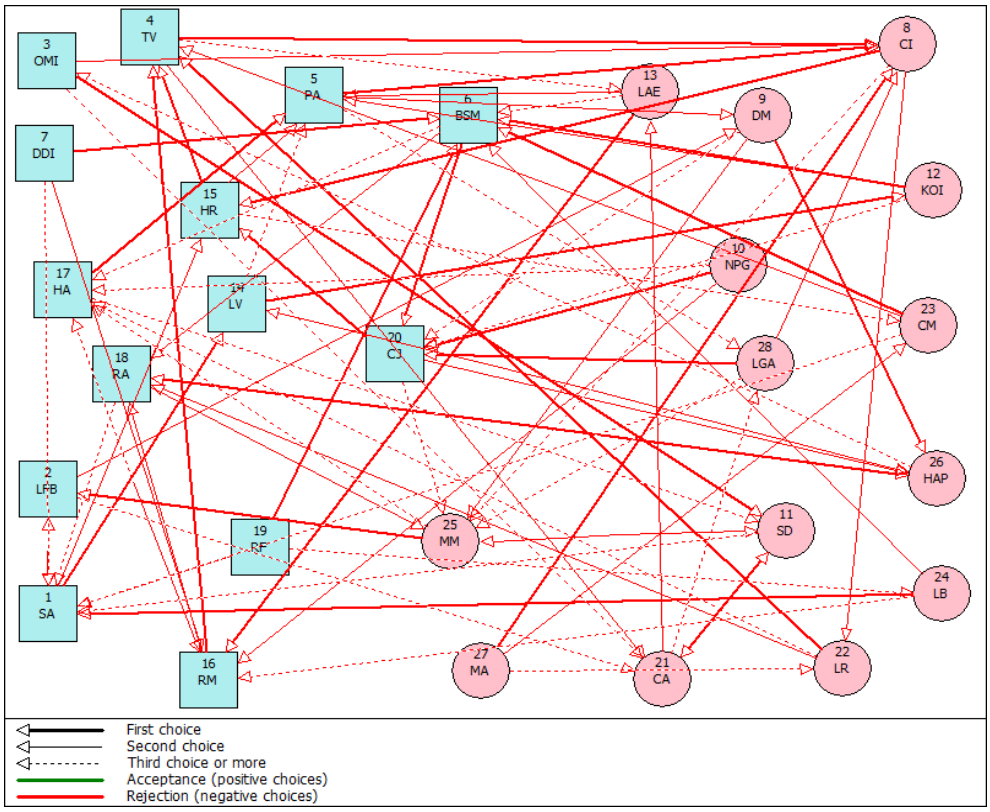

Figure 4. Diagram of subjects' rejections for the fourth question of the test

Question five of the test sought to identify the subjects' degree of indifference towards the other colleagues (*List 3 colleagues who are indifferent to you in what concerns the team members.*). Figure 5 illustrates that the first options in choices focus on the opposite gender. For instance, NPG – a female subject – received 4 first options from boys and one from a girl. In addition, DDI and TV – male subjects – received 3 first options from girls each. The same Graph shows that CM and KOI – female subjects – did not receive any choice from the other group members.

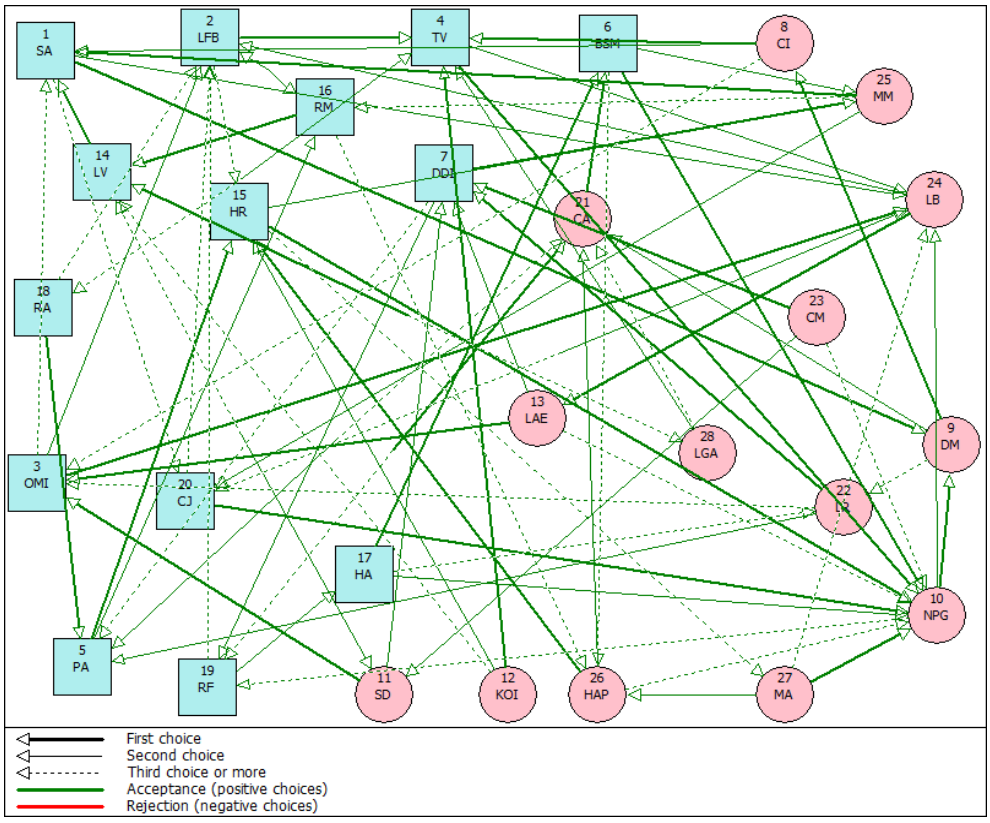

Figure 5. Diagram of the subjects' choices for the fifth question of the test

For question 6 (*List 3 colleagues, in order, to whom you think you are indifferent.*) none of the subjects – regardless of their gender – received more than two first choices (see Fig. 6). These data may be explained by the fact that the group subjects care for one another; hence, they find it difficult to point out a degree of indifference. These data are backed up by the absence of subjects in areas E "Rejected" and F – "Neglected".

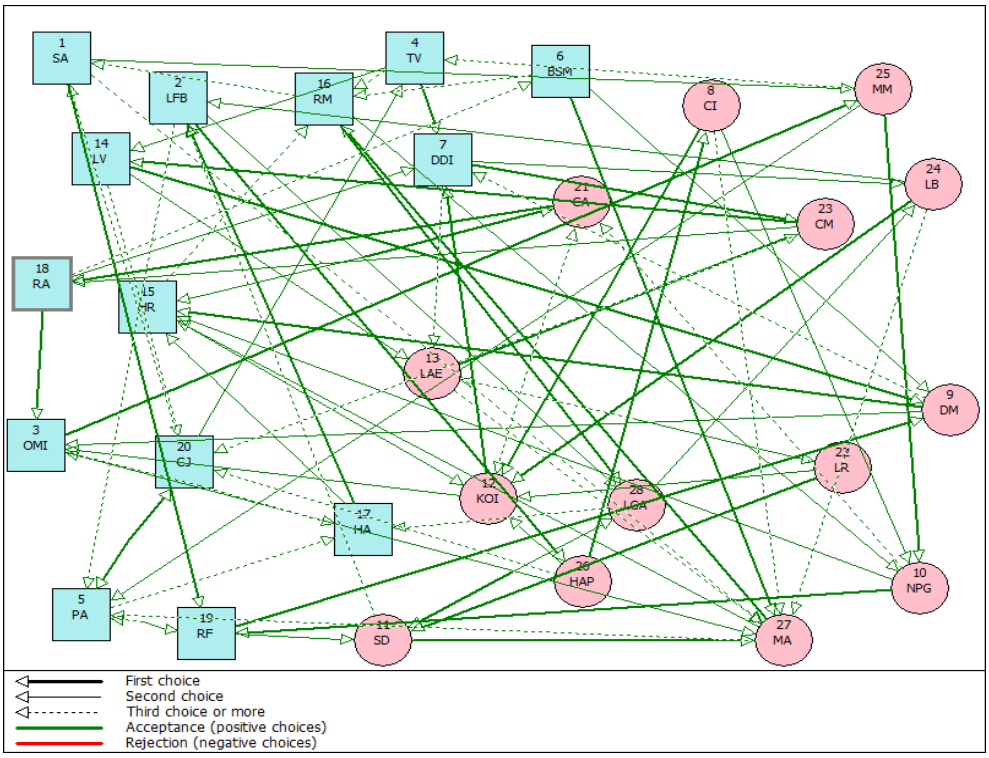

Figure 6. Diagram of the subjects' choices for the sixth question of the test

Discussion

Figure 7 illustrates that the male subjects received more positive choices than rejections compared to the female subjects. The highest number of positive choices obtained by a girl is 15 (NPG), while by a boy is 23 (RF), which makes them the most popular within the group.

Only two of the research subjects (DDI and RF), both male, received only positive choices – RF received the most choices (23), while DDI had 18 choices. Among the male subjects, too, a relatively significant number of the positive choices concerned CJ (20 choices), LV (18 choices, just like DDI), but they also received rejections: LV – 3 rejections, while CJ – 5 rejections.

Among the female subjects, the highest number of positive choices concerned NPG (15), who also recorded a rejection. In addition, LB (who received 14 positive choices) had a rejection just like MA (with 12 positive choices).

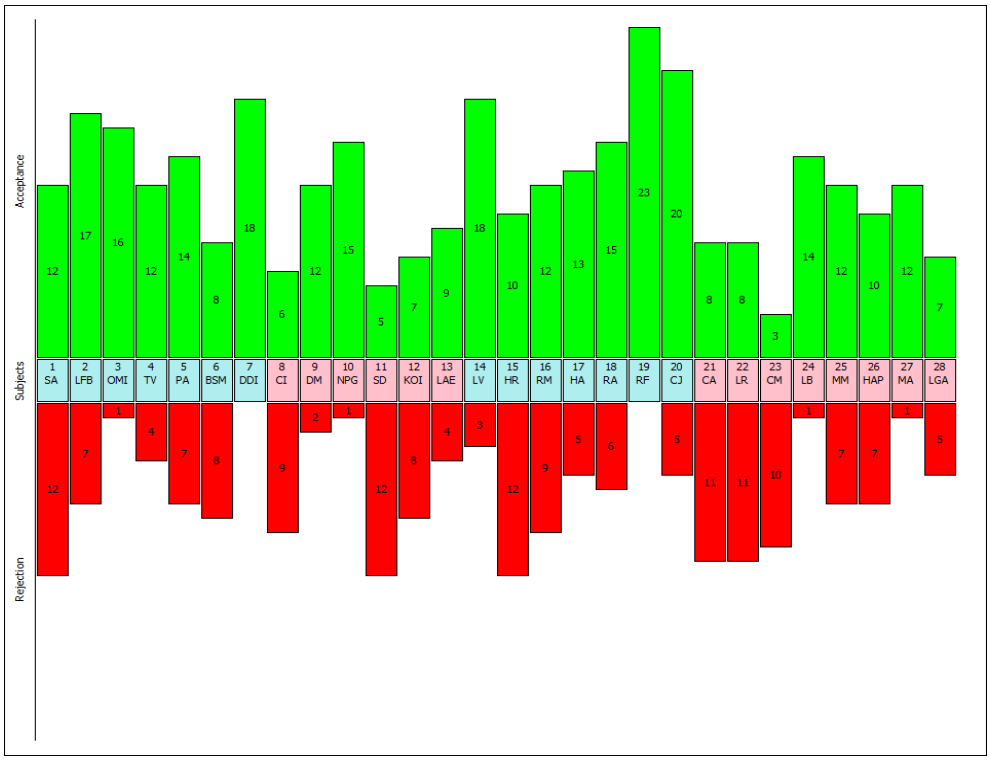

Figure 7. Types of choices (positive and negative) of research subjects

A girl (CM) recorded the lowest number of positive choices – 3, while the lowest number recorded by boys, namely by BSM, is 8 (he had the same number of rejections). Most rejections – 12 – were recorded by 2 boys and a girl. One of the boys (SA) received the same number of positive choices and rejections.

It is worth noting that the subjects RF and DDI – who received most of the acceptance choices and no rejection – are part of the 13-14 years old category (they are older, thus the group leaders).

The resulting sociogram (fig. 8) highlights 5 subjects (3 boys and 2 girls) as popular at the level of the sample group (RF, DDI, OMI, and NPG and LB, respectively), aged 13 years old except for one boy – DDI – who is 14 years old. Interestingly, none of the subjects are in areas E – "Rejected" and F – "Neglected". These aspects may be explained by the fact that the students know each other, participate in activities. Hence, they know each other and accept each other enough to avoid being excluded from the group.

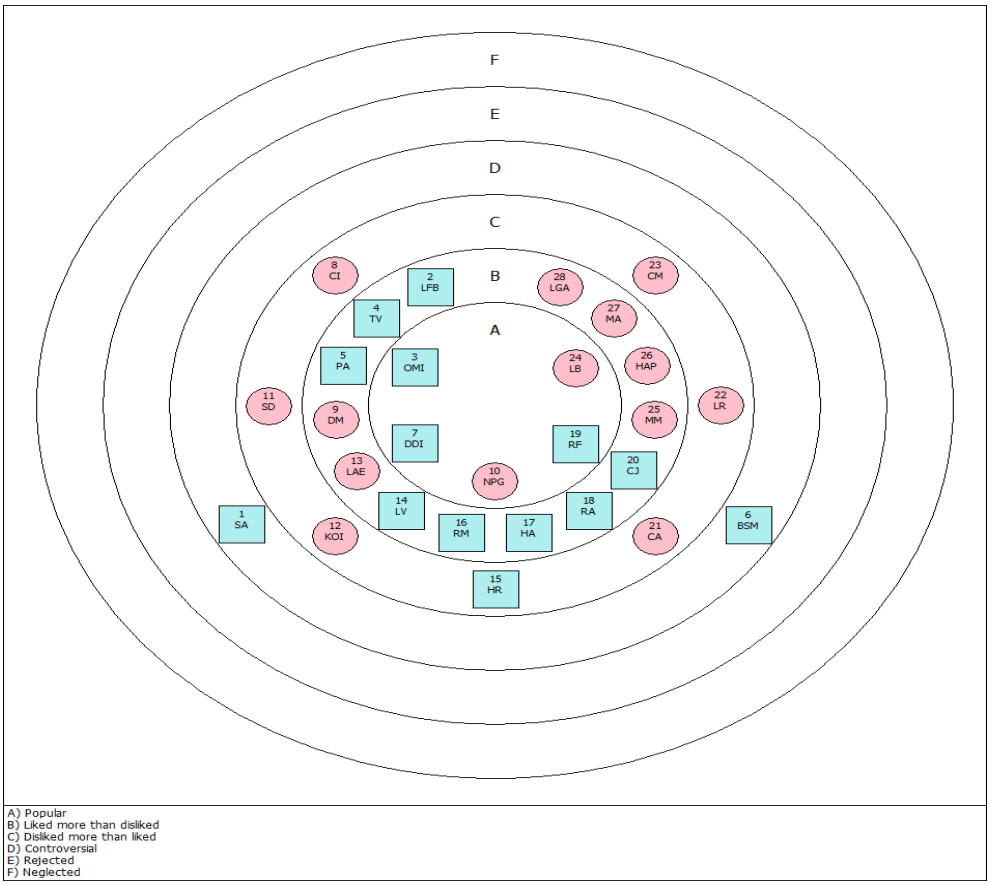

Figure 8. Sociogram of the group of subjects

Most subjects are in area B, "Liked more than disliked", 14 (8 are boys and 6 girls). The group members within this area are part of the age category 12-14 years old. In the case of boys, 2 are 12 years old, 3 are 13 years old and 2 are 14 years old. In the case of girls, one is 12 years old, two are 13 years old and 3 are 14 years old. Consequently, some of the new students selected at the beginning of the school year managed to develop positive relations with the "old" group members.

Area C ("Disliked more than liked") includes 7 subjects, 1 boy and 6 girls. It is worth noting that all those in this area are part of the younger age category: the boy is 11 years old, while the girls between 11 and 13 years old (one is 11 years old, 4 are 12 years old, and another one is 13 years old).

Results do not seem to be fortuitous in this area because – given that the team is in its beginning stages – group composition highlights that the younger students had been selected at the beginning of the school year to take part in the activities of the representative team and they did not all manage to be acknowledged and considered by the other group members.

Area D – "Controversial" comprises only two male subjects (both aged 14 years old). Hence, RF, DDI and OMI (male subjects) and LB and NPG (female subjects) received most of the first positive choices (see Fig. 9). In what concerns the rejections, most of the first negative options regarded KOI (female) – 5, while HR and SA (male) received 5 each (see Fig. 10).

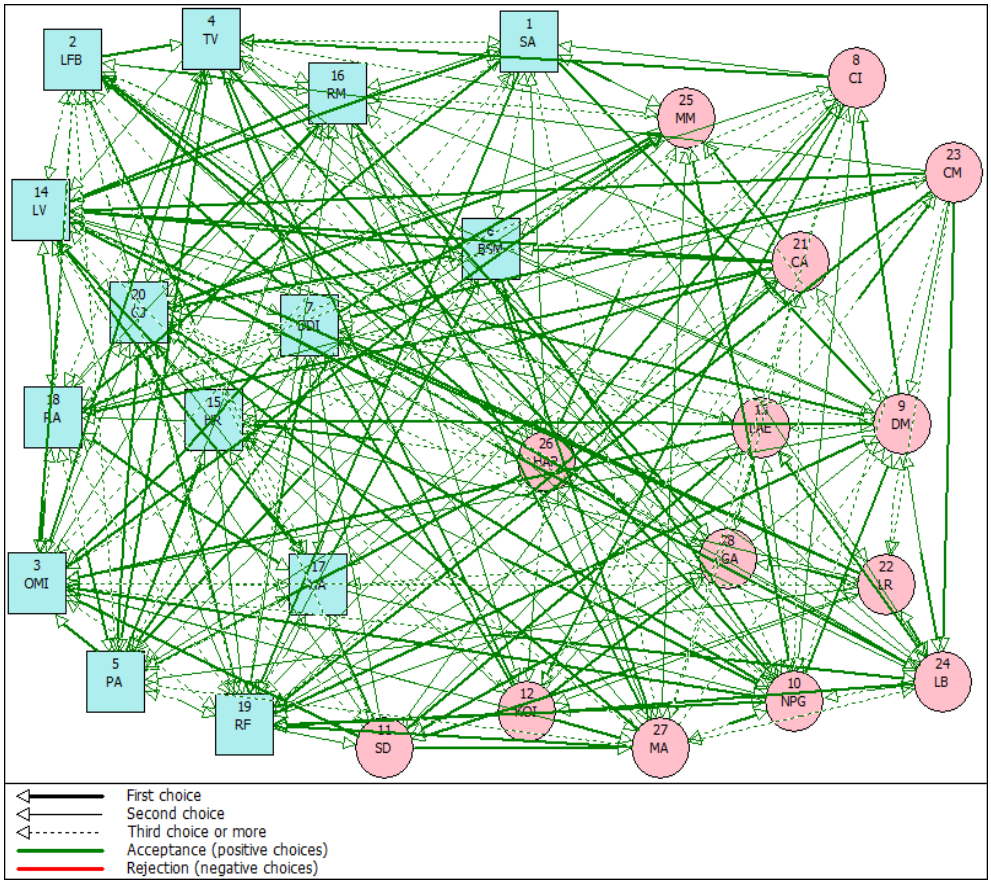

Figure 9. Diagram of the types of positive choices made by research subjects

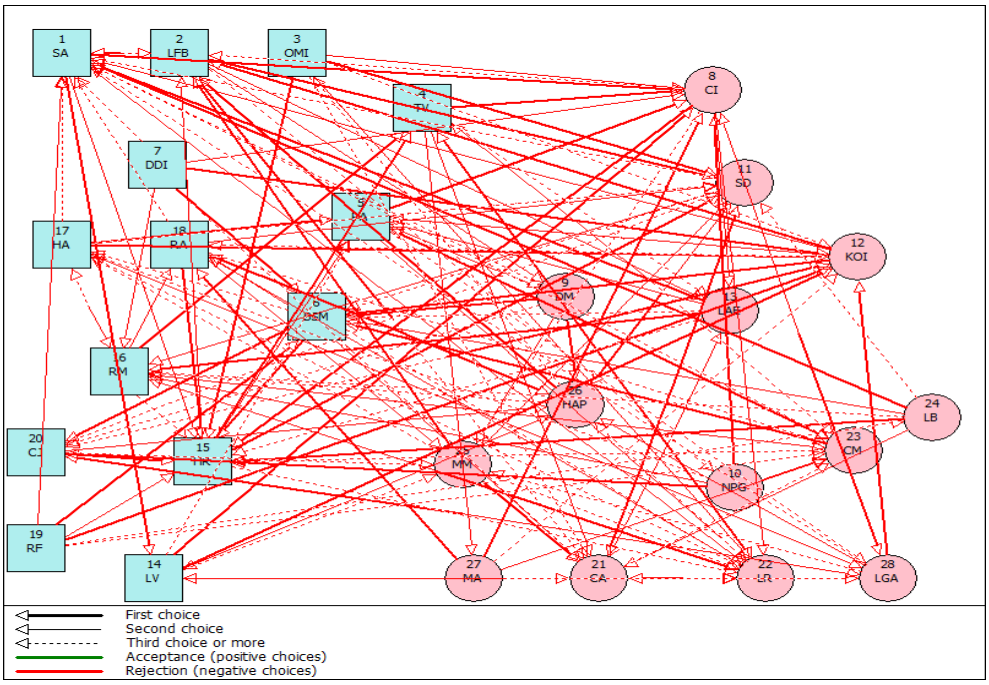

Figure 10. Diagram of the types of positive choices made by research subjects

Conclusions

This study was pilot research aiming to get a better insight into the dynamics of relations within a Romanian representative rural handball team. To this end, we used a software called *GroupDynamics*, *Inc.*, which allowed me to conduct the data input through sociometric designed in a database and then to process the data.

Thus, we formulate below a series of conclusions in conformity with the results obtained:

The male subjects received more positive choices than rejections compared to the female subjects. These data may correspond to the sociocultural model specific to the Romanian area. It is a cultural-traditional society where values are conveyed to the new generation, all the more in the rural areas.

Only two of the research subjects – both male – received only positive choices. They belong to the 13-14 years old category. In their turn, two girls obtained many positive choices, but they also received a rejection, and their

score was lower than the one of the boys. Team seniority (the presence of subjects within the group several years in a row) may represent an independent variable influencing these positive preferences.

The distribution of the subjects by social status areas highlighted that at group level, area A "Popular" comprised 5 subjects (3 boys and 2 girls) as popular at the level of the sample group. Except for one of the boys, who is 14 years old, all the other leaders are 13 years old. Subjects gain their popularity by highlighting their qualities, given that sports activity is vocational. Hence, besides the relations, communication and encouraging skills, the handball-specific technical and tactical skills may have played a role, too, in the positive preferences for both genders. If we also consider the first options in the positive and the negative choices, depending on gender, we may draw the following conclusions:

- None of the subjects are in areas E – "Rejected" and F – "Neglected". The subjects know each other, they partake in activities together, which may explain this aspect.
- Most subjects are in area B – "Liked more than disliked", namely 14 (8 are boys and 6 girls). Their ages (11 to 14 years old) show that some of the younger members (aged 11-12) were accepted by the others or that they managed to integrate faster than the others. Hence, individualised acceptance depends on the personality, qualities and sports skills specific to each student.
- Area C – "Disliked more than liked" includes 7 subjects (1 boy and 6 girls). It is worth noting that all of them are younger students: the boy is 11 years old, while the girls between 11 and 13 years old (one is 11 years old, 4 are 12 years old, and another one is 13 years old).
- Area D – "Controversial" comprises only subjects, both male, both with the age category of 14 years old. The common experiences and deeper affective relations between the members with greater seniority in the team may have led to the inclusion of the two older subjects in the neutral area.
- The male subjects oriented their first positive choices mostly towards those of the same gender. Most of the girls had mostly boys as their first choice (in some cases, they chose the leader female colleagues).
- The first rejection option focuses on the other gender: boys towards girls and girls towards boys. Of course, there are also rejections as first options within the same gender.

  Given the results, it may be stated that *the hypothesis was confirmed*.

By analysing the situation of each subject, we can provide relevant information for each teacher or coach (Physical Education Teacher), thus creating a premise in the teaching endeavour to obtain performance with the group they coordinate. Such information may be used in the following directions:

- The organisation and course of practice lessons, the choice of various exercises, especially in pairs or groups, depending on the affinities between subjects (group members). Organising activities and games where students of both genders (their seniority, qualities and sports skills) may interact can entail group performance and improve it. In addition, rotating and changing partners may provide a chance of interacting more often with each other.
- The choice of specialised positions (it is known that in handball, like in any other collective sport, the choice of a player for a position must rely on their relations with the other, besides their physical and technical/tactical qualities). Though it may seem relatively too early, one may choose the position of players even at this stage.
- The choice of a defence or attack tactical strategy considering understanding, communication, cooperation and mutual help between players in different situations. During training sessions, one may practice various technical and tactical combinations, taking into account the socio-affective relations between the group members.
- The choice of strategies to attract the subjects in the "neutral" area, for them to develop positive relations by using "bridge" subjects. The last students can connect those at the periphery of the group and the leaders, or those who do not like each other, but like the same subjects.
- The choice of strategies to highlight students who are shier or more introverted, to integrate them in the group, by empowering them and increasing their self-esteem.
- Possible strategies in partnership with the parents, to facilitate the connections between children who reject or ignore each other at the level of the team.

This study has a series of limits. The sociometric test makes it possible to photograph the structure and position of individuals within the group as it is recorded at a certain point, but it does not show the causes, nature, subsequent evolution of group relations. It would be relevant to correlate the data obtained by the sociometric test with those obtained through other methods. In addition, we have not found any studies on rural subjects.

Several future research directions provide us with the possibility of getting a deeper insight into the topic. By considering other independent variables (team seniority, positions, first-team or substitute player, etc.) and by making comparisons with other sports groups (from various school settings, sports branches or rankings), new information becomes available regarding the dynamic of relations between the members of a sports group.

REFERENCES

Arrow, H., McGrath, J.E. & Berdahl, J.L. (2000). *Small groups as a complex systems: formation, coordination, development, and adaptation*. Sage Publications.

Bahar, H.H. (2010). The effects of gender, perceived social support and sociometric status on academic success. *J. Procedia Social and Behavioral,* 2, 3801-380.

Bakkaloglu, H. (2010). A comparison of the loneliness levels of mainstreamed primary students according to their sociometric status. *J. Procedia Social and behavioral,* 2, 330-336.

Bansal, S. (2014). Sociometry a conceptual introduction. *J. International Journal of Education and Science Research REVIEW,* 1(05), 147-153.

Barile, S., Riolli, L. & Hysa, X. (2016). Modelling and Measuring Group Cohesiveness with Consonance: Intertwining the Sociometric Test with the Picture Apperception Value Test. *Systems Research and Behavioral Scienc*e, John Wiley & Sons, Ltd.

Cannon, K.L. (1954). Sociometric scores among high school students and their relationships to selected variables of family living, *Retrospective Theses and Dissertations*. 14224, https://lib.dr.iastate.edu/rtd/14224.

Carron, A.V. & Hausenblas, H.A. (1998). *Group Dynamics in sport*, second edition. Book Crafters, USA.

Erickson, K. & Côté J. (2016). An Exploratory Examination of Interpersonal Interactions between Peers in Informal Sport Play Contexts. *PLoS ONE* 11(5): e0154275. doi:10.1371/journal.pone.0154275.

Gadžić, A. & Vučković, I. (2009). Participation in sports and sociometric status of adolescents. *Biomedical Human Kinetics*, 1, 83 – 85. DOI: 10.2478/v10101-009-0021-y.

Gutierrez, J.H., Astudillo, C.A., Perez, P.B., Melia, D.M. & Vejar, A.C. (2016). The multiple team formation problem using sociometry. *J. Computers & Operations Research*, 75, 150-162.

Inglés, C.J., Aparisi, D., Delgado, B., Torregrosa, M.S. & García-Fernández, J.M. (2017). Sociometric types and academic self-concept in adolescents. *Psicothema,* 29(4), 496-50. doi: 10.7334/psicothema2016.54.

Lozovina, M., Bonacin, D. & Lozovina, V. (2012). Emotional intelligence and determination of sociometric status in sport. *Sport Science*, 5(2), 66-74.

Lucius, R.H. & Kuhnert, K.W. (1996). Using sociometry to predict team performance in the work place. *The Journal of Psychology*, 131(1), 21-32.

Moreno J.L. (1960). *The Sociometry Reader.* Glencoe Illinois: The Free Press.

Moreno, J.L. (1941). Foundations of Sociometry: An Introduction. *Sociometry*, 4(1), 15-35, Published by: American Sociological Association Stable URL: http://www.jstor.org/stable/2785363 Accessed: 27/10/2010 16:18.

Neculau, A. (1981). *Grupul – mediu și mijloc de formare psihosocială*. Viitorul social.

Neculau, A. (1983). *A fi elev*. Bucharest: Albatros.

Neculau, A. (coord.) (2003). *Manual de psihologie socială*. Iasi: Polirom.

Neculau, A. (2007). *Dinamica grupului și a echipei*. Iasi: Polirom.

Parker, J.N., Cardenas, E., Dorr, A.N. & Hackett, E.J. (2020). Using Sociometers to Advance Small Group Research. *Sociological Methods & Research*, 49(4), 1064-1102. DOI: 10.1177/0049124118769091.

Rusu, O. (2012). *Psiho-sociologia grupurilor sportive. O introducere*, Iasi:Tehnopress.

Sopa, I.S., Sanislav, M. & Pomohaci, M. (2014). The Importance and Utility of the Sociometric Survey Method in Physical Education Research. *Procedia - Social and Behavioral Sciences*, 117, 185 – 192.

Tohănean, D.I., Chicomban, M. & Drugău, S. (2011). Socializing students in physical education and sports activities. *Ovidius University Annals, Series Physical Education and Sport / SCIENCE, MOVEMENT AND HEALTH*, XI(2), Supplement, 638-644.

Underwood, P.H. (1959). A comparison of two sociometric tests, designed to measure the social value of individuals in groups of preschool children, master thesis. Oklahoma State University.

Ungureanu–Dobre, A. (2017). Organizing the women's football team according to the inter-individual preferences of its members. *Journal of Sport and Kinetic Movement*, II(30), 82-88.

Vajarim M,R. (2012). What is sociometry and how we can apply it in our life? *J. Advances in* Asian Social Science (AASS), 2(04), 570-573.

Vierimaa, M. & Côté J. (2016). An exploration of sociometric status and peer relations in youth sports. *Journal of Sport Behavior*, 39(1), 72-91.

Vojvodić, M. & Jovanović, M. (2014). Sociometric structure of premier league volleyball club. *SportLogia*, 10(2), 96–105. doi: 10.5550/sgia.141002.en.006V.

Waluyo, E., Djeni, D., Pratama, L.D. & Anggraini, V.A. (2019). Clustering based on sociometry in Pythagoras theorem. *IOP Conf. Series: Journal of Physics: Conf. Series 1211*, 012058 IOP Publishing, doi:10.1088/1742-6596/1211/1/012058.

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HIGH SCHOOL FEMALE STUDENTS' SATISFACTION DEGREE AFTER PRACTICING SPECIFIC AQUAGYM PROGRAMS AS AN EXTRACURRICULAR ACTIVITY

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ABSTRACT. Introduction. The aquatic environment offers numerous exercise opportunities with a focus on achieving sports performance, as well as a number of beneficial effects compared to the terrestrial environment. The biological adaptation to aquagym-specific exercises, supported by the physical properties of the aquatic environment, is the response of the body to physical stimuli leading to ameliorative changes in body functions. The novelty of the activity and the relative ease of this form of physical exercise stimulated and motivated the female participants in an aquagym program carried out in the 1st semester of the school year 2021-2022. **Objective.** Our statement is supported by the results obtained from carrying out a satisfaction survey which aimed to highlight the impact of aquatic recreational activities, namely aquagym, and the effectiveness of the means selected in the operational programs on motor and functional capacity. **Materials and Methods.** The study included 37 high school female students, aged 16-17, from "Carol I" National College in Craiova. In order to optimize the students' motor skills, an aquagym-specific program of exercises was developed and carried out along 12 sessions of 50 minutes each. At the end of the program, an opinion questionnaire was administered addressing high school female students' degree of satisfaction with the content of aquagym sessions. **Results.** The application of the questionnaire-based satisfaction survey highlighted the advantages of practicing aquagym ranging from bio-motor benefits, such as the increase in flexibility, balance and muscular strength, to

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aspects outlining the improvement in some components of quality of life. The result of this survey confirms that the aquagym program was appreciated by the students who became aware of the positive effects obtained. **Conclusions.** Our students' participation in aquagym-specific programs revealed the need to improve the educational offer of the school subject Physical Education and to harmonize the contents of the classes with students' options. The analysis of the survey findings shows that the students rated the recreational content higher than the effects on motor skills and, surprisingly, a very small percentage of the students appreciated the effects on body shaping.

Keywords: *aquagym program, motor capacity, action systems, satisfaction, high school female students*

REZUMAT. ***Gradul de satisfacţie al elevelor de liceu după practicarea programelor specifice de aquagym ca activitate extracurriculară*****. Introducere.** Mediul acvatic oferă numeroase oportunităţi de exerciţii fizice, cu accent pe obţinerea de performanţe sportive, precum şi o serie de efecte benefice în comparaţie cu cele oferite de mediul terestru. Adaptarea biologică la exerciţiile specifice aquagym-ului, susţinută de proprietăţile fizice ale mediului acvatic, este răspunsul organismului la stimuli fizici care provoacă modificări ameliorative ale funcţiilor corpului. Noutatea activităţii şi relativa facilitate a acestei forme de practicare a exerciţiului fizic a stimulat şi motivat participantele la un program de aqugym, desfăşurat în anul şcolar 2021-2022, semestrul I. **Obiectiv.** Afirmaţia noastră este susţinută de rezultatele obţinute în urma aplicării unui chestionar de satisfacţie care şi-a propus să evidenţieze impactul activităţii ludico-recreative acvatice, respectiv a aquagym-ului şi eficienţa mijloacelor selecţionate în cadrul programelor operaţionale asupra capacităţii motrice şi funcţionale. **Materiale şi metode.** Studiul a inclus 37 de eleve de liceu cu vârsta cuprinsă între 16-17 ani de la Colegiul Naţional „Carol I" Craiova. Pentru optimizarea capacităţii motrice a elevelor s-a alcătuit un program de exerciţii specifice aquagym-ului, desfăşurat timp de 12 şedinţe, cu o durată de 50 de minute. La sfârşitul programului a fost aplicat un chestionar de opinie vizând gradul de satisfacţie al elevelor de liceu cu privire la conţinutul şedinţelor de aquagym. Rezultate. Aplicarea chestionarului de satisfacţie a evidenţiat avantajele practicării aquagym-ului pornind de la beneficiile bio-motrice, cum ar fi creşterea flexibilităţii, echilibrului şi forţei musculare, către aspecte ce conturează îmbunătăţirea unor componente ale calităţii vieţii. Rezultatul prezentei anchete confirmă faptul că programul de aquagym a fost apreciat de eleve, care, au conştientizat efectele pozitive obţinute. Concluzii. Participarea la programele specifice aquagym-ului a evidenţiat nevoia de îmbunătăţire a ofertei educaţionale la disciplina educaţie fizică şi a racordării conţinuturilor lecţiilor la opţiunile elevilor. Din analiza rezultatelor chestionarului se remarcă faptul că elevele apreciază mai mult conţinutul recreativ, mai puţin efectele asupra capacităţii motrice şi în mod surprinzător, un procent foarte mic au apreciat efectele asupra modelării corporale.

Cuvinte cheie: *program aquagym, capacitate motrică, sisteme de acţionare, satisfactie, elevele de liceu*

Introduction

The aquatic environment offers numerous exercise opportunities with a focus on achieving sports performance, recovering from various conditions and, last but not least, on increasing exercise capacity which results in physical fitness.

Innovative ways to increase the level of fitness through physical activity are intensely looked for in contemporary society. Many scientists believe that the use of innovative technologies could solve this problem (Kovaleva & Andrieieva, 2011; Krutsevich, Vorobiov & Bezverkhnya, 2011).

Nowadays physical exercise plays a key role in people's well-being and health, and exercising regularly, especially outdoors, can help improve their health and ensure a more productive and enjoyable life.

Several authors state that the physical inactivity of high school students has become a major concern for current and future public health (Bonnema, Coetzee & Lennox, 2020; Mayorga-Vega, Saldías & Viciana, 2019). That is why today's society aspires to promote education that develops life skills and creates healthy environments in which children and adolescents are taught to adopt a healthy lifestyle.

Teenage girls are much more physically inactive than boys. Health and sports experts recommend water sports as a viable alternative. The benefits of exercise in the terrestrial environment are well known, but if they are performed in the aquatic environment, they bring an important advantage for the human body, especially when they are practiced in an organized setting.

Swimming is an activity that requires all the muscles. But the fear of water is a barrier for many young people. For them, aquagym is an easy alternative with approximately similar effects.

Aquagym is part of the modern exercise trends and is an activity that transfers the means of basic gymnastics into the aquatic environment. The action systems can be taught analytically or globally, individually but especially in groups, their purpose being to stimulate the cardiovascular system and increase motor (Banks & Reimann, 2012; Costa et al., 2012) and functional capacity, pursuing a harmonious physical development and an increase in quality of life (Bădău et al., 2015; Silva et al., 2019). Exercises in warm water have also been suggested to reduce depression and improve mood (Silva et al., 2019). They are considered attractive, combining the benefits of aerobics with those of swimming, fitness, stretching and hydromassage. The attractiveness of aquagym is also supported by the fact that it has a low impact on the joints compared to the exercises performed in the terrestrial environment, generating greater comfort and satisfaction (Jones et al., 2009; Fisken et al., 2015). The hydrodynamic properties of water, such as density, buoyancy, and resistance, make these exercises less strenuous than the physical activity on land, while

providing similar physiological effects (Folsom, 2008). Also, hydrostatic pressure, viscosity and the specific heat make the aquatic activity beneficial for certain people (Williams, Barreria & Tseh, 2020). Many studies have shown that exercises performed in water improve flexibility, balance, joint mobility, endurance and muscle strength, the aerobic capacity, muscle mass composition, and, over time, it also enhances the neuromuscular coordination in people with disabilities (Takeshima et al., 2002; Adami, 2004; Bădău, 2016).

Objective and Hypothesis

The aim of the research was to include aquagym practice as a means of attractive physical activity in the preferences and motivations of high school female students.

Determining the degree of satisfaction of a group of female teenagers who participated in 12 aquagym sessions can endorse the practice of this form of leisure-time exercise.

Materials and Methods

The present research included a number of 37 high school female students, aged 16-17, of "Carol I" National College in Craiova. The high school has an ultramodern swimming pool, but because of the pandemic there were restrictions on its use. That is why the programs of free exercises and with portable equipment, which are specific to aquagym, were performed in Leamna de Sus, at "Alegria" swimming pool.

The questionnaire-based survey was used in the approach, the data being statistically processed and the results highlighted by suggestive synoptic graphs.

In order to identify the high school female students' degree of satisfaction with aquagym programs based on free exercises, we compiled a questionnaire containing 17 items which included open-ended, closed-ended and multiple choice questions.

Results and Dicussions

Statistics of relevant items

For the first item, "On an increasing scale of 1 to 5, how much do you want aquagym to be integrated in Physical Education classes?", 26 of the students (70.30%) chose level 5, 10 students (27.00%) chose level 4, and 1 student (2.70%) chose level 3.

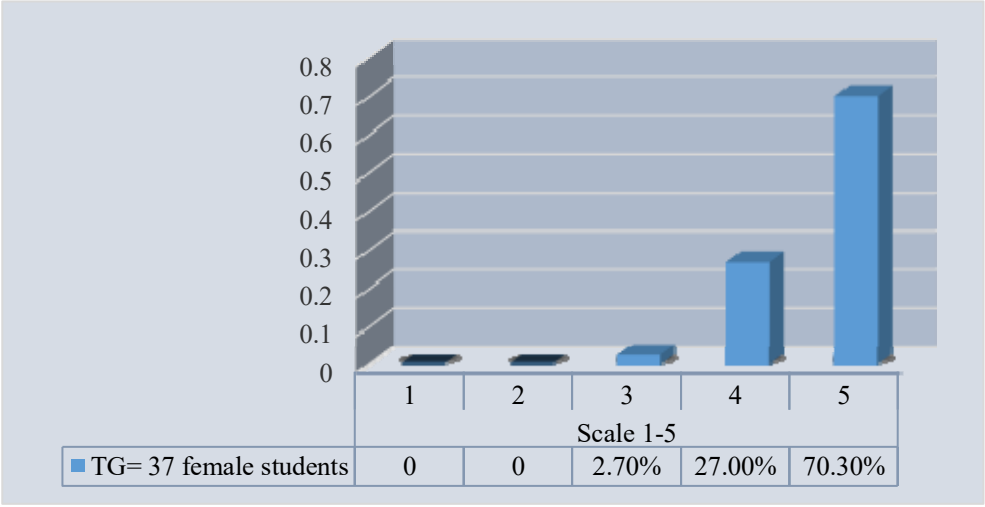

Chart 1. Percentage representation of the respondents' answers to the first item – Integrating aquagym in Physical Education classes.

At the second item, "Did you notice any positive effects on your fitness after the aquagym sessions?", 32 students (86.50%) answered "YES", and the rest of 5 students (13.50%) chose the answer "NO".

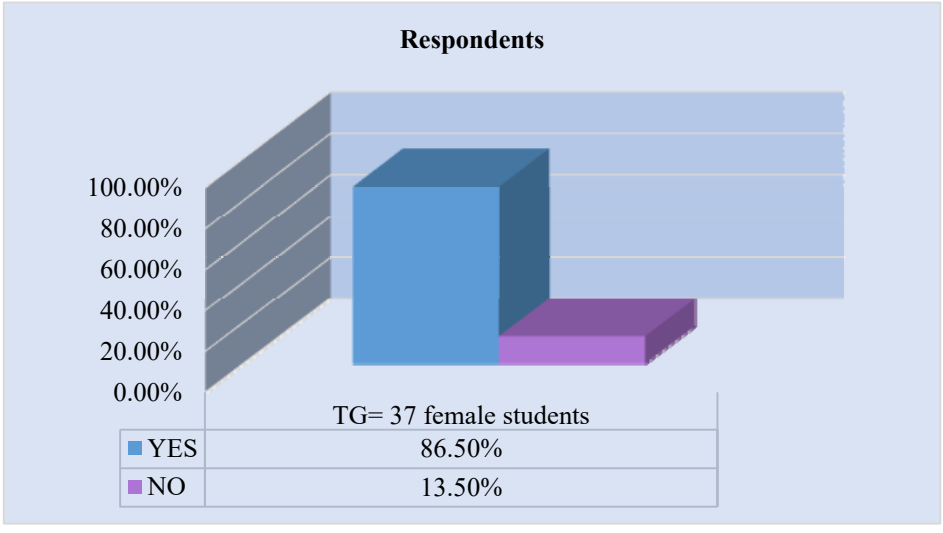

Chart 2. Percentage representation of the positive effects on fitness.

The respondents who answered in the affirmative to the previous question were then asked, at the third item, to indicate which aspect was improved.

Of those interviewed, more than 21% opted for mental relaxation and muscle toning, followed by 16% who chose improvement in exercise endurance, and 13% opted for the third option - improvement in fitness. The fourth option was represented by improvement in balance, mobility and health, as well as hydromassage, each being chosen by 8%. Of the 9 options, the least motivating were body shaping (3%) and weight loss (2%).

Table 1. Answers to question 3.

Effect	Option
Improvement in fitness	5
Muscle toning	8
Weight loss	1
Mental relaxation	8
Improvement in exercise endurance	6
Improvement in balance and mobility	3
Hydromassage	3
Body shaping	1
Improvement in health	3

As regards the fourth item on the degree of attractiveness of aquagym sessions, out of a total of 37 subjects, 31 assessed it at the maximum level, which represents 83.80%, 5 subjects rated it with 4, representing a percentage of 10.80%, and the remaining 2 subjects graded the activity with 3, corresponding to 5.40%.

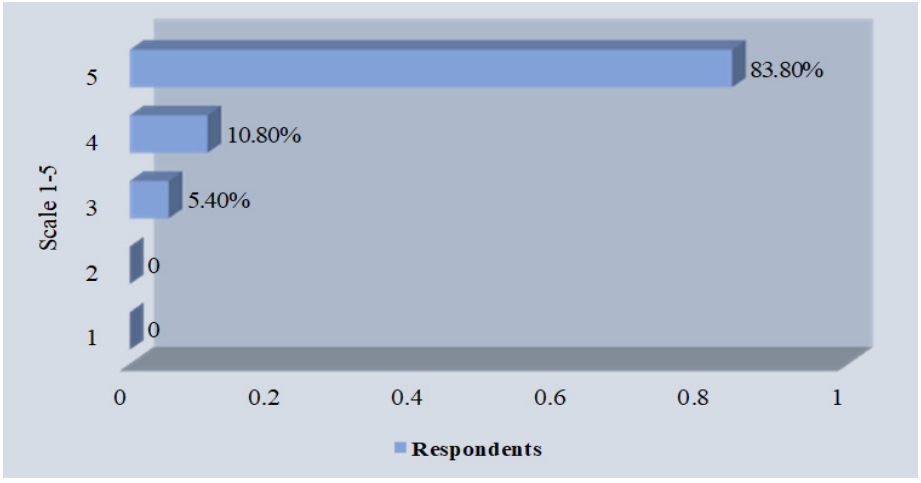

Chart 3. Percentage representation of aquagym attractiveness.

The next item was focused on the effectiveness of aquagym exercises to improve fitness. Of the 37 subjects, 30 gave a maximum of 5, which represents 81.10%, 6 students marked it with 4, namely 16.20%, and 1 student assigned it 3 points, which represents 2.70%. This means that 75% of the surveyed female students realized that they were in good physical shape after participating in the exercise programs carried out in the aquatic environment.

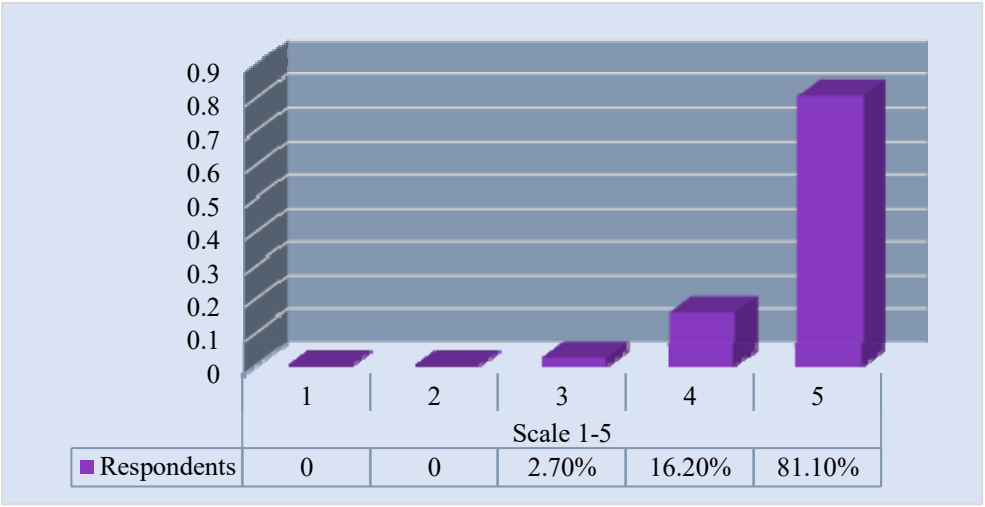

Chart 4. Percentage representation of the exercises used in the aquagym program from the point of view of achieving good physical fitness.

The sixth item, "Which part of the aquagym program did you enjoy the most?", triggered the following answers:

Table 2. Answers to question 6.

Workout program – content	Number of respondents	Percentage
the warm-up exercises performed in water	2	5.40%
the aerobic part	7	18.90%
the localized part	0	0
the stretching round	3	8.10%
the recreational games	4	10.80%
the breathing exercises	0	0
the entire program	21	56.80%

At the seventh item, "Practicing aquagym has influenced you more from a physical, mental, emotional or social point of view?", 27 of the respondents, representing 73%, answered that it influenced them from the point of view of physical development, 6 students responded that it influenced them mentally, representing 16.20%, followed by 3 students who were influenced emotionally, that is 8.10%, and 1 student picked the social point of view, namely 2.70%.

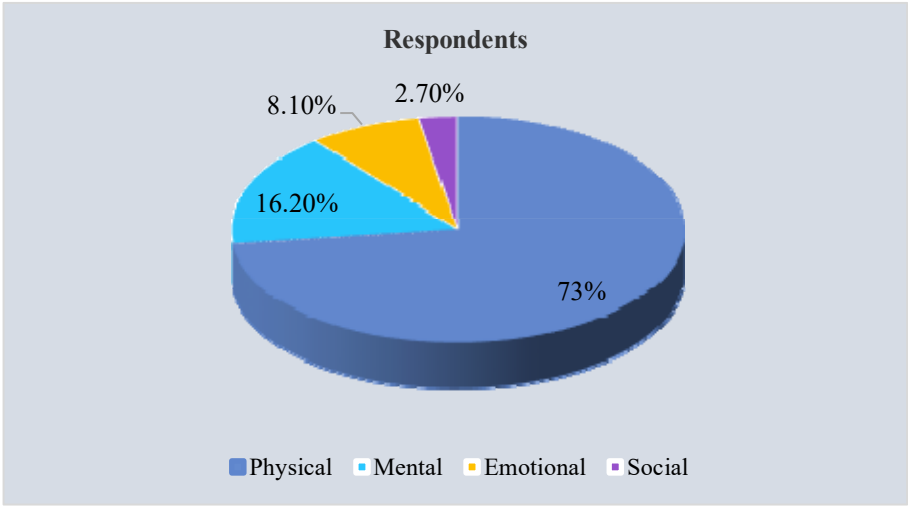

Chart 5. Percentage representation of physical, mental, emotional and social development after practising aquagym.

As regards the item "From a psychological point of view, do you think that this activity can contribute to reducing the levels of anxiety faced by young people nowadays?", 36 respondents answered "YES", that is 97.30%, which means that the vast majority of subjects considered that this form of exercise had a positive effect on students' anxiety in today's society whereas only 1 student, representing 2.70%, believed that, from a psychological point of view, it did not contribute to the decrease of anxiety.

At the ninth item, "Aquagym as a form of exercise good for health is: very important, little important and not important", the subjects answered as follows: out of a total of 37 respondents, 18 answered "very important", namely 48.60%, and the other 19 chose the answer "important", corresponding to 51.40%. The last two options, "little important" and "not important", were not picked by any students. Therefore, the respondents appreciated this form of exercise as important and very important for their health.

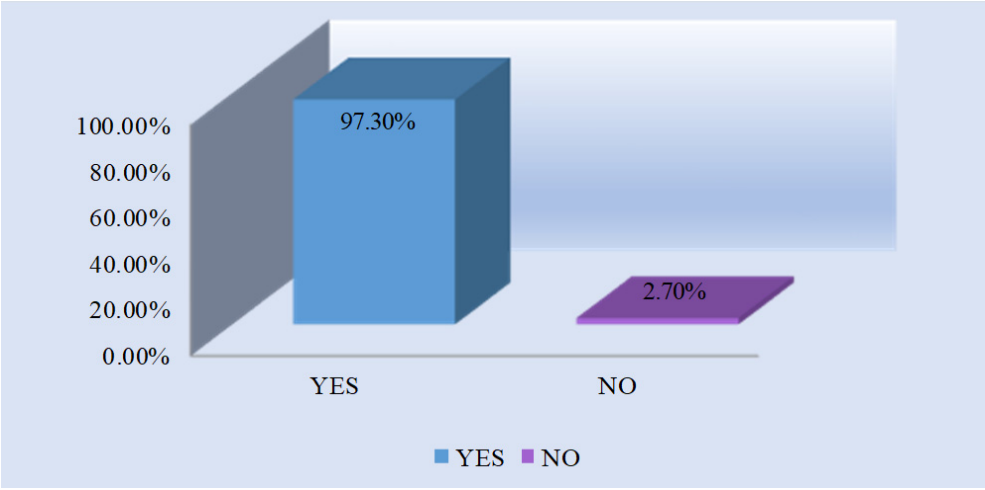

Chart 6. Percentage representation of the respondents' answers about the potential of aquagym to relieve anxiety.

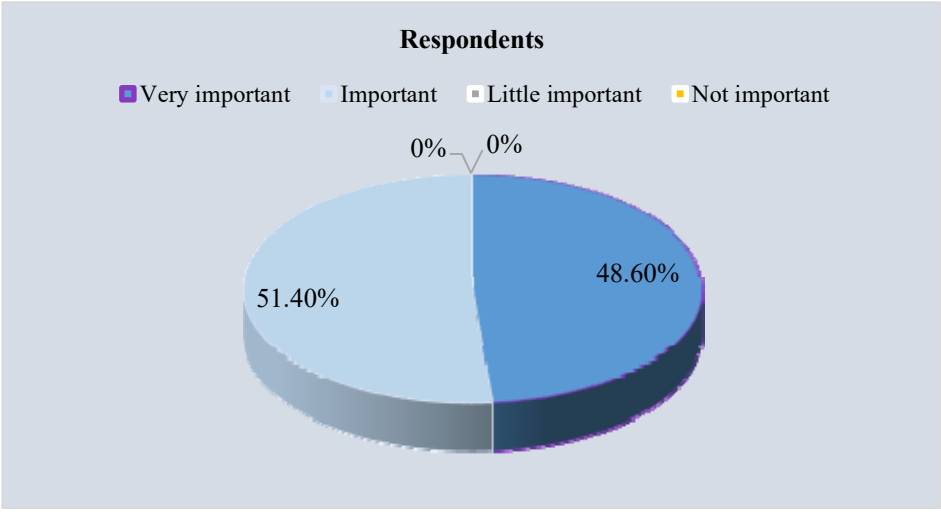

Chart 7. Percentage representation of the importance of aquagym as a form of exercise for health.

The answers to the tenth item, "Do you think that aquagym programs have had a beneficial effect on the development of motor skills (strength, endurance, speed, skill)?", were an unanimous "Yes", as 100% of the respondents noticed the beneficial effects of aquagym programs on motor skills.

The next item was worded as follows: "On a scale of 1 to 3 (1 is the least important, 2 important, 3 very important) which of the following aspects do you consider most relevant to you?". As can be seen, mental relaxation still ranked first, followed by the increase in endurance capacity. Also, 24 respondents considered muscle toning important.

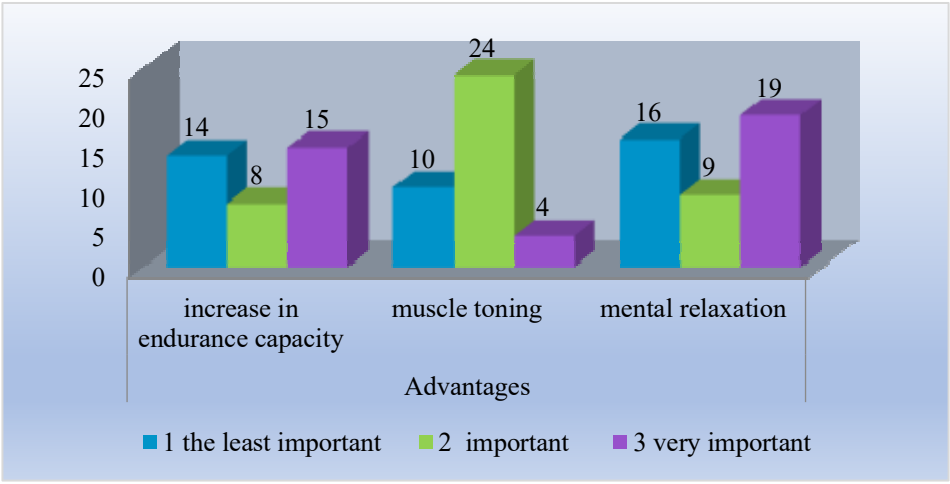

Chart 8. Percentage representation of the importance of the increase in endurance capacity, muscle toning and mental relaxation.

At the twelfth item, "Do you think that the diversity of the exercises used in the aquagym classes was effective?", 100% of the respondents in the experimental group answered that the diversity of exercises was effective.

Likewise, at the next item, "Do you think that the number of exercises and their dosing were effective?", all the participants in the research, namely 100%, answered that that the number of aquagym exercises and their dosing were effective.

For the fourteenth item on the effectiveness of teaching resources used in aquagym classes, structured on programs for preparing free exercises and with portable equipment, 35 students chose the answer "effective". The attractiveness of the design of the teaching resources was 100% appreciated, the ease of handling them was appreciated by 33 students, and 4 considered that they were difficult to handle.

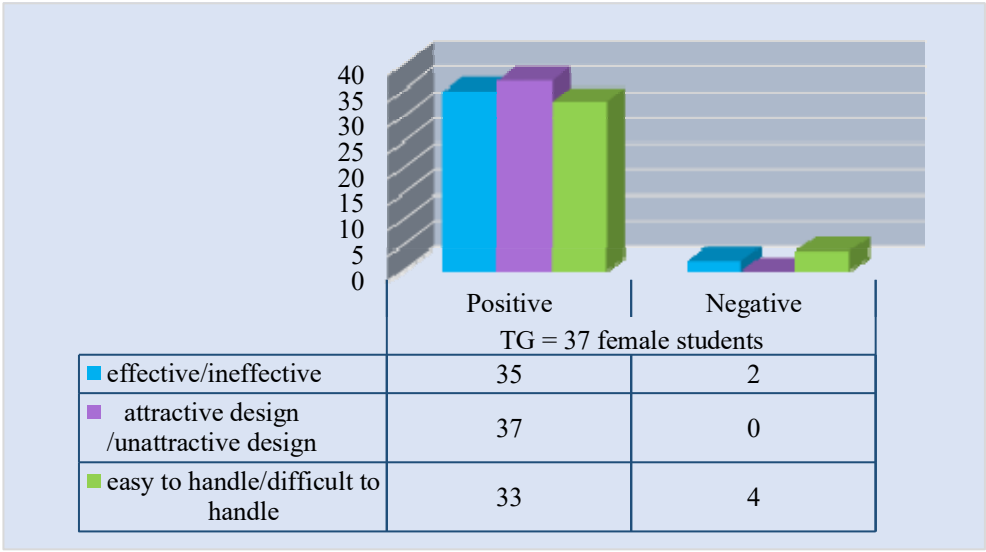

Chart 9. Percentage representation of the respondents' answers about the effectiveness of teaching resources, the attractiveness of their design and their user-friendliness.

Table 3. Respondents' opinion about the benefits of aquagym.

Benefits after participating in aquagym programs	Number of respondents	Percentage
General improvement in fitness	33	89.20%
Improvement in muscle flexibility and suppleness	29	78.40%
A relaxing effect and stress relief	27	73.00%
Improvement in endurance capacity	23	62.20%
Calory burn and weight loss	17	45.90%
Increased self-confidence and self-esteem	15	40.50%
Cellulite reduction	14	37.80%
Improvement in balance	14	37.80%
Strenuous exercises are easier to perform	13	35.10%
No risk of injury	9	24.30%

Chart 10 shows the satisfaction degree of the female students in the experimental group regarding the innovative method aquagym. Out of 37 subjects, following the aquagym specific exercise programs, 27 students responded that they were very satisfied, that is 73.00%, and 11 students answered that they were satisfied, corresponding to 29.70%.

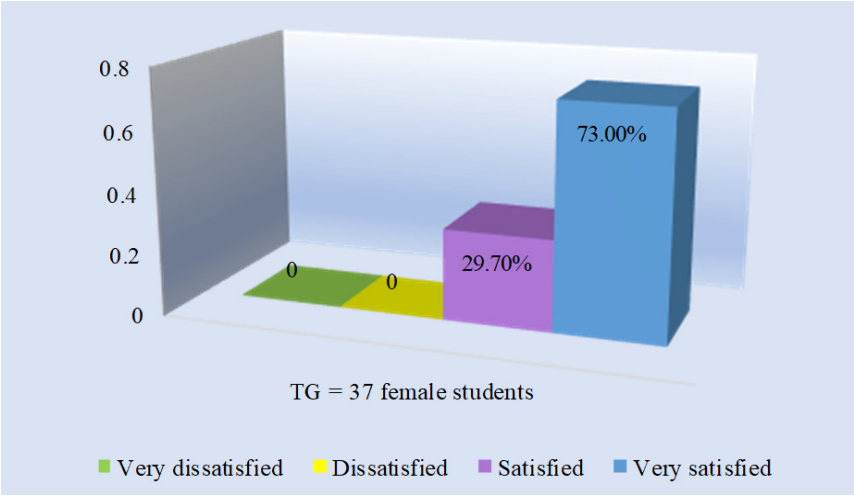

Chart 10. Percentage representation of experiencing the innovative method aquagym.

At the last item, "Would you attend such classes again in the years to come?", 89.20% of the subjects answered "YES", and 10.80% answered "NO". 33 students declared that they wanted to participate again in such programs in the following years, and only 4 students responded in the negative. As can be seen, a relatively high percentage (89.20%) of the total number of female students in the sample (37) under research expressed their wish to take part in such aquagym programs in the coming years, as well.

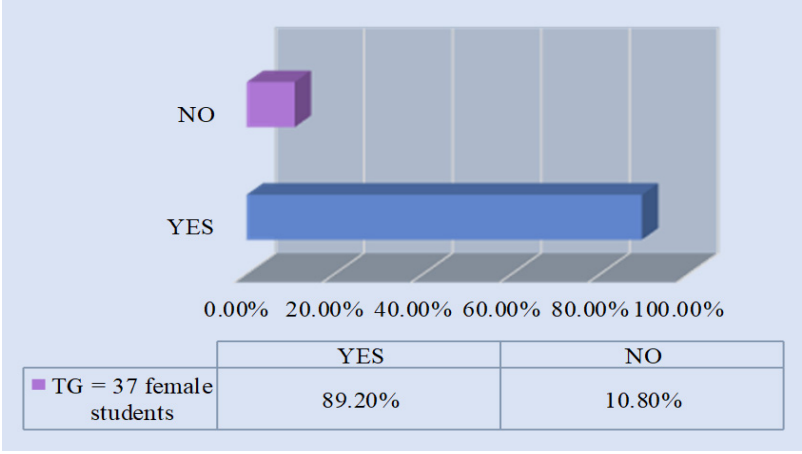

Chart 11. Percentage representation of the students' feedback on attending aquagym classes in future years.

Conclusions

The processing of the obtained data and their interpretation led us to the following conclusions.

Taking into account the answers to this questionnaire-based survey, we can infer that aquagym is a recreational and enjoyable aquatic activity with an attractive and effective structure due to the specific means of action which also include exercises with portable equipment having an appealing user-friendly design.

Applying the questionnaire led to the students' awareness of some benefits of practicing aquagym, which contributed to the increase in the interest for this activity but also for the constant practice of physical exercise. Being carried out in a group, the activity contributed to the improvement in interpersonal relationships, the subjects being motivated to endure the effort and complete the proposed program.

Given that our subjects were girls, it is surprising that they did not mark body shaping as their first option. The constant choice in various forms of the answers regarding mental relaxation and the attractiveness of the workout sessions, but also the appreciations for their effectiveness in developing motor skills give certainty to the answers to the last item regarding students' willingness to continue participating in such physical activities. As a result, we can say that the respondents' degree of satisfaction is very high and this will make them practice aquagym in their free time and convince other colleagues to join them in doing this type of physical activity.

The swimming pool at "Carol I" National College in Craiova will enable the promotion of aquagym among adolescents and its systematic practice will significantly contribute to increasing the quality of their lives. Being aware of the specificity and benefits of aquagym, young people will become interested in performing sports activities during their leisure time, thus changing their mentality and adopting an active lifestyle.

REFERENCES

Aquatic Physiotherapy Group, Australian Physiotherapy Association. (2020). Australian guidelines for aquatic physiotherapists working in and/or managing hydrotherapy pools. Second edition. Retrieved from https://australian.physio/sites/default/files/tools/Aquatic_Physiotherapy_Guidelines.pdf

Banks, A., & Reimann, B. (2012). New aquatic activities and games for secondary physical education. *JOPERD: The Journal of Physical Education, Recreation & Dance, 83*(2), 13-34. doi: 10.1080/07303084.2012.10598723

Barbosa, T. M., Garrido, M. F., & Bragada, J. (2007). Physiological adaptations to head-out aquatic exercises with different levels of body immersion. *Journal of strength and conditioning research*, *21*(4), 1255–1259. doi: 10.1519/R-20896.1

Beck, B.R., Daly, R.M., Singh, M.A.F., & Taaffe, D.R. (2017). Exercise and Sports Science Australia (ESSA) position statement on exercise prescription for the prevention and management of osteoporosis. *Journal of Science and Medicine in Sport, 20*(5), 438-445. doi: 10.1016/j.jsams.2016.10.001

Bonnema, J., Coetzee, D., & Lennox, A., (2020). Effect of a three-month HOP Sports Brain Breaks® intervention programme on the attitudes of Grade 6 learners towards physical activities and fitness in South Africa. *Journal of Physical Education and Sport, 20* (1), 196-205.

Costa, A. M., Marinho, D. A., Rocha, H., Silva, A. J., Barbosa, T. M., Ferreira, S. S., & Martins, M. (2012). Deep and shallow water effects on developing preschoolers' aquatic skills. *Journal of human kinetics, 32*, 211–219. doi: 10.2478/v10078-012-0037-1

Fisken, A.L., Waters, D.L., Hing, W.A., Steele, M., & Keogh, J. (2015). Comparative Effects of 2 Aqua Exercise Programs on Physical Function, Balance, and Perceived Quality of Life in Older Adults With Osteoarthritis. *Journal of Geriatric Physical Therapy, 38*(1), 17-27. doi: 10.1519/JPT.0000000000000019

Folsom, B. (2008). Water weightlessness - the advantages of a water aerobics workout. *Am Fitness, 9*(10), 66-67.

Jones, L.M., Meredith-Jones, K., & Legge, M. (2009). The Effect of Water-Based Exercise on Glucose and Insulin Response in Overweight Women: A Pilot Study. *Journal of Women's Health, 18*(10), 1653-1659.

Lind, M.S.E., Joens-Matre, R.R., & Ekkekakis, P. (2005). What intensity of physical activity do previously sedentary middle-aged women select? Evidence of a coherent pattern from physiological, perceptual, and affective markers. *Preventive Medicine,40* (4), 407-419.

Mayorga-Vega, D., Saldías, M. P., & Viciana, J. (2019). Physical fitness, physical activity, sedentary behavior and psychological predictors in Chilean adolescents: Differences by gender. *CCD, 14* (42), 233-241.

Silva, L.A.D., Tortelli, L., Motta, J., Menguer, L., Mariano, S., Tasca, G., … Silveira, P.C.L. (2019). Effects of aquatic exercise on mental health, functional autonomy and oxidative stress in depressed elderly individuals: A randomized clinical trial. *Clinics (Sao Paulo), 74*, e322. doi:10.6061/clinics/2019/e322

Takeshima, N., Rogers, M.E., Watanabe, I., Brechue, W.F., Okada, A., Yamada, T., Islam, M.M. & Hayano, J. (2002). Water-based exercise improves health-related aspects of fitness in older women. *Medicine & Science in Sports & Exercise, 33*(3), 544-551.

Williams, R.E., Barreria, T.V., & Tseh, W. (2020). Fitness-related benefits: land-based versus aqua-base. *Journal of Sports Medicine and Physical Fitness, 60*(1), 26-31. doi: 10.23736/S0022-4707.19.09675-0

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ONLINE UNIVERSITY TEACHING SYSTEM, WITH 7 MODULES, QUANTIFIED WITH EXPERIENCE POINTS (XP), IN COMPUTER-ASSISTED TRAINING, PSYCHO-PEDAGOGICAL TRAINING MODULE

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ABSTRACT. In the present study, a gamified didactic system structured on 7 modules was built. Each training module offered students mandatory and optional assignments. A number of 53 assignments were designed for this didactic system, distributed on the 7 modules, of which 23 assignments were mandatory and 30 were optional. Each assignment had an equivalent number of experience points (XP). For the correct solving of each assignment the student received the grade "admitted" and the equivalent XP. It was verified, by evaluating the implemented system, the general level of attractiveness and students' perceptions on the level of pragmatism and on the hedonic aspect. Our research has shown that the degree of attractiveness of this system has been high enough to motivate us to implement it in the future. The stimulation and innovation that such a system brings are strong points that can promote involvement in didactic activity, but we must look for very effective ways to properly condition the solving of as many assignments as possible.

Key words: *teaching system, experience points (XP), computer-assisted training, education, online.*

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REZUMAT. ***Sistemul didactic universitar online, cu 7 module, cuantificat cu puncte de experienţă (XP), la instruire asistată de calculator, modul de pregătire psihopedagogică.*** În studiul de faţă s-a construit un sistem didactic gamificat structurat pe 7 module. Fiecare modul de instruire a oferit studenţilor teme obligatorii şi teme facultative. Au fost proiectate pentru acest sistem didactic un număr de 53 de teme didactice, distribuite pe cele 7 module, dintre care 23 de teme au fost obligatorii, iar 30 de teme au fost facultative. Fiecare temă a avut un număr echivalent de puncte de experienţă (XP). Rezolvarea corectă a fiecărei teme aducea studentului calificativul "admis" şi XP echivalent. S-a verificat, prin evaluarea sistemului implementat, nivelul general de atractivitate şi percepţiile studenţilor asupra nivelului de pragmatism şi asupra aspectului hedonic. Cercetarea noastră ne-a arătat că gradul de atractivitate al acestui sistem a fost suficient de mare astfel încât să ne motiveze pentru implementarea lui şi în viitor. Stimularea şi inovaţia pe care o aduc un astfel de sistem sunt puncte forte care pot promova implicarea în activitatea didactică, dar trebuie căutate modalităţi foarte eficiente care să condiţioneze corect trimiterea unui număr cât mai mare de teme didactice.

Cuvinte cheie: *sistem didactic, puncte de experienţă, instruire asistată de calculator, învăţământ, online.*

Introduction

The pandemic caused by Covid-19 has had severe effects on the global community, leading to significant restrictions on all branches of society. Educational institutions have had to react quickly by moving from face-to-face teaching to online teaching (Nordmann et al., 2020).

Online teaching has been made possible by the continuous development of digital technology. Technology gives students much more access to information and promotes creativity, but it also requires teachers to find ways to optimally stimulate student engagement in the educational process (Nieto-Escamez & Roldán-Tapia, 2021).

According to Opre et al. (2020) for an effective online teaching, the following aspects must be taken into account:

1. A well-structured instructional plan;
2. Encouraging interaction with students and setting up learning groups: studying the bibliography before each meeting;
3. Supporting persistence in assignments and motivating students to learn;
4. Developing the most effective learning strategies and tools.

In recent decades, the development of strategies to improve student motivation and maximize knowledge acquisition has been approached with great interest. Among these strategies, gamification has attracted the interest of many teachers who have explored its potential to improve learning (Nieto-Escamez et al. 2021).

Gamification has emerged as a new approach in solving everyday tasks, in various fields, by applying the concepts used by digital game designers, being defined by some promoters of this system as "a process of using game thinking and game mechanics to engage users and solve problems" (Zichermann & Christopher, 2011, p XIV).

A mini-review conducted to analyze the use of gamification-based learning during the pandemic lockdown highlights a predominantly positive perception of students, who described gamified learning systems as innovative, engaging, effective in delivering curriculum and fun (Nieto-Escamez et al. 2021). An essential condition, which must be taken into account in these gamified learning systems, is the assumption and observance, from the very beginning, of a healthy pedagogical paradigm to guide our teaching, learning and assessment sequences (Opre, 2020).

Thus, in the present study, a gamified didactic system was built based on the following premises:

- Students receive a coherent and clear document at the beginning of the semester outlining the assignments they must complete during the semester, with all deadlines set;
- Students are given the freedom to build personalized versions of their teaching content, depending on their personal preferences and how the assignments and grading were built into this gamified system;
- The personalized course of the students is supported by a grading system based on experience points and a leaderboard.

The asynchronous teaching activity allows the students to go through the materials sent by the teacher and to solve the assignments at their own pace, also having a feedback provided by the teacher. Asynchronously, online teaching activities are usually complemented by synchronous ones, so as to best support the learning objectives that are targeted (Opre et al., 2020).

Moreover, it is important that the teacher's expectations are clearly communicated at the beginning of the course, highlighting the number of synchronous participations, as well as the time they have to spend for the activities carried out asynchronously. These expectations will help students form a routine (Nordmann et al., 2020). The student is the one who, assisted correctly and constantly by the teacher, builds his own baggage of knowledge and skills (Opre et al., 2020).

A good education system gives students the freedom to recognize their individual abilities and potential and to plan their time and learning strategy (Radovic-Markovic & Markovic, 2012). A fundamental goal of education is supposed to be to develop in individuals the ability to make their own decisions about what they think and do (Boud, 1987).

Objectives

1. Measuring the level of attractiveness of the system at the beginning of the semester, immediately after presentation of the system, and at the end of the semester, after completing the system.
2. The level of pragmatism (perspicuity, efficiency and dependability) perceived at the beginning of the semester, immediately after the presentation of the system, and at the end of the semester, after completing the system
3. The hedonic level (stimulation and novelty) perceived at the beginning of the semester, immediately after the presentation of the system, and at the end of the semester, after completing the system.
4. The difference in perception of the system (attractiveness, pragmatism and hedonic) between students who solved a few optional assignments (maximum 10 optional assignments), marked with UEQ-Fmin, and those who solved many optional assignments (at least 15 optional assignments), marked with UEQ-Fmax.

Material and methods

The didactic system was applied in the academic year 2020-2021, first semester, during the Covid-19 pandemic period, with online teaching, at the Faculty of Physical Education and Sports within the Babeş-Bolyai University of Cluj-Napoca. The students enrolled in the psycho-pedagogical module within the Teacher Training Department benefited from this didactic system. For these students this model of didactic system was applied for the first time, they had no experience with such a system until that moment.

To meet the research objectives, the UEQ questionnaire tool (User Experience Questionnaire (UEQ), n.d.) was applied, built for online use with the help of Google Forms.

The didactic system was built on 7 modules (course and seminar) that covered the entire semester related to the subject Computer-Assisted Training. Each training module offered students mandatory and optional assignments.

In order to solve the assignments related to each training module, the students had at their disposal a minimum of 16 days and the support of the teacher both at the synchronous meetings and through asynchronous discussion channels within the IAC team from MS Teams. Also, the students had at their disposal several didactic tutorials uploaded on the RV didactic channel on YouTube (IAC - YouTube, n.d.). This didactic system, applied in the academic year 2020-2021, was influenced by Paul Andersen's practice and experience with Biohazard 5 (Văidăhăzan, 2020).

A number of 53 teaching assignments were designed for this didactic system, distributed on the 7 modules, of which 23 assignments were mandatory and 30 assignments were optional. Each assignment had an equivalent number of experience points (XP). The correct solution of each assignment brought the student the grade "admitted" and XP equivalent. The 23 mandatory assignments summed up 111 XP, the minimum number necessary to promote the subject. The total number of possible XP to be obtained was 300 (for all 53 didactic assignments - 23 mandatory assignments + 30 optional assignments). The final grade given to the student at the end of the semester, depending on the XP number obtained along the way, can be extracted from the following table.

Table no. 1 – Final grade based on the XP number obtained during the semester.

Final grade	minimum XP	Distinction
Final grade: 5	111	Utilizator novice = uN (Novice user)
Final grade: 6	125	Utilizator intermediar = uI (Intermediate user)
Final grade: 7	145	Utilizator avansat = uA (Advanced user)
Final grade: 8	175	Utilizator experimentat = uE (Experienced user)
Final grade: 9	200	Utilizator strateg = uS (Strategist user)
Final grade: 10	220	Utilizator instructor = uINS (INStructor user)

UEQ was applied at the beginning of the semester (UEQ-I), immediately after the presentation of the didactic system to be applied to Computer-Assisted Training and was applied at the end of the semester (UEQ-F), after all didactic activities in the subject of Computer-Assisted Training.

Results

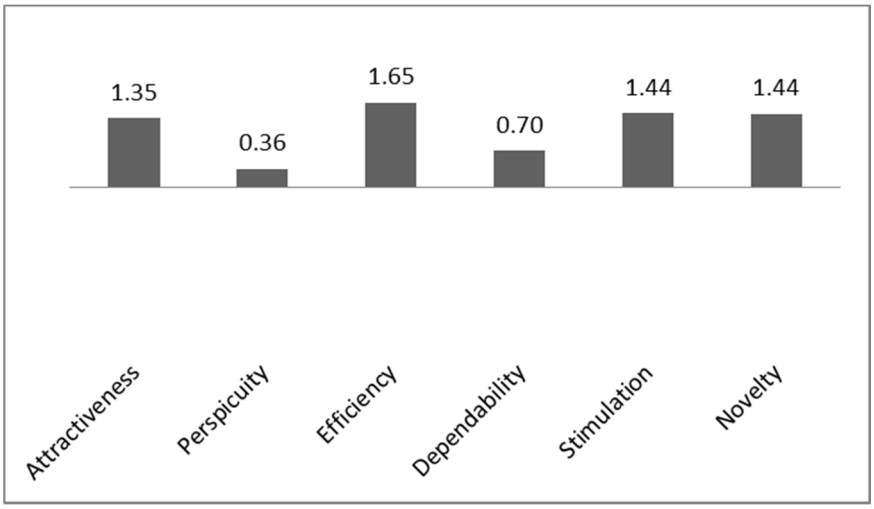

Chart 1 – UEQ-I

Chart 1 shows positive results for all evaluation scales.

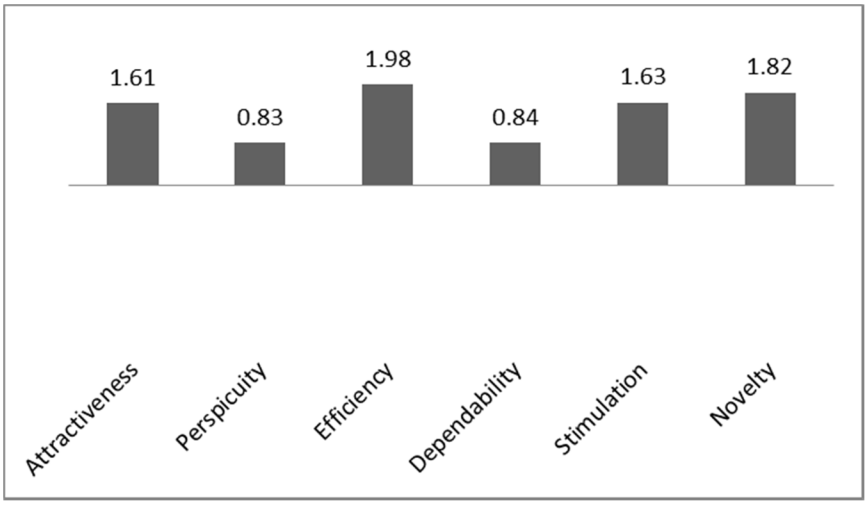

Chart 2 – UEQ-F

Chart 2 shows an increase in scores on all assessment scales.

Two sample T-Test (UEQ-I:UEQ-F), Alpha-Level 0.05 did not show a significant difference on any of the scales.

Table 2 - Two sample T-Test (UEQ-I:UEQ-F), Alpha-Level 0.05

Attractiveness	0.9906	No Significant Difference
Perspicuity	0.4453	No Significant Difference
Efficiency	0.6906	No Significant Difference
Dependability	0.8202	No Significant Difference
Stimulation	0.7609	No Significant Difference
Novelty	0.4687	No Significant Difference

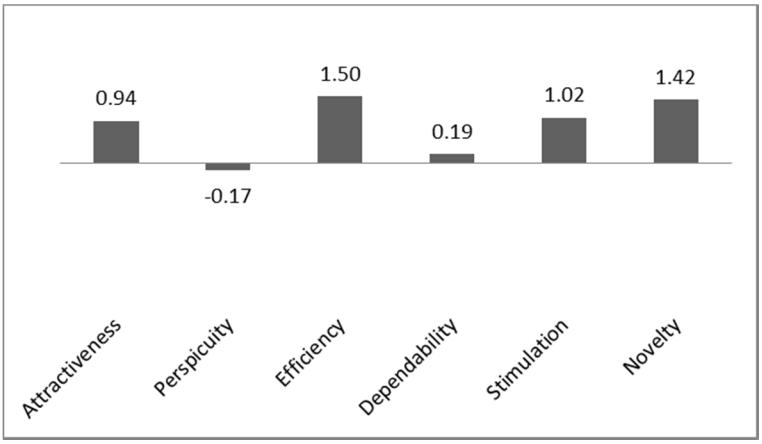

Chart 3 – UEQ-Fmin

Chart 3 shows a negative score for Perspicuity and a low score, even if positive, for Dependability.

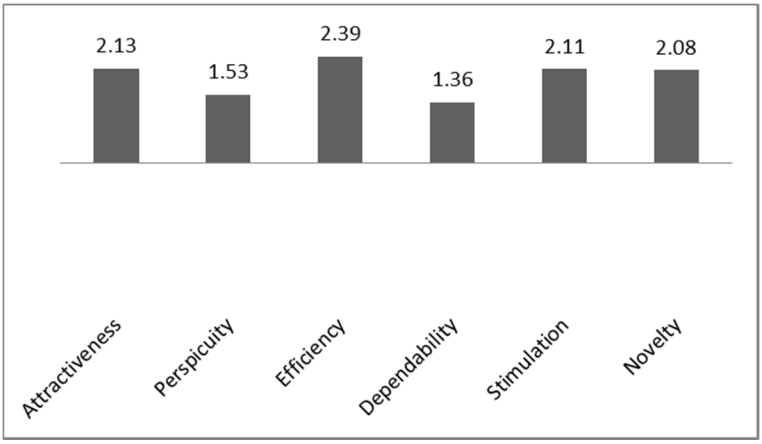

Chart 4 – UEQ-Fmax

Chart 4 shows large increases on all assessment scales, for students who submitted at least 15 optional assignments, thus registering significant differences in Attractiveness, Perspicuity, Efficiency, Dependability and Stimulation compared to students who submitted a maximum of 10 optional assignments, as can be seen in table 3, at Alpha-Level 0.05.

Table 3 - Two sample T-Test (UEQ-Fmin:UEQ-Fmax), Alpha-Level 0.05

Attractiveness	0.0180	Significant Difference
Perspicuity	0.0015	Significant Difference
Efficiency	0.0058	Significant Difference
Dependability	0.0002	Significant Difference
Stimulation	0.0282	Significant Difference
Novelty	0.0864	No Significant Difference

Discussions

From the beginning of the semester, positive values can be observed for all scales in the UEQ. The records made at the end of the semester show an increase on all evaluated scales, but not large enough to be a statistically significant, at p = 0.05. We note, however, that after participating in the proposed didactic system, the degree of attractiveness increased (from 1.35 to 1.61). We have, therefore, confirmation that participating in such a system did not "scare" the students.

We are also pleased with the values obtained for the hedonic aspects. The students considered that this system was stimulating and brought innovation. Even the efficiency part of the system was constructively appreciated by the participants in the didactic activity, obtaining the highest score at the end of the semester.

The lowest scores were obtained for Perspicuity and Dependability, an aspect we expected from the beginning, given that students have never seen such a didactic system. However, participation in this didactic system has greatly increased the score for Perspicuity. And, if we take into account the answers of students who sent, during the didactic activities, at least 15 optional assignments (half of the total optional assignments) then we notice that things become much clearer for participants who are involved above average in the didactic system.

In fact, all scores were much higher for participants who became more involved in the didactic activity during the semester. Except for the degree of novelty, on all the scales researched, statistically significant differences were obtained between the students who were involved with the minimum necessary and the students who were more involved in the didactic activity.

Conclusions

To sum up, we can say that the attractiveness of this system was high enough to motivate its implementation in the future. We recommend, however, to design a period of accommodation with the specifics of such a system in order to increase the degree of clarity and controllability among the participants.

The stimulation and innovation that such a system brings are also strong points that can promote involvement in didactic activity, but we must look for very effective ways to properly condition the solving of as many assignments as possible. This aspect, as it was observed, strongly conditions the success of such a didactic system, from the perspective of the affordances pursued.

REFERENCES

Boud, D. (1987). *Developing Student Autonomy in Learning*. London: Routledge. https://doi.org/10.4324/9780203059036

IAC - YouTube. (n.d.). Retrieved 25 April 2022, from https://www.youtube.com/playlist?list=PLjvbgTMXGiO_0NfaJNLhFEN_8WOIav2e-

Nieto-Escamez, F. A., & Roldán-Tapia, M. D. (2021). Gamification as Online Teaching Strategy During COVID-19: A Mini-Review. *Frontiers in Psychology*, *12*(May), 1-9. https://doi.org/10.3389/fpsyg.2021.648552

Nordmann, E., Horlin, C., Hutchison, J., Murray, J. A., Robson, L., Seery, M. K., & MacKay, J. R. D. (2020). Ten simple rules for supporting a temporary online pivot in higher education. *PLoS Computational Biology*, *16*(10), 1-18. https://doi.org/10.1371/journal.pcbi.1008242

Opre, A. (2020). Sincron si asincron in activitatea didactica desfasurata on line: principii si strategii. *Consiliul Didactic şi Centrul pentru inovare în predare – învăţare din cadrul UBB*. Retrieved from https://www.youtube.com/watch?v=9GygjLl65-c

Opre, A., Opre, D., Glava, A., Glava, C., Consiliul Didactic, & Centrul de Inovare în Predare - Învăţare (CIPI). (2020). *Ghidul educaţiei on line la Universitatea Babeş-Bolyai din Cluj-Napoca (UBB). Principii şi strategii de optimizare a activităţilor didactice în pandemia COVID- 19*.

Radovic-Markovic, M., & Markovic, D. (2012). A New Model of Education Development of Individuality through the Freedom of Learning. *World Academy of Art and Science*, *1*(1), 97-114.

User Experience Questionnaire (UEQ). (n.d.). Retrieved 25 April 2022, from https://www.ueq-online.org/

Văidăhăzan, R. (2020). Paul Andersen. In Introducere în Gamificare didactică (învățare continuă prin joacă). (pp. 19–23). Presa Universitară Clujeană. https://libraria.ubbcluj.ro/produs/gamificare-didactica/

Zichermann, G., & Christopher, C. (2011). *Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps (1st. ed.)*. O'Reilly Media, Inc.

STUDIA UBB EDUCATIO ARTIS GYMN., LXVII, 2, 2022, pp. 97 – 116
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THE SOCIAL MATTER OF INCLUDING PUPILS WITH SPECIAL EDUCATIONAL NEEDS IN PHYSICAL EDUCATION CLASSES

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ABSTRACT. Introduction: The specific educational needs of pre-university teachers in physical education and sports classes in working with students with special educational needs has certain peculiarities. **Objectives**: Identifying the profile of the physical education and sports teacher; their attitudes, skills and abilities necessary to promote the social inclusion of students with special educational needs in the physical education and sports classes provided in the school curriculum. Identifying examples of good practice to combat the social exclusion of students with special educational needs in physical education and sports classes. **Materials and methods**: Using the Systematic Review method, a number of 434 articles were initially identified. Following the establishment of the inclusion and exclusion criteria, a number of 18 studies were retained for analysis. **Results**: Peer guidance has proven to be an effective way to facilitate inclusive physical education. However, supplementing the findings with qualitative data from students with disabilities and their teachers on the peer guidance strategy in different cultural and school settings could provide a deeper and more comprehensive understanding of the strategy. Furthermore, it is also suggested that more studies could focus on the roles and responsibilities of support teachers in physical education and sports classes. **Conclusions:** Future studies examining the effects of inclusion on students with or without disabilities should also address student attitudes, social interactions, and the acquisition of cognitive development and motor skills in inclusive physical education settings.

Keywords: *the social matter (continuous training), inclusion, inclusive education, needs inclusion, physical education and sports (teachers).*

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REZUMAT. ***Problematica socială a incluziunii elevilor cu cerințe educaționale speciale în cadrul lecțiilor de educație fizică și sport – O analiză sistematică a literaturii de specialitate.*** **Introducere:** Nevoile educaționale specifice ale cadrelor didactice din învățământul preuniversitar în cadrul orelor de educație fizică și sport în lucrul cu elevii cu cerințe educaționale speciale are anumite particularități. **Obiective**: Identificarea profilului cadrului didactic de educație fizică și sport; a atitudinilor, a competențelor și abilităților acestora necesare promovării includerii sociale a elevilor cu cerințe educaționale speciale în cadrul orelor de educație fizică și sport prevăzute în programa școlară. Identificarea de exemple de bune practici în vederea combaterii excluziunii sociale a elevilor cu cerințe educaționale speciale în cadrul orelor de educație fizică și sport. **Materiale și metode**: utilizând metoda Systematic Review, au fost identificate inițial un număr de 434 articole. În urma stabilirii criteriilor de includere și excludere au fost reținute pentru analiză un număr de 18 studii. **Rezultate:** Îndrumarea de la egal la egal s-a dovedit a fi o metodă eficientă de facilitare a educației fizice incluzive. Cu toate acestea, completarea constatărilor cu date calitative de la elevii cu dizabilități și profesorii lor cu privire la strategia de îndrumare de la egal la egal în diferite setări culturale și școlare ar putea oferi o înțelegere mai profundă și mai cuprinzătoare a strategiei. Mai mult, se sugerează, de asemenea, că mai multe studii s-ar putea concentra pe rolurile și responsabilitățile profesorilor de sprijin în cadrul orelor de educație fizică și sport. **Concluzii:** Studiile viitoare care examinează efectele incluziunii asupra elevilor cu sau fără dizabilități trebuie de asemenea să abordeze atitudinile elevilor, interacțiunile sociale și dobândirea dezvoltării cognitive și a abilităților motorii în medii incluzive de educație fizică.

Cuvinte cheie: *problematica socială (formarea continuă), incluziune, educație incluzivă, nevoi speciale, educație fizică și sport (cadre didactice)*

Introduction

Physical activity is the fundamental component of the general well-being and of the majority of children, the experience in this sense being realized during the physical education classes in school (Cheung, 2019; O'Connor & McNabb, 2020; Ross er al., 2016). The universal popularity of sports makes it an ideal transformer, a tool for encouraging participation through equal access to activities, both inside and outside the school system (UN, 2006). However, research shows that students with special educational needs and disabilities (SEND) in ordinary schools continue to experience fewer participatory sports options than others (Bloemen et al., 2015). The matters related to health, adapted physical activity, social rehabilitation and integration of students with SEN, are becoming increasingly relevant while employing a growing contingent of people interested in this matter (WHO, 2017; Bertills et al., 2019).

Inclusive education is based on the fundamental right of all learners to receive a quality education which meets their basic learning needs, encourages their personal development to the greatest possible extent and considers the environments' diversity and skills to be more of a learning opportunity rather than a barrier (Ainscow & Miles, 2008). Physical education classes are an integral and indispensable element, part of the general education for children who need a special kind. Disabilities and long-term health conditions may limit the significance of participation in physical education lessons, unless appropriate support is provided.

The structure of physical education lessons is important for the participation of students with special educational needs in school education, both in terms of physical and social adaptations. (Toptaș & Demirci, 2018). Different adaptations and modifications are essential, depending on the type of disability. Significant learning experiences for students with disabilities in physical education and sports (PES) lessons largely depend on the teachers' skills and attitudes toward communicating and structuring their teaching in an inclusive direction (Neville et al., 2020). The restriction of participation can be experienced if the activity is not being adapted to students who need special support (Coates & Vickerman, 2010; Haegele et al., 2017).

Students with physical disabilities describe enjoyable learning experiences as lessons in which they experienced a sense of belonging, their participation being skillful and beneficial. Encouraging, strengthening, helping and guiding facilitates colleagues 'positive interaction. Patience and social encouragement are examples of the kind of support they have received. Above all, several studies conclude that sharing physical education lessons with a student with disabilities creates positive attitudes toward the inclusion of these students. (Liu et al., 2010; McKay et al., 2015; Sullivan and Glidden, 2014). However, while physical education lessons encourage students with disabilities' acceptance, it is also noticed that there are barriers and facilitators to inclusion (Darretxe et al., 2016; Haegele et al., 2017).

International research shows that students with SEN still do not access or they are yet to be fully included in the curricula of ordinary schools (Neville et al., 2020). This matter of inclusion is particularly acute when it comes to children with SEN participating in physical education lessons. Furthermore, research evidence shows signs of a double link in this case: children with SEN are disproportionately affected by social and emotional conditions, behavioral and health-related physical inactivity, along with exclusion from physical education and sports lessons (Bloemen et al., 2015). However, physical education teachers often lack the knowledge, confidence, or pedagogical training to adapt their lessons in ways that could include them appropriately (Rekaa et al., 2018).

Physical education programs for children with SEN have to be prepared based on their individual requirements and characteristics, such as diagnosis, severity of diagnosis, and the existing level of performance (Hutzler, 2003; Ozer & Sahin, 2010). It is acknowledged that physical education helps children with SEN to develop self-concept and social competence in order to develop motor skills, physical and motor adaptation, leisure skills, and play and creative time skills as long-term goals (Neville et al., 2020) The physical education of students with SEN must be adequate in improving psychomotor, sensory and cognitive development. If these areas of improvement are achieved, these long-term goals will also be accomplished. Nevertheless, physical group activities promote the sharing, communication, and learning of social behaviors among people with special needs (Konar & Yildiran, 2012; Ozer & Sungu, 2016; Demirci & Toptaș Demirci, 2016). Teachers' knowledge regarding the adapted training and their ability to apply suitable methods and tools is a guarantee for the successful socialization of children with different disabilities and allows these children to cope with the curricular requirements of different disciplines. A pecial attention should be paid to physical education and adapted sports lessons. All in all, they offer children the opportunity to increase their physical development, to improve their physical capacity and to develop valuable skills, which will be necessary both in their training and in their following years.

Thus, having as a starting point this information and all the specialized studies, going through a systematic review of literature, I intend to detail the specific educational needs of physical education teachers in pre-university education working with students with SEN. It all begins with the question: What are the current training needs of physical education and sports teachers regarding the social inclusion of students with special educational needs in physical education and sports lessons? The objectives of this investigative research approach goes in 2 directions: 1. Identifying the physical education teachers' profiles; their attitudes, skills and abilities necessary to promote the social inclusion of students with SEN in the physical education classes provided in the school curriculum. 2. Identify examples of good practice in order to combat the students with SEN' social exclusion in physical education classes.

Methodology

Methodology or Methods/ Research Instruments or Sources Used

This study was undertaken as a systematic approach to literature review based on the original guidelines, as proposed by Gough et all. (2012), in accordance with the new provisions supported by Zawacki-Richte et al. (2020), who aims to reveal research trends, developments and open issues of this topic,

which still need to be addressed. The review process is also guided by the Grounded Method for Rigorously Reviewing Literature by Wolfswinkel et al. (2013). Quantitative and qualitative studies were included in the review using the Petticrew and Roberts' (2006) model as a basis.

1. The research process

Starting from the fundamental research question and the 2 directions of analysis / objectives, an advanced search algorithm was established in order to list the articles / books of interest for a clearer search efficiency: (inclusion) AND (special educational needs) AND (physical education), and then for a more precise search we used this other algorithm: (inclusion) AND (special educational needs) AND (students) AND (physical education) AND (physical education and sports teachers) AND (educational needs) AND (best practice) AND (attitudes). The databases searched in this study included SPORTDiscus, JSTOR Arts & Sciences, ProQuest, SAGE, Taylor & Francis Online and Web of Science.

2. Inclusion and exclusion criteria

- Collected peer-reviewed articles on the following topics were included:

Systematic literature reviews (RSL), namely literature surveys containing defined research questions, search process, data extraction and data presentation, even if the researchers referred to their study as a systematic review of the literature.

- Meta-analysis (MA).
- Experimental and quasi-experimental studies

Articles on the following topics were excluded: informal literature surveys (no definite research questions; no definite research process; no definite data extraction process). Duplicate reports of the same study (in the case when there are several reports of an analysis in different journals, the most complete version of the study was included in the review), and non-English research was excluded.

3. Data collection

In the initial review, all articles were revised as to whether their titles, abstracts and keywords met our inclusion criteria. Through the initial screening, 434 articles (for all 2 directions) were identified as relevant for this review, and the authors performed a preliminary coding of the selected articles. During the coding process, 197 items were identified as not fulfilling the inclusion criteria. Thus, the first two stages led to 216 articles. The data extracted from each study was: Source (journal or conference) and full reference. Study type classification (RSL, Meta-Analysis MA); Scope (research trends). The main field. The author (s)

and their institution and the country in which they are located. The study summary, including the main research questions and answers. Research question / problem. Quality assessment. After a re-evaluation of them all as well as after reading the abstract and the entire study, a number of 18 studies and articles were analyzed (See figure 1).

4. Data analysis

The reading was performed in three stages. In the first phase, during the online search, before downloading each article, we carefully scanned the title, the keywords and the abstract. In the second phase, for the selection of the relevant material, the reading was finished for all the downloaded articles. In the final phase, the study was fully read (close and repeated reading) in the case of the sample of articles (N = 18). Also, in the case of books and articles used to establish the background of the study, structuring the literature review and adapting the study method, reading the index (using the index to locate specific elements and reading only the sections).

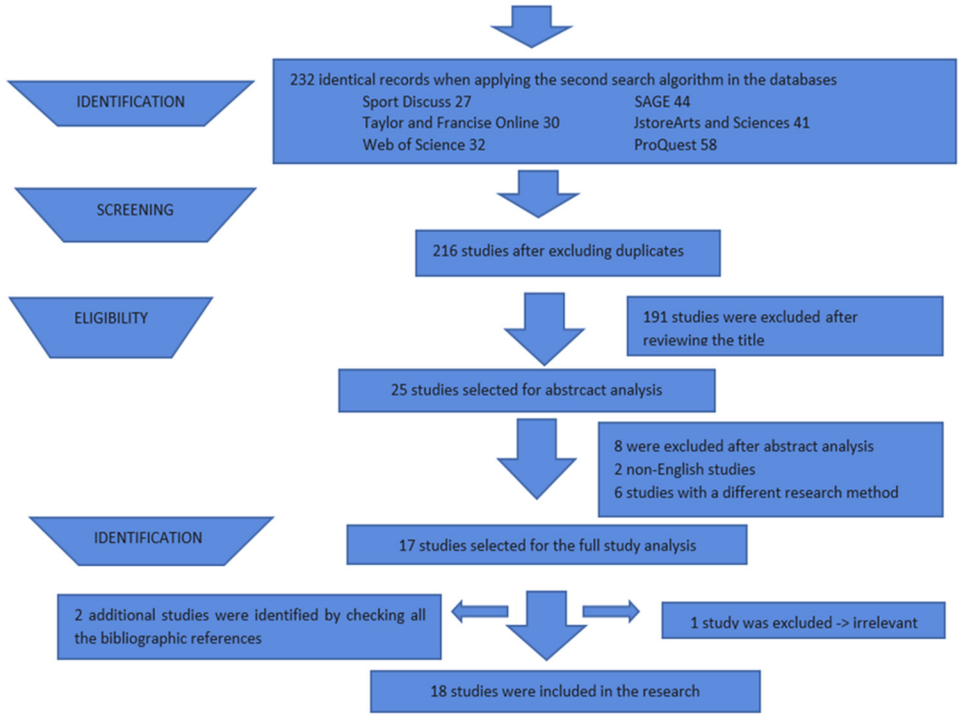

Fig. 1. Flow chart illustrating literature research and selection process

Data presentation

Table 1 provides an overview of all studies included in the research, in reference to the main findings in specialized literature of studies on identifying the needs and attitudes of physical education teachers regarding the inclusion of students with SEN in physical education classes.

Table 1. The main findings of studies on the promotion of inclusive attitudes and behaviors of students with SEN in physical education classes

Article, authors	***Sample (profile, n, sex, age)***	***Research design***	***Research method***	***The main findings***
Pedersen, Cooley, & Rottier (2014)	450 physical education and sports teachers	Exploratory	Questionnaire	The physical education and sports teachers' training requierements regarding competences of including children with SEN are high, but with a good communication with the support teacher, this can be highly improved.
Majoko, Tawanda (2019)	24 sports teachers, 18 men, 6 women	Qualitative	Semi-structured interview	"Teachers' competence in notifying special education and evaluation procedures have also been reported to be important for the inclusive education. This has been proved to help teachers identify children who need differentiated training and intensive training, respectively, to enable them to teach and learn to accomplish their individual needs in the regular classroom community! "
Kudlacek, Martin & Ješina, Ondřej & Flannagan, Pat (2010)	12 studies	Qualitative	Literature analysis	"Teach students with special educational needs in an inclusive setting along students without disabilities where one of the KEY ROLE would be: to adapt the teaching process to face students' needs in inclusive physical education."
Baglama, Yucesoy, & Beyazit, F. (2019)	105 teachers	Qualitative	Descriptive questionnaire	"Teacher training programs should focus more on teaching people with special needs to promote physical education teachers' knowledge, skills and attitudes."
Demirci, & Tzarova (2021)	67 students	Qualitative	Questionnaire	"The vast majority of teachers surveyed were not open enough to work with children with SEN."

Article, authors	***Sample (profile, n, sex, age)***	***Research design***	***Research method***	***The main findings***
Qi, Jing & Ha, Amy (2012)	75 studies	Qualitative	Literature analysis	"The results of these studies also indicated that, although students with disabilities can benefit from social interactions in inclusive vocational education, there is also a social isolation of the students with SEN."
SR, Filipe & Mónico, Lisete (2013)	115 teachers	Qualitative	Questionnaire	"Students with SEN have more easily developed their skills with individualized support and there are advantages to including them in regular education. Attitudes towards teaching aids are less favorable, due to the lack of adequate services, as well as the lack of adequate resources / specific materials available to work with students with SEN."
Andrew (2004)	10 teachers	Qualitative	Questionnaire	"For a full inclusion of students with SEN in all the activities offered in the curriculum, there must be a specific adaptation for this category of students."
Vickerman (2007)	30 physical education teachers	Qualitative	Questionnaires and innervations were structured	"Lacking a coherent plan for teacher training in the educational needs of children with SEN, different attempts to include these children in the mainstream would be difficult"
Cooper, Heron, & Heward (1987)	53 subjects	Qualitative	Questionnaire	"The positive effects of peer guidance on improving students' motor performance"
Auxter, Pyfer, & Huettig (2005)		Qualitative	Case study	"The roles and responsibilities of support teachers may include guiding, collecting and maintaining, implementing behavior management plans, preparing instructional materials, and collaborating with teachers. "
Heikinaro-Johansson, Sherrill, French & Huuhka (1995)	Case studies	Exploratory	Case study	"The first goal was to develop an adapted consultant model in physical education classes in order to assist regular elementary school teachers while integrating students with special needs into physical education lessons."

Article, authors	***Sample (profile, n, sex, age)***	***Research design***	***Research method***	***The main findings***
Grenier (2006)	Case study	Qualitative	Case study	"This topic draws attention to the importance of context and the organizational factors which support the students in their ability to demonstrate their skills. The specific curriculum, the modified results and the group dynamics are challenges that teachers need to consider in the planning stages of the training."
Coates, Janine & Vickerman, Philip (2013)		Qualitative	Literature study	"Therefore, by taking such approaches, teachers and researchers should be creative and should consider ways to think outside the box when developing methods of fully employing children."
Klavina, Block (2008)	2 groups of students from different schools and 9 tutorials	Exploratory	Quasi-experimental	"To summarize, examining the relationships between student-teacher and student-student interaction behaviors using the data collection tool (which included contextual variables of both students and teachers) provided a realistic approach to determining and understanding the benefits and / or the problems of peer learning strategies in the case of the strategy for the inclusion of students with SEN."
Klavina, Aija & Rodionova, Karina (2016)	2 groups of students from different schools	Exploratory	Quasi-experimental	"The activity involvement data did not show a significant change in outcomes for target students under teacher-led and peer-mediated conditions. The support provided by trained teachers and other classmates did not negatively affect the level of involvement in regard to the activity for students with SMD in general."
Hodge, S.R. (2010)		Qualitative	Literature study	"In my opinion, effective teachers need to reflect on their practice, carefully plan lessons, adapt, modify and individualize instruction in order to promote student learning.

Article, authors	***Sample (profile, n, sex, age)***	***Research design***	***Research method***	***The main findings***
				They must also possess different managers' skills which should be as effective and efficient when working with SEN' student behavior. Physical education teachers can use different training formats to organize and provide instruction and to build practice opportunities for students in different curriculum models."
Tsakiridou, Helen & Polyzopoulou, Konstantia (2014)		Qualitative	Questionnaire	"Teachers who participated in this study expressed generally neutral attitudes towards the practice of inclusion, with the exception of students with social difficulties, for whom they seemed to adopt a more avorable attitude."

We started with the deductive phase of the analysis; that is, the development of categories based on reviews and the coding of data according to categories. Subsequently, the inductive approach was used for open coding and category identification. Finally, the data collected from the revised studies was described and interpreted. At the same time, the second co-author of this article, specialized in inclusive education was invited to ask for comments and suggestions for the reasoning behind the categories. On the basis of the relevant literature and expert opinion while using the analytical framework approach, there were two categories of research areas identified: the analysis of attitudes and skills needed by the physical education and sports teachers in combating social exclusion of students with SEN and the encouragement of an inclusive education adapted to the needs of students with SEN in the teaching process. On the other hand, it was finding solutions and good practices that would support this approach to inclusion.

Table 2 presents the research categories, the main objectives of the studies classified in each category and the relevant studies. Firstly, each study was evaluated according to the data selection criteria and placed in the relevant category. Then, all data and research results were annotated for a rigorous subsequent correlation and issuance of a solid conclusions based on the data collected.

Table 2. Research categories and the main purpose of the study

Category	The main purpose of the study
The analysis of attitudes and skills requiered by physical education and sports teachers in combating the social exclusion of students with open educational needs	To examine teachers' perceptions on the integration of children with SEN in SAI classes
Solutions for the children with SEN in SAI classes' integration	To examine the effects of different practices or strategies which can be used in order to meet the needs of students with disabilities in SAI classes

Results and discussion

The analysis of and skills and demeanor necessary for physical education teachers in combating social exclusion

Numerous studies have identified different variables associated with teachers' views and attitudes. Significant concerns seems to have focused on identifying the factors which contribute to the positive attitude teachers carry towards the inclusion of students with disabilities. For example, the frequently mentioned potential facilitators include vocational training, perceived competence, previous teaching experiences and support available from school (Branco & dos Santos, 2013). In contrast, potential inhibitory factors include lack of training, inadequate training and the type and severity of students' disabilities. Clearly, intervention studies are vital in order to change teachers' attitudes. On the other hand, the most recent study by Demerici (2021) showed that the vast majority of teachers surveyed were not open enough to work with children with SEN in physical education and sports classes. The comparative analysis of physical fitness in children with and without special educational needs shows that, even with some exceptions at the beginning of the experiment, the level of development of boys' and girls' physical capacity with and without special needs does not differ significantly, which is a guarantee of fairness straight from the beginning of the experiment. Each group of children with specific disabilities has its own characteristics related to the nature of the disability in question. The emphasis on work during future physical education and sports activities should focus on those signs of physical fitness where the group has the lowest grades. Efforts to develop the other signs - those with the highest scores - will not have the same building effect on the physical ability of children with special needs. Both at the beginning and at the end of the sports-

pedagogical experiment, the assembled sets are homogeneous and relatively homogeneous in terms of the physical signs studied. The means of physical education and sports applied in the classroom did not cause significant changes in most of the evidence of physical ability examined, both for boys and girls with and without special needs. This requires appropriate changes in the curricula and methods used in school.

In the study by Majoko (2007), we find that all student development and the individual learning differences, learning environments, knowledge of curricular content, assessment, planning and training strategies, learning and professional practice and collaboration are essential to inclusive practice. Regular teachers require a certain level of competence in the skills of the common core of the Children's Council with SEN. According to the same study, it is specified that important skills for teachers in inclusive classrooms include peer guidance, cooperative learning, curricular modification and adaptation, learning to learn and analyze applied behavior, use of classroom assistance, instructional technology and support for children with SEN (Mastropieri & Scruggs, 2010; Oliver & Reschly, 2010; Philpott et al., 2010). Studies also show that regular teachers need to use instructional strategies, such as individualized and adaptive instruction and activity-based learning in order to facilitate the processes of teaching and learning pertaining to children with special needs (Apelgren & Giertz, 2010; Friend & Bursuck, 2012; May, 2005).

When we talk about adapting the curriculum and the teaching scenario, (according to the study Coates, Janine & Vickerman, Philip, 2013), inevitably, we are talking about certain teachers' key competencies, which are found in Kudlacek's study (et. All, 2010) and which are the following:

- Adapting or purchasing appropriate equipment that can facilitate inclusive physical education (eg brightly colored, loud, light or heavy, larger, etc.);
- Analysis of tasks in correlation with desired skills, in order to adapt them to suit the needs of students with special educational needs;
- Adapting the rules of the games to facilitate inclusion;
- Adapting the teaching style to facilitate inclusion;
- Adapting the learning environment to facilitate inclusion.

The results of another study converge in the same direction as Majko's study, Baglama, Yucesoy, & Beyazit, (2019). These provided evidence on physical education and teachers' attitudes toward students with special needs along with the association of their attitudes among demographic variables. Regarding the results of this study, there is a requirement to support positive attitudes amid physical education teachers and protection against people with special needs. The following recommendations were provided depending on the results of the study:

• Teacher training programs should focus more on how to teach people with special needs in order to promote the knowledge, skills and attitudes attributed to physical education teachers.

• The association with different demographic variables could be examined, as a relative or close person with special needs or teaching experience in special education.

• In the context of the special education course, physical education teachers could be encouraged to make school visits to recognize and gain experience with children with special needs and therefore develop positive attitudes towards them.

• Elective courses may include curriculum which allows for increased awareness of people with special needs. During the teaching practice course, physical education teachers may be required to participate in the observation and implementation of inclusive education practices. Thus, we see how the results of this study correlate both in formal training and in a compulsory internship, in order to see concretely various typologies of children with SEN. Of course, a study measuring this impact would be welcome in order to be able to develop a public policy proposal in this regard.

Of course, not all studies show this positive relationship between teachers and students with SEN. According to a study conducted in Greece (Tsakiridou & Polyzopoulou, 2014), teachers who participated in this study expressed generally neutral attitudes towards the practice of inclusion, with the exception of students with social difficulties, for whom it seemed they adopted a more favorable attitude, as shown in the relevant research. These attitudes seem to stem from the absence of qualified staff in special education, problems with the organization and operation of Greek Centers for Diagnosis and Public Assessment, lack of materials and technical infrastructure, and inadequate support services to reach the requirements of the whole integration process for special education. School principals have expressed a desire to implement inclusive education for students with SEN. However, it was clear that the school system has a real difficulty in fully meeting the needs of these students.

Another idea is outlined in the study by Pedersen, Cooley & Rottier, (2014), namely that itinerant and support teachers should exist in each and every school. Moreover, they should cooperate with teachers as to promote social inclusion. This may indicate an opening to a different research' direction which aims to the exact cooperation degree between the support teacher and the classroom teacher in order to ensure an inclusive educational process. This teacher' competence to cooperate and work in a team with other professionals is also presented as a favorable result for the inclusion of children with SEN in the study conducted by Heikinaro-Johansson, Sherrill, French and Huuhka (1995).

In this case, they used an evaluative case study project to examine the effects of the collaborative team approach on facilitating the inclusion of students with disabilities. Here, the class teacher and the support teacher from the collaboration team. The team organized meetings to identify and analyze the needs related to the successful inclusion of students with SEN. The results showed that teachers, support teachers and students have successfully benefited from the collaborative team approach for facilitating inclusive vocational education.

Solutions and good practices in promoting the inclusion of children with SEN in physical education and sports classes

• *Peer tutoring*

Of all the revised studies, three of them examined the effects of peer guidance in inclusive settings during SAI classes. All of these studies used a multi-data-delayed research project with a single subject (Klavina & Rodionova, (2016)) and provided evidence for the positive effects of peer guidance for improving students' motor performance. As stated in Klavina and Block's study (2007), they highlighted the effect of peer tutoring on interaction behaviors between students with SEN and students without SEN in physical education and sports classes. Behavioral data collected under teacher-directed conditions indicated a high level of interactions between students with SEN and teachers. In regard to the interactions with potential tutors, all targeted students occasionally interacted with selected students as a result of teacher instruction and the positive attitude of individual general education students.

It must be noted that these 3 studies used intentional sampling to select targeted students with different disabilities. Therefore, it is difficult to generalize the results to the entire population of students with SEN. The future studies shall try studies involving random selection, which would allow a greater results' generalization (Block & Obrusnikova, 2007). All studies which examined the effects of peer guidance were conducted in the United States. Research in other countries and other contexts is needed as to add diversity (Qi & Ha (2012). In addition, only one study examined the effects of peer guidance on students with SEN, which is the study by Cooper, Heron, and Heward (1987). It provided evidence for the positive effects of peer guidance in improving students' motor performance. Future research on the effects of peer guidance in the context of primary and secondary education is necessary. Moreover, the individual conditions and characteristics of fellow tutors (eg gender, previous experience of interacting with colleagues with SEN, communication skills and motor skills) should be examined. Finally, the three studies used a quasi-experimental and

qualitative design by applying questionnaires. Completing all the findings with qualitative data from students and their teachers on the peer guidance format could be useful.

• *Adaptation of the teaching process by physical education and sports teachers*

As highlighted in the study started by Hodge (2010) a number of important indicators of effective teaching are applicable to students with SEN in physical education. These include:

1. finding ways in order to keep the students appropriately involved in the subject for a higher percentage of time and doing this without resorting to coercive, negative or punitive behavioral techniques;

2. developing and maintaining a positive classroom climate, in which students have many opportunities to practice levels appropriate to their abilities;

3. individualizing instructions for students' success and task-oriented behaviors, which include adapting and adjusting strategies to suit contextual variables;

4. the use of peer tutors to assist and pay extra attention, which allows students to practice greater opportunities;

5. using appropriate reinforcement strategies to motivate students;

6. providing congruent feedback, specific to skills and behavior;

7. organizing practices in a way that promotes student learning and retention.

The time which students spend in the lesson activity should be directed towards the skills' acquisition with clear measures of responsibility regarding the learning outcomes through active participation. In planning lessons, teachers and service providers need to design learning experiences which ensure that their students actively participate in fun movement activities. It is important for teachers to focus on the fun of the students as they move. However, they must hold students accountable for the correct movement' forms towards the acquisition, development or competence of skills. For all of this to happen in real life and for physical education and sports teachers to develop these skills and abilities, the study by Smith (2004) shows that there is a need for a change in curriculum. This should include a wider range of physical activities, adapted to students with SEN, other than the 'traditional' team sports, which could be the best course of action. In addition to his own, Vickerman (2007) also emphasized "the need for the profession to establish a clear and consistent approach to physical education and sports classes in an inclusive manner through initial teacher training and continuing professional development programs". Indeed, although there is a tendency to overemphasize the significance of training for the practice of physical education teachers, it would be appropriate

to start a change with trainees themselves and to continue some education programs with their already qualified colleagues, in order to facilitate it even more, as specified in the conclusions of the study by Auxter, Pyfer, & Huettig (2005).

• *Cooperative learning*

Cooperative learning is defined as "the instructional use of small groups so that students can work together to maximize their own and mutual learning" (Johnson, Johnson, & Holubec, 1993, p. 6). Group goals can only be achieved if individual students in the group work together (Grineski, 1996; Johnson & Johnson, 1999). Grenier (2006) described teachers' behaviors and students in inclusive environments in SAI classes from a constructionist social perspective. The participant in Grenier's (2006) study was a physical education and sports teacher in primary education who adopted cooperative learning strategies to include a student with severe cerebral palsy and visual impairment in her physical education program. She used a small group format to increase the level of interaction through face-to-face involvement, positive interdependence and group processing. The findings showed that cooperative learning supported her beliefs in developing social skills for students with or without disabilities, as well as the effectiveness of her inclusion practices. Nonetheless, students did not always have the ability to include their disabled colleagues in activities despite all the teacher's attempts to place them in support groups. This finding drew attention to the importance of context and the organizational factors which support students in their ability to demonstrate their skills. Despite the progress in establishing more effective inclusive practices, further research on how to improve the effectiveness of training for students with or without disabilities in the inclusive framework of SAI classes is essential. Future research should continue to address the effects of different inclusive strategies. For example, a single study (Grenier, 2006) explored the effects of cooperative learning strategies. More evidence from several research methodologies is necessary.

Conclusions

This review provided a summary and a discussion of the existing work on the format of physical education and sports classes conducted in an inclusive manner. The data in this analysis indicate that the number of studies on inclusive research has increased in the last 20 years. Regarding their research projects, most studies were generally classified as non-experimental studies (causal comparative method and correlational studies) and about over 80% of

them were conducted using a qualitative approach. There was no experimental research with random sampling among the studies that were reviewed. It is suggested that the quality and generalization of experimental design could be improved through collaborative studies.

Aditionally, it is also necessary to increase the quality of the qualitative studies by applying well-planned approaches or strategies. Although many of the research studies have focused on teachers' attitudes and perceptions towards inclusion, future studies are still vital to identify the factors which contribute to the development of positive attitudes towards inclusive education in physical education and sports classes. Furthermore, future studies should explore effective inclusive practices in different social and cultural contexts.

The results of this review showed that peer guidance has proven to be an effective method of facilitating inclusive physical education (e.g., Klavina & Block, 2008; Ward & Ayvazo, 2006). However, supplementing the findings with qualitative data from students with disabilities and their teachers on the peer guidance strategy in different cultural and school settings could provide a deeper and more comprehensive understanding of the strategy. Besides, it is also suggested that more studies could focus on the roles and responsibilities of support teachers in physical education and sports classes.

Finally, future studies examining the effects of inclusion on students with or without disabilities should also address student attitudes, social interactions, and the acquisition of cognitive development and motor skills in inclusive physical education settings. There are a number of limitations to this literature review. For example, the keywords used in this study (namely: inclusion, inclusive education, inclusive physical education, disabilities and integration) may have limited the number and range of studies identified. Future research may need to consider including other words. However, this review improved our knowledge of the type of studies undertaken in the field of inclusive physical education for students with SEN.

REFERENCES

Apelgren, K., & Giertz, B. (2010). Pedagogical competence—A key to pedagogical development and quality in higher education. In R. Asa, A. Karin, & O. Thomas (Eds.), *A Swedish perspective on pedagogical competence,* 25-38. Uppsala University, Division for Development of Teaching and Learning

Auxter, D., Pyfer, J., & Huettig, C. (2005). *Principles and methods of adapted physical education and recreation* (10th ed.). Boston, MA: McGraw Hill.

Baglama, B., Yucesoy, Y., & Beyazit, F. (2019). Attitudes of Preservice Physical Education Teachers towards Individuals with Special Needs. *Revista Romaneasca pentru Educatie Multidimensionala*, 11 (4), 08–21. doi:10.18662/rrem/174

Bertills, K. Granlund, M. Dahlström, Ö. & Augustine, L. (2018). Relationships between physical education (PE) teaching and student selfefficacy, aptitude to participate in PE *and* functional skills: with a special focus on students with disabilities. *Physical Education and Sport Pedagogy*, 23 (4), 387–401. doi: 10.1080/17408989.2018.1441394

Block, M. E. (1995). Development and validation of the Children's Attitudes Toward Integrated Physical Education-Revised (CAIPE-R) inventory. *Adapted Physical Activity Quarterly*, 12 (1), 60–77.

Branco, M. F. S. R., & dos Santos, M. L. (2013). Attitudes towards the inclusion of students with special educational needs in physical education classes. International Journal of Developmental and Educational Psychology, 1 (1), 603–614.

Coates, J. & Vickerman, P. (2010). Empowering children with special educational needs to speak up*: Experiences of inclusive physical education. Disability and Rehabilitation*, 32 (18), 1517–1526. doi:10.3109/ 09638288.2010.497037

Coates, J. & Vickerman, P. (2013). A review of methodological strategies for consulting children with special educational needs in physical education. *European Journal of Special Needs Education,* 28 (3), 333–347. 10.1080/08856257.2013.797705.

Cooper, J. O., Heron, T. E., & Heward, W. L. (1987). *Applied behaviour analysis*. Columbus, OH: Merrill.

Demirci, N. & Toptaş Demirci, P. (2016). The Evaluation of rough and fine motor skills of disabled children having learning difficulties. İnönü University, *Journal of Physical Education And Sport Science*s, 3 (1), 47-57.

Demirci, N., Yıldırım, İ., Toptaş Demirci, P. & Ersöz, Y. (2018). Why should we do physical activity? more active people for a healthier world. *International Journal of Disabilities Sports and Health Sciences,* 1 (2), 1-14. doi:10.33438/ijdshs.488292

Demirci, P.T. & Tzarova, R. (2021). Effect of the Physical Education and Sport Classes on the Physical Capacity of Children with Special Educational Needs*. Educational Policy Analysis and Strategic Research*, 16 (1), 328-355. doi: 10.29329/epasr.2020.334.18-614.

Grenier, M. (2006). A social constructionist perspective of teaching and learning in inclusive physical education. *Adapted Physical Activity Quarterly*, 23, 245–260.

Gough, D., Thomas, J., Oliver, S. (2012). Clarifying differences between review designs and methods. Systematic Review 1, 28. https://doi.org/10.1186/2046-4053-1-28

Haegele, J. Zhu, X. & Davis, S. (2017). Barriers and facilitators of physical education participation for students with disabilities: an exploratory study. *International Journal of Inclusive Education*, 22 (2), 130–141. doi: 10.1080/13603116.2017.1362046

Heikinaro-Johansson, P., Sherrill, C., French, R., & Huuhka, H. (1995). Adapted physical education consultant service model to facilitate integration. *Adapted Physical Activity Quarterly*, 12 (1), 12–33.

Hodge, S.R. (2010). Adapted Physical Activity for Students with Special Needs. *International Encyclopedia of Education,* 518–529. 10.1016/B978-0-08-044894-7.01124-6.

Jing. Q., & Ha, A. (2012). Inclusion in Physical Education: A review of literature. *International Journal of Disability Development and Education,* 59 (3), 257–281. 10.1080/1034912X.2012.697737.

Klavina A., Block ME. (2008) The effect of peer tutoring on interaction behaviors in inclusive physical education. *Adapted Physical Activity Quarterly,* 25 (2), 13–258. doi: 10.1123/apaq.25.2.132. PMID: 18493089.

Klavina, A., & Rodionova, K. (2016). The Effect of Peer Tutoring in Physical Education for Middle School Students with Severe Disabilities. *European Journal of Adapted Physical Activity,* 8 (2), 13–17. 10.5507/euj.2015.005.

Konar, N. & Yildiran, I. (2012). Physical education and sports teaching for the disabled: requirements and a program model. *Selçuk Unıversıty Journal of Physıcal Education and Sport Scıence*, 14 (2), 208–216.

Kudlacek, M., & Ješina, O., & Flannagan, P. (2010). European Inclusive Physical Education Training. *Advances in Rehabilitation,* 3, 14–17. 10.2478/v10029-010-0003-6.

Majoko, T., (2005). Specialist teachers' perceptions on the inclusion of children with disabilities mainstream school system in Zimbabwe (BEd unpublished thesis), Masvingo State.

Majoko, T. (2019). *Teacher Key Competencies for Inclusive Education: Tapping Pragmatic Realities of Zimbabwean Special Needs Education Teachers*, *SAGE Open*, 9 (1), doi:10.1177/2158244018823455

Mastropieri, M. A., & Scruggs, T. E. (2010). *The inclusive classroom: Strategies for effective instruction* (4th ed.). Upper Saddle River, NJ: Prentice Hall.

Miftahov, A.F. (2020). Organization of physical education lessons in an inclusive education. *Scientific trends: pedagogy and psychology*. 10.18411/sciencepublic-04-11-2020-06.

Neville, R. D. Makopoulou, K. & Hopkins, W. G. (2020) Effect of an ınclusive physical education (ıpe) training workshop on trainee teachers' self-efficacy, *Research Quarterly for Exercise and Sport*, 91 (1), 10–2114, doi: 10.1080/02701367.2019.1650877

Nişli, M. Y., & Şirinkan, A., Acar, Z., Öz Nişli, E., & Toy, H. (2021). The Investigation of Acquisition Sufficiency of Physical Education Lesson Aims in A Special Education School in Turkey: A Pilot Study (Physical Education and Sports for Disabilities). *International Journal of Disabilities Sports & Health Sciences,* 4 (1), 2–437. 10.33438/ijdshs.800381

Oliver, R. M., & Reschly, D. J. (2010). Special education teacher preparation in classroom management: Implications for students with emotional and behavioral disorders. *Behavioral Disorders*, 35 (3), 188–199. doi:10.1177/019874291003500301

Pedersen, S. J., Cooley, P. D., & Rottier, C. R. (2014). Physical Educators' Efficacy in Utilising Paraprofessionals in an Inclusive Setting*. Australian Journal of Teacher Education*, 39 (10). http://dx.doi.org/10.14221/ajte.2014v39n10.1

Petticrew, M., & Roberts, H. (2006). *Systematic reviews in the social sciences: A practical guide.* Malden, MA: Blackwell. doi: 10.1002/9780470754887.fmatter

Philpott, D. F., Furey, E., & Penney, S. C. (2010). Promoting leadership in the ongoing professional development of teachers: Responding to globalization and inclusion. *Exceptionality Education International,* 20 (2), 38–54.

Ross, S. M., Bogart, K. R., Logan, S. W., Case, L., Fine, J. & Thompson, H. (2016). Physical activity participation of disabled children: a systematic review of conceptual and methodological approaches in health research. *Frontier Public Health*, 4 (11), 1–11. doi:10.3389/fpubh.2016.00187.

Smith, A. (2004). The inclusion of pupils with special educational needs in secondary school physical education, *Physical Education and Sport Pedagogy*, 9 (1), 37–54, doi: 10.1080/1740898042000208115

Tsakiridou, H., & Polyzopoulou, K., (2014). Greek Teachers' Attitudes toward the Inclusion of Students with Special Educational Needs. *American Journal of Educational Research,* 2 (4), 208–218. 10.12691/education-2-4-6.

Toptaş, D. P., Tzarova, R. (2021). Effect of the Physical Education and Sport Classes on the Physical Capacity of Children with Special Educational Needs. *Educational Policy Analysis and Strategic Research,* 16 (1), 328–355. doi:10.29329/epasr.2020.334.18.

Vickerman P. (2002). Training physical education teachers to include children with special educational needs: Perspectives from physical education initial teacher training providers. *European Physical Education Review*. 13 (3), 385–402. doi:10.1177/1356336X07083706

Wolfswinkel, J., Furtmueller, E., & Wilderom, Celeste P M. (2013). Using grounded theory as a method for rigorously reviewing literature. *European journal of information systems*, 22 (1), 45–55. doi:10.1057/ejis.2011.51

Zawacki-Richter, O., Kerres, M., Bedenlier, S., Bond, M., Buntins, K., (2020). *Systematic Reviews in Educational Research. Methodology, Perspectives and Application.* Wiesbaden: Springer. https:///doi.org/10.1007/978-3-658-27602-7

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AN OVERVIEW OF THE OPPORTUNITIES OFFERED BY THE ADVANCEMENT OF INFORMATION AND COMMUNICATION TECHNOLOGY IN THE FIELD OF PHYSICAL EDUCATION AND SPORTS

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ABSTRACT. Introduction. With the outbreak of the COVID-19 pandemic, caused by the novel coronavirus, major challenges have arisen in terms of the development of the teaching process and sports training. For some of them, the solution was offered by the already existing hardware and software technologies, and this created new educational contexts, as well as opportunities for adaptation and evolution of the teaching and training process. **Objectives.** Identify in the literature some principles, guidelines, and recommendations regarding the implementation of technology in the educational and training process. **Methods**. In this paper, the method of studying the literature was used, using information published in international databases. Results. The specialized literature offers many studies on the subject of education assisted by information and communication technology tools, being available examples of success in the specialized practice. **Conclusions.** The challenges and objectives of current education must be considered in the incorporation of technology into education before deciding how information and communication technology tools can be used to achieve them. The educational context has adapted to the current times, teachers become guides and designers of learning situations where technology is a tool that must be used masterfully by them.

Keywords*: physical education, sports, information technology.*

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REZUMAT. ***O privire de ansamblu asupra oportunităţilor oferite de avansul tehnologiei informaţiei şi comunicaţiilor în domeniul educaţiei fizice şi sportului.*** **Introducere.** Odată cu izbucnirea pandemiei de COVID-19, cauzată de noul coronavirus, au apărut provocări majore în privinţa desfăşurării procesului didactic şi a antrenamentelor sportive. Pentru o parte dintre acestea, soluţia a fost oferită de tehnologiile hardware şi software existente deja, iar acest lucru a creat noi contexte educaţionale, precum şi oportunităţi de adaptare şi evoluţie a procesului didactic şi de antrenament. **Obiective.** Identificarea în literatura de specialitate a unor principii, direcţii şi recomandări în privinţa implementării tehnologiei în procesul educaţional şi de antrenament. **Metode**. În realizarea acestei lucrări s-a folosit metoda studiului literaturii de specialitate, folosind informaţii publicate în bazele de date internaţionale. Rezultate. Literatura de specialitate oferă o cantitate mare de studii pe tema educaţiei asistate de instrumentele tehnologiei informaţiei şi a comunicaţiilor, fiind disponibile exemple de succes din practica de specialitate. **Concluzii.** În încorporarea tehnologiei în educaţie trebuie avute în vedere provocările şi obiectivele educaţiei curente înainte de a decide cum pot fi utilizate instrumentele din tehnologia informaţiei şi a comunicării la atingerea acestora. Contextul educaţional s-a adaptat vremurilor actuale, profesorii devin ghizi şi designeri ai situaţiilor de învăţare unde tehnologia este o unealtă care trebuie folosită cu măiestrie de către aceştia.

Cuvinte cheie: *educaţie fizică, sport, tehnologia informaţiei.*

Introduction

In this paper, we will analyze the new educational and sports training opportunities offered by technologies in the field of physical education that promote not only health but also education.

Technologies, especially since the 2000s, have enriched school education, expanded content, tools, methodologies, and changed the relationship between specific knowledge, teachers, coaches, and students or athletes. Rapid developments in electronic technology have brought important changes to the world's education systems.

Kretschmann (2015) says that the use of technology is an important effect of mediation between discipline and student, helping to change learning patterns, develop intrinsic motivation and metacognition. The most important technologies used in schools (video recordings and personal computers) have led to a reset of knowledge and new areas of intervention have emerged in each area in relation to key disciplinary topics.

Objectives

This article sought to identify in the literature some information about the principles, directions and recommendations made by other authors regarding the implementation of technology in the process of education and sports training.

Materials and methods

In this paper, the method of studying the specialized literature was used, using information published in the Science Direct, ProQuest, EBSCO and Google Scholar international databases, starting from keywords such as: physical education, sports, information technology and their derivatives.

Results

Following the analysis of the identified articles, we found out that there are a multitude of software applications in the field of health and education. They are available and can be used to enrich and improve curricula in most schools. Numerous technology applications for promoting physical activity and fitness are available and easily accessible.

Today, the application of various technologies by students and teachers requires new skills. Students must demonstrate motor skills and use technology primarily through a process of self-learning. It is essential to learn how to manage the organization of activities together with the use of different equipment.

Teachers, on the other hand, "need to become more aware of teaching styles and strategies and should always support the use of technological applications in physical education" (Herring, Edginton, Geadelmann, & Chin, 2012).

In their study Gibbone, Rukavina, & Silverman (2010) examine attitudes, physical education teacher training, technology integration, and the relationship between attitudes and practice.

Their results show that teachers have positive attitudes, but still show limited use of technology.

The limitations that affect the use of technology are the school budget, the large number of classes / groups and the process of ongoing teacher training. Physical educators are willing to apply teaching technology only if adequate training and financial resources are provided.

The National Association for Sport and Physical Education (NASPE) (2009), an entity in the United States, has published guidelines on the appropriate use of teaching technologies in physical education:

"Guideline 1: Educational technologies in the field of physical education aim to increase teaching efficiency;

Guideline 2: Educational technologies in the field of physical education aim to supplement not to substitute, teaching efficiency;

Guideline 3: Educational technologies in physical education should provide learning opportunities
and education for all students;

Guideline 4: Educational technologies in physical education should be an effective tool for storing student data on its curricular objectives."

NASPE studies (2009) also state that it is important for teachers to learn and understand technological tools before using them in gyms so that their students can use these tools effectively and not use equipment and tools. it must interfere with the achievement of the lesson objectives.

Subsequently, Sanders & Witherspoon (2012) summarized the important processes that must be performed when using technology in physical education. The authors (Sanders & Witherspoon, 2012) argue the following:

"1) technology can be a challenge;

2) continuing education is needed for physical educators to develop their skills in the use of technology;

3) availability of a budget for the purchase of technological tools in schools with priority in physical education;

4) there must be defined standards for safe technological use in all areas of sports and physical education for students of all ages;

5) periodic updating of the software must be included in the budget;

6) physical education programs for teachers should include technological applications;

7) technologies should be used in the assessment process and for the exchange of information with teachers, principals, students and parents. "

Other studies (Castelli, Cenetio, Beighle, Carson, & Nicksic, 2014, 66) also warn that technology is innovative in the way students learn and teachers teach, and physical education and health promotion programs are developed for to provide participants with better opportunities instead of the traditional way of learning in gyms.

Regarding the relationship between physical education and technology, it is possible to identify different directions and complementary studies: epistemological, psycho-pedagogical, and socio-cultural.

The epistemological perspective is essentially a didactic one based on scientific evidence.

Regarding physical education, several areas of interdependence between education and technology can be identified, as follows:

a. technology in and for physical education (i.e., contribution to a learning of motor skills in school; integration of new methods for assessing motor development, data processing and storage, etc.);

b. physical education and technology (i.e., the relationship between physical activity and the use of tools and equipment, for example, heart rate monitors, accelerometers, stereo systems, video cameras, digital cameras, projectors, i-pads or online education). online, including various teachings such as physiology, neuroscience, history, science, through interactive videos, web pages and learning effects, etc.);

c. technologies for promoting health through physical activity (use of pedometers and accelerometers to assess levels of physical activity, use of GPS to assess and customize, use of web platforms to record performance and parameters and comparison of performance benchmarks, preparation of training etc.).

Physical education is becoming richer than in the past and every field (expressive activities, games, sports, outdoor education, motor and interdisciplinary learning) receives a significant contribution and is revised and expanded. By using different tools, physical education establishes closer links between scientific fields and stronger links between different fields of knowledge.

From a psycho-pedagogical perspective, the use of technology in physical education promotes an efficient process of learning motor skills, allowing students to evaluate the experience gained by comparing it in different periods of time. Teaching motor skills (skills, knowledge, motivations, attitudes and relationships), through different teaching styles and strategies (Schmidt A., 2000); (Mosston & Ashworth, 2002) with technological tools, not only broadens and specifies the didactic-educational directions, but introduces new ways to learn skills and knowledge in different contexts. In this direction, technologies promote the learning and recapitulation of motor skills, psychological factors related to practice, perception of competence, mutual evaluation, joy, mental processes and metacognitive processes (Fiorentino, 2005; Dillon, 2008).

From a socio-cultural perspective, technologies support curricula in schools, produce reticular knowledge and expand or connect learning environments. Computers and video cameras allow you to share data and experiences from physical and sports activities (simultaneously and / or at a different time) among users and for the development of interpersonal relationships. The student can participate in physical activities and online fitness programs, analyze and

share video analysis data related to physical education classes and training sessions, compare experiences and activities in different geographical locations. The effects on teaching and learning have been extended. With the help of smartphones in physical education and sports, they can compose and send texts, data, photos and videos, participate in social media on health promotion issues or sports, receive real-time information on the development of demonstrations, events, and to recognize the availability of facilities and the use of equipment for physical activities.

Discussions

The inclusion of information and communication technology (ICT) in physical education to encourage exercise is still in its infancy. However, there are already many examples of how the use of ICT in physical education can stimulate physical activity among students. In fact, when social networks are used correctly, they become a powerful tool for promoting a healthy lifestyle among adolescents (Monguillot, González, & Guitert, 2015).

For example, the project #tuitactiu (Nieto Tó, 2012) uses Twitter in physical education to spread the practice of physical exercise among students. The #quesepegue project (Herrero Serrano, 2012) uses Twitter to cheer up downtime with healthy physical activity. Finally, the use of m-learning or mobile-learning (Monguillot M., González, Guitert, & Zurita, 2014) paves the way for new forms of learning and teaching that are useful and functional and facilitate interaction, collaboration, knowledge generation. and combining formal and informal learning environments. In this way, learning tends to become more personalized and extends beyond the walls of the classroom.

Although teachers have used technology for many years (Wozney, Venkatesh, & Abrami, 2006), physical education teachers have now also integrated the use of different electronic platforms in their instruction (Gibbone, Rukavina, & Silverman, 2010; Riley & Stern, 2004). Technology allows teachers to have a much wider range of broadcasting their message (Hastie, Farias, & Gutiérrez, 2013). It can play a central role in supporting learning, especially in physical education (Fiorentino, 2005). The experiences with technology that students have can increase their understanding and can cause the pleasure of practicing physical activities (Kooiman & Sheehan, 2014).

Education is moving towards a technology-based training and learning forum. Technology brings with it new ways for teachers and students to communicate remotely. Teaching and learning methods can be transformed by technology. Using technology effectively for training planning (Riley & Stern, 2004) and implementing training can enable culturally relevant training.

Teachers can use current technology to create the curriculum that can use it (Summers, Waigandt, & Whittaker, 2005). The scarcity (rarity) of extensive research into the efficiency of technology is due to the ever-changing and rapid evolution of electronic platforms. However, technology has provided various learning outcomes in motor skills (Fery & Pontserre, 2001) and curriculum (Goddard, 2002).

The variety of electronic platforms available to physical education teachers is constantly growing and changing (Williamson, 2015). New and emerging technologies promise efficiency and different ways of teaching and learning (Palao, Hastie, Cruz, & Ortega, 2015). By infusing technology into the physical education curriculum, the realization of cultural relevance can be intensified. Increasing the ability of teachers to take and disseminate information about training methods and content used around the world can also help to create more connected lessons for a diverse class.

The literature also suggests that effective technological integration in education requires teachers to apply their knowledge of curricular content, general pedagogy, and technology. This approach, known as " Technological Pedagogical Content Knowledge Framework" (TPACK).

Conclusions

Therefore, in order to incorporate technology into education, we must first consider the challenges and objectives of current education and then decide how information and communication technology tools can be used to achieve them. In the new methods, students take on the role of leader in educational activity, while teachers become guides and designers of learning situations.

In addition, technology must be and remain a tool masterfully used by specialists in our field and not a way to replace them with "soft" skills, which are an asset of the teacher and the coach.

REFERENCES

Castelli, D., Cenetio, E., Beighle, A., Carson, R., & Nicksic, H. (2014). Physical literacy and comprensive school physical activity programs. *Preventive Medicine*, *Sep. 66*, 95-100.

Dillon, S. (2008, aprilie 8-12). Time-Delayed Video Feedback in Physical Education: A Pilot Study. *Poster presentation presented at the 2008 AAHPERD National Convention and Exposition*. Fort Worth, TX.

Fery, Y. A., & Pontserre, S. (2001). Enhancing the control of force in putting by video game training. *Ergonomics, 44*, 1025-1037.

Fiorentino, L. H. (2005). Creating a virtual gymnasium. *Journal of Physical Education, Recreation & Dance, 76(4)*, 16-18.

Gibbone, A., Rukavina, P., & Silverman, S. (2010). Technology integration in secondary physical education: teachers' attitudes and practice. *Journal of Educational Technology Development and Exchange, 3(1)*, 27-42.

Goddard, M. (2002). What do we do with these computers? Reflections on technology in the classroom. *Journal of Research on Technology in Education, 35*, 19-26.

Hastie, P. A., Farias, C., & Gutiérrez, D. (2013). Students' and teachers' responses to a transatlantic sport education league. *Journal of the International Society for Comparative Physical Education and Sport, 35(2)*, 22-33.

Herrero Serrano, G. (2012). *Resumen del proyecto #quesepegue*. Preluat de pe http://gloriaherreroserrano.blogspot.com.es/2012/05/resumen-del-proyecto-quesepegue.html

Herring, M. C., Edginton, C. R., Geadelmann, P. L., & Chin, M. K. (2012). Emerging perspectives on learning and technology in physical education: Policy implications. In S. Sanders & L. Witherspoon (Eds.), *Contemporary uses of technology in K–12 physical education: Policy, practice and advocacy*, 21-53.

Kooiman, B. J., & Sheehan, D. P. (2014). The efficacy of exergames played proximally and over the internet on cognitive functioning for online physical education. *American Journal of Distance Education, 28*, 280-291.

Kretschmann, R. (2015). Effect of Physical Education Teachers' Computer Literacy on Technology Use in Physical Education. *The Physical Educator, 72*, 261-277.

Marchesi, A. (2009). Las Metas Educativas 2021. Un proyecto iberoamericano para transformar la educación en la década de los bicentenarios. *Revista CTS*.

Monguillot, M., González, C., & Guitert, M. (2015). Diseño de situaciones de aprendizaje mediadas por TIC en Educación Física. *Revista iberoamericana de educación / revista ibero-americana de educação, 68(2)*, 63-82.

Monguillot, M., González, C., Guitert, M., & Zurita, C. (2014). Mobile learning: a collaborative experience using QR codes. Aplicaciones para el aprendizaje móvil en educación superior [Monográfico]. *Revista de Universidad y Sociedad del Conocimiento (RUSC). Vol. 11, no 1.*, 175-191.

Mosston, M., & Ashworth, S. (2002). *Teaching physical education - 5th edition.* London: Benjamin Cummings.

National Association for Sport and Physical Education. (2009). *Appropriate use of instructional technology in physical education.* Reston V.A.

Nieto Tó, N. (2012). Presentación #tuitactiu al FIEP. Barcelona. Preluat de pe Disponibil online: http://www.slideshare.net/nurianietoto/presentacin-tuitactiu-al-fiep-2012-barcelona.

Palao, J. M., Hastie, P. A., Cruz, P. G., & Ortega, E. (2015). The impact of video technology on student performancein physical education. *Technology, Pedagogy and Education, 24(1)*, 51-63.

Riley, K. L., & Stern, B. S. (2004). Problems and possibilities of web-based instruction: Transforming social studies methods and practice. *Journal of Computing in Teacher Education, 21(2)*, 65-71.

Sanders, S., & Witherspoon, L. (2012). *Contemporary uses of technology in K–12 physical education: Policy, practice and advocacy.* Charlotte, NC: Information Age.

Schmidt A., R. W. (2000). *Motor Learning and performance. Second edition.* Champaign, IL: Human Kinetics.

Summers, J. J., Waigandt, A., & Whittaker, T. A. (2005). A comparison of student achievement and satisfaction in an online versus a traditional face-to-face statistics class. *Innovative Higher Education, 29(3)*, 233-246.

Williamson, B. (2015). Algorithmic skin: Health-tracking technologies, personal analytics and the biopedagogies of digitized health and physical education. *Sport, Education and Society, 20(1)*, 133-151.

Wozney, L., Venkatesh, V., & Abrami, P. C. (2006). Implementing computer technologies: Teachers perceptions and practices. *Journal of Technology and Teacher Education, 14*, 173-207.

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THE NIVOLOGICAL POTENTIAL OF THE BÂRGĂU MOUNTAINS WITH RELEVANCE FOR THE PRACTICE OF WINTER SPORTS AND RECREATIONAL ACTIVITIES

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ABSTRACT. The Bârgău Mountains are located in the northern group of the Eastern Carpathians and represent a territory with a vocation for practicing winter sports (especially cross-country skiing), but also for sports leisure (hiking, cross-country skiing, freeride). This is due to the snow potential of the mountainous area, especially above 1000 m, where the specific phenomena of winter favor the deposition of a thick layer of snow, which, however, fluctuates in duration and thickness depending on climatic variations affecting the region. The analysis of the snow potential was based on the observations made during 2018-2022, on winter phenomena and snow deposits, and the data obtained were correlated with the morphometric characteristics of the relief, finally establishing the optimal areas for certain sports and leisure activities.

Keywords: *snow cover, snowpack, reliable snow cover, snow section (pit snow), stratigraphic profile, winter sports, winter leisure, winter season, climate change, land reclamation*

REZUMAT. ***Potenţialul nivologic al Munţilor Bârgău, cu relevanţă pentru practicarea sporturilor de iarnă şi a activităţilor recreative.*** Munţii Bârgăului sunt situaţi în grupa nordică a Carpaţilor Orientali şi reprezintă un teritoriu cu vocaţie pentru practicarea sporturilor de iarnă (în special a schiului fond), dar şi a agrementului sportiv (drumeţie, schi de tură, freeride). Acest fapt se datorează potenţialului nivologic al arealului montan, mai ales peste altitudinea

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de 1000 m, unde fenomenele specifice iernii favorizează depunerea unui strat consistent de zăpadă, care, totuși, fluctuează ca durată și ca grosime în funcție de variațiile climatice care afectează regiunea. Analiza potențialului nivologic s-a bazat pe observațiile efectuate în perioada, 2018-2022, asupra fenomenelor de iarnă și asupra depozitelor de zăpadă, iar datele obținute au fost corelate cu caracteristicile morfometrice ale reliefului, în final stabilindu-se suprafețele optime pentru anumite activități sportive și agrementale.

Cuvinte cheie: *cuvertură de zăpadă, depozit de zăpadă, strat fiabil de zăpadă, secțiune prin zăpadă, profil stratigrafic, sporturi de iarnă, agrement de iarnă, sezon de iarnă, schimbări climatice, bonitarea terenului*

Introduction

Nivology is a branch of meteorology that studies the physical and chemical characteristics of snow, namely: density, hardness, stability, changes in state, crystallography, and the influence of atmospheric conditions (pressure, temperature, wind, precipitation, evaporation, sublimation, condensation) which It affects its stability, favoring the onset of avalanches.

Snow is a solid, winter-specific atmospheric precipitation, formed by the deposition on the ground of snowflakes resulting from frozen water crystals. The succession of several episodes of snow causes the formation of a layer of snow, which has several functions:

- insulates and protects the soil from the atmosphere;
- reflects solar radiation;
- reduces the roughness of the ground;
- melting increases soil moisture and river flow;
- ensures the environment for winter sports activities;
- is a tourist attraction and favors the practice of specific leisure activities.

As a result of repeated snowfalls during the winter, the snow deposit is formed, consisting of several layers, which are very changeable and unstable. Its transformations begin immediately after deposition on the ground, it is very sensitive to external influences coming from the atmosphere (frost, melting, wind).

In recent decades, we have witnessed many fluctuations in terms of winter phenomena and the amount of snow deposited, a fact induced by climate change affecting the planet. For Europe, snow-rich periods are linked to the presence of humid Atlantic and Mediterranean air masses, and dry periods are caused by high-pressure air masses (polar-temperate, arctic) coming from the east and north of the continent.

These fluctuations have had important repercussions on sports competitions and leisure activities. In the last 5-10 years, many sports competitions have been held, mostly on artificial snow, and low amounts of snow and melting glaciers threaten the future of tourism in the mountainous areas of the planet (https://www.nationalgeographic.com/environment/article/alps-ski-resorts-desperately-battling-climate-change-local-resistance).

In Romania, according to ANM, in January and February of 2022, the thickness of the snow layer in the Carpathians, at over 1400 m, exceeded 50 cm, as follows: 160-215 cm at Bâlea-Lac (Făgăraș Mountains); 130 cm at the top. Omu (Bucegi Mountains); 120-144 cm at peak. Tarcu (Tarcu Mountains); 65 cm in Parang (Parang Mountains); 89-95 cm at the top. Răchitiș Călimani (Călimani Mountains); 75 cm at Lăcăuți (Vrancea Mountains); 59-84 cm at Ceahlău-Toaca (Ceahlău Mountains); 54 cm at Iezer Station (Rodna Mountains); 54 cm in the Bucin Pass (Gurghiu Mountains); 60-80 cm at Stâna de Vale in (Vlădeasa Mountains) (https://www.climbromania.com/IstoricNivo.aspx#ShowImage).

For sports and leisure activities to take place in optimal conditions, a reliable layer of snow is needed. For high mountains (above 2000 m) the reliable snow layer is considered to have a thickness of 30-50 cm, at least 100 days a year, in 7 of 10 winters, from December 1 to April 15 (Elsasser, Messerli, 2001). For the mountains in Romania, included in the category of medium and low mountains, we consider that the reliable layer of snow, at over 1000 m, is distinguished by thicknesses of 30-50 cm, at least 75 days a year, from January 1 to March 15.

Methodology

To carry out this study, the following methodological steps were followed:

- consultation of works related to the area of the Bârgău Mountains (Bîca, 2012; Naum, Butnaru, 1984; Rusu, 1998);
- consulting snowology and the impact of climate change on tourism and sports (Beniston, 1997; Bigano et al., 2005; Brugnot, 2017; Elsasser, Messerli, 2001; Fang et al., 2021; Gonseth, 2013; Hallmann et al. al., 2012; Hammond et al., 2018; Martin et al., 2021; Marty, 2013; Moen, Fredman, 2007; Neuvonen, Sievänen, Fronzek, 2015; Nicholls, 2006; Petrović, 2013; Pütz, Gallati, Kytzia, 2011; Rixen et al., 2011; Roussillon-Nadal, 2014; Scott, McBoyle, 2007; Scott, Dawson, Jones, 2008; Steiger, Scott, Abegg, 2019; Weaver, 2011; Zeng et al., 2018);
- performing nivological observations in the period 2018-2022, which aimed at the distribution, thickness, duration, and stability of the snow layer, the stratigraphy of snow deposits, metamorphic transformations of snow, as

well as the quality of snow deposits to capitalize on them in sports activities and leisure;

- a collection of meteorological data from the automatic stations installed in the localities of Piatra Fântânele, Lunca Ilvei, and Prundu Bârgăului for the period December 2021-February 2022;
- geomorphometric and morphographic analysis of the relief (energy, fragmentation, orientation, orographic structure), based on the topographic map of Romania, scale 1: 25000;
- performing observations on the recreational activities practiced within the mountainous area;
- performing sections through snow deposits, in certain representative points (peaks, slopes, plateaus);
- Land improvement by delimiting areas and land surfaces, depending on the characteristics of the snow, for their capitalization through various leisure activities (ski touring, hiking, snowshoeing, sleigh rides).

From a methodological point of view, the paper makes several contributions to the study of snow, namely:

- correlation of the characteristics of snow deposits with the optimal surface type for a certain sports and leisure activity;
- analysis of the stratigraphic profile to establish the favorable parameters for the capitalization of snow in tourism;
- land improvement on specific sports and leisure activities (determination of the tourist value of a land area, based on certain criteria).

Study area

The Bârgău Mountains are located in the northern group of the Eastern Carpathians, between the Someşul Mare valley to the north, the Dornelor Depression to the east, the Bistriţa valley to the south, and the Bistriţa Hills to the west (fig.1). The major relief of the mountainous area is represented by weakly undulating surfaces, modeled on sedimentary formations (sandstones, marls, clay), with altitudes between 1000-1200 m, above which jump intrusive magmatic massifs, made of andesites, with altitudes between 1000-1600 m (Heniu Mare peak, 1611 m). The mountain building is fragmented longitudinally by valleys tributary to Someşul Mare (Ilva, Leşu), and Bistriţa (Bârgău). Due to the low altitudes, the degree of humanization of the mountainous area is high, the settlements being located in valleys, where access is easy (fig.2).

In terms of climate, the Bârgă Mountains are characterized by a temperate-mountain climate of medium mountains (1000-1600 m), with average winter temperatures between -4^{0}C and -6^{0}C (between 1000-1600 m), average daily temperatures below 0^{0}C, between October 1 and April 1, and average annual rainfall between 700-800 mm below an altitude of 1000 m (e.g. Tihuța (897 m) 888 mm; Colibița (793 m) 789 mm; Poiana Ilvei (490 m) 672 mm; Prundu Bârgăului (465 m) 778 mm), and 800-1000 mm at over 1000 m altitude. The absolute minimum temperatures recorded were -34.3^{0}C at Poiana Stampei and -29.4^{0}C at Prundu Bârgăului (1950-1990), and the number of frosty days (minimum temperatures below 0^{0}C) was 179.4C at Poiana Stampei.

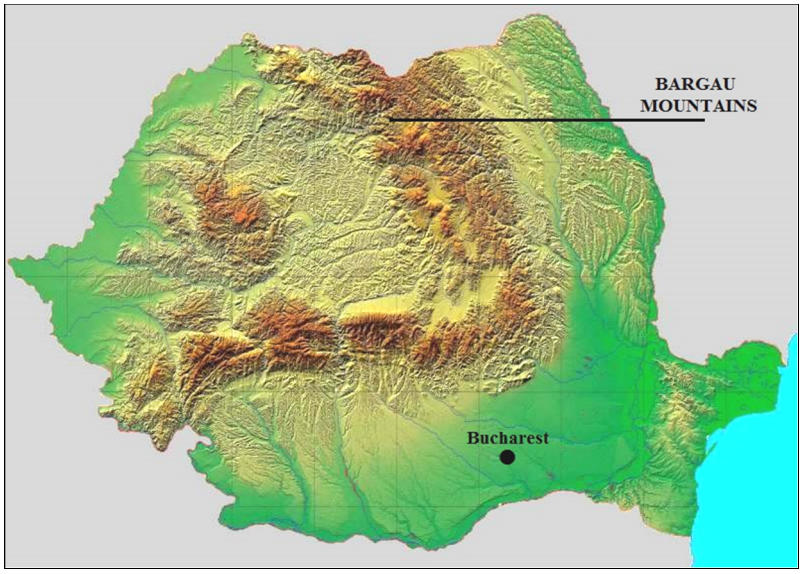

Fig. 1. The geographical position of the Bârgău Mountains in the Romanian Carpathians (source: https://greatnews.ro/wp-content/uploads/2015/08/harta-fizica-a-romaniei.jpg-with changes)

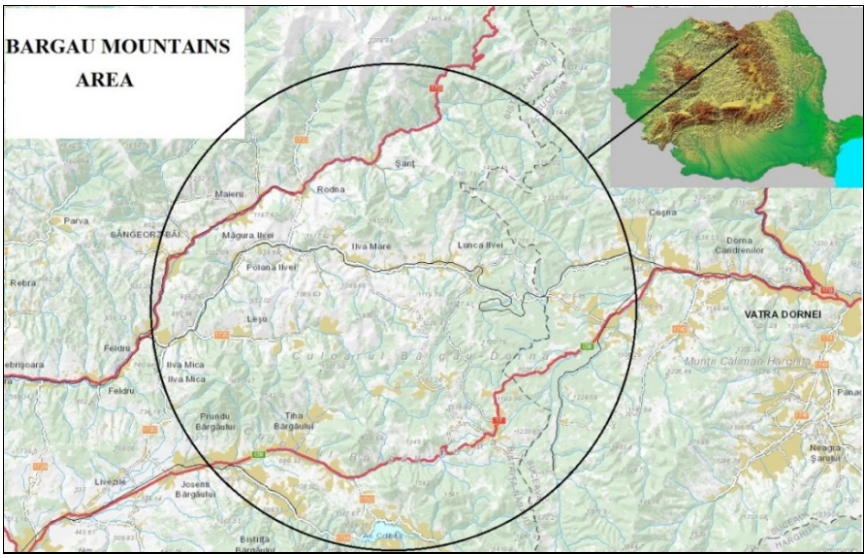

Fig. 2. The limits of the Bârgău Mountains
(source: INIS Viewer-with changes)

The permissiveness of the relief and the snow potential are elements that established the Bârgău Mountains as a favorable location for organizing sports competitions, such as cross-country skiing, in the 7th and 8th decades of the twentieth century. Based on this fact, in recent years these sports competitions have been resumed (e.g. The cross-country skiing and biathlon festival in Piatra Fântânele) and new ones have appeared, which make full use of the snow layer (e.g. The mushing competition from Piatra Fântânele).

Results and discussions

The snow potential of a region includes all the conditions induced by the presence of snow to capitalize on it through winter-specific sports and leisure activities (hiking, snowshoeing, cross-country skiing, tubing, sleigh ride, horse-drawn sleigh rides). It is important to establish the snow potential of the Bârgău Mountains, because, due to the permissive relief and the existing roads, it is a mountain unit accessible to tourists, has a high degree of humanization, has adequate tourist infrastructure (roads, tourist pensions), especially in the two resorts of local interest Colibița and Piatra Fântânele, and has a vocation for practicing winter sports and leisure activities (eg Piatra Fântânele-Tihuța Pass area).

In general, the winter environment of the Bârgău Mountains is distinguished by the following meteorological elements:

a) The period with specific winter phenomena:
-freeze: November-April;
-snow: November-April;
-blizzard: January-February;
-snow layer: December-March;

b) The period with continuous snow cover:
-January, February;

c) The period with a discontinuous layer of snow:
-December, March;

d) The period with spring snow:
-March, April.

Depending on the climatic changes registered at the global and regional levels, the winters in the Bârgău Mountains differ in snow level, from one year to another, but the specific manifestations of winter, regardless of their intensity, are present at over 1000 m altitude (table 1).

Table 1. Winter phenomena in Bârgău Mountains between 2018-2022 years

Year	Falling snowflakes period	Duration of continuous snow cover (days)	Average snow layer thickness (cm)
2018-2019	15.12.2018-01.03.2019	01.01.2019-25.02.2019=56	60
2019-2020	02.12.2019-22.03.2020	03.01.2020-20.02.2020=48	25
2020-2021	19.11.2020-14.04.2021	05.01.2021-25.02.2021=51	30
2021-2022	30.11.2021-17.04.2022	10.01.2022-10.03.2022=59	67

(Source: personal observations)

For the period December 2021-February 2022, the data provided by the automatic weather stations, located in Tihuța Pass, Lunca Ilvei and Prundu Bârgăului, highlighted the following meteorological parameters:

- average temperature: -3,6^{0}C in Tihuța Pass, -2,6^{0}C at Lunca Ilvei, -1,4^{0}C at Prundu Bârgăului;

- minimum temperature: -25,3^{0}C at Lunca Ilvei, -19,6^{0}C at Prundu Bârgăului, -15,4^{0}C in Tihuța Pass;

- maximum temperature: +9,2^{0}C at Prundu Bârgăului, +8,2^{0}C at Lunca Ilvei, +6,4^{0}C in Tihuța Pass;

- minimum temperature below freezing (-10^{0}C): 27 days at Lunca Ilvei, 16 days in Tihuţa Pass, 15 days at Prundu Bârgăului;

- average amount of rainfall: 60 mm at Lunca Ilvei, 47,5 mm at Prundu Bârgăului, and 120 mm at Piatra Fântânele;

-wind speed: 60,5 km/h at Tihuţa Pass, 58,7 km/h at Prundu Bârgăului, and 27,7 km/h at Lunca Ilvei.

For the study of snow deposits on the Bârgău Mountains, several sections were carried out in February-March, in the observations period, in a series of relevant places, at over 1000 m altitude, such as flat surfaces, slopes with northern exposure, and slopes with southern exposure (Table 2). The detailed analysis of the snow deposits revealed the following snow features:

- the individual thickness of the sections was between 60-110 cm, and the average thickness of the snow deposits was 67 cm;

- the stratigraphy of the deposits was made up of 5-8 layers of snow, separated by crusts (fig. 3).

Fig. 3. Snow stratigraphy in Poiana Vulturilor (Bârgău Mountains).
We can see the snow layers delimited by crusts
(source: author)

These crusts formed due to melting during the day and freezing of the deposited snow layers during the night. Everywhere, the base layer was frozen and hard, the middle layers had lower hardness, medium granulation, and ice structures (lenses, columns, etc.), and the top layer came in the form of wind plates;

- the stability of snow deposits on open slopes was high, in general, except on slopes with slopes of more than 40 degrees.

Table 2. Quantitative characteristics of the sections made through the snow deposits in the Bârgău Mountains

Current nr.	Geographic place	Geomorphologic surface	Altitude m	The thickness of the snow deposit cm	The stratigraphy of snow deposits
1	Perşa Mountain	Plateau	1400	110	8
2	Măgura Corni-Poiana Berengenilor	Plateau	1200	100	6
3	Măgura Neagră	Northern slope	1100	80	6
4	Miroslava Mountain Poiana Vulturilor	Eastern slope	1250	100	8
5	Măguriţa Mountain Poiana Andreichii	Southern slope	1100	80	7
6	Căsaru Mountains Poiana Tomnaticului	Southern slope	1200	100	6
7	Miroslava Mountain Poiana Făget	Southern slope	1250	60	5
8	Heniu Mountain Poiana Muncel	Northern slope	1300	80	6
9	Dealul Blajei	South-Western slope	1300	80	7
10	Dealul Toader	Plateau	1100	60	7

Given these snow characteristics, in the next stage, we proceeded to the delimitation of optimal land areas for certain recreational activities (fig. 4). For this, we resorted to the analysis of the relief, based on certain criteria, such as fragmentation, energy, slope, and exposure of surfaces, as well as the inventory of current leisure activities.

Finally, the following land areas, leisure, and sports activities for which it is recommended have been established:

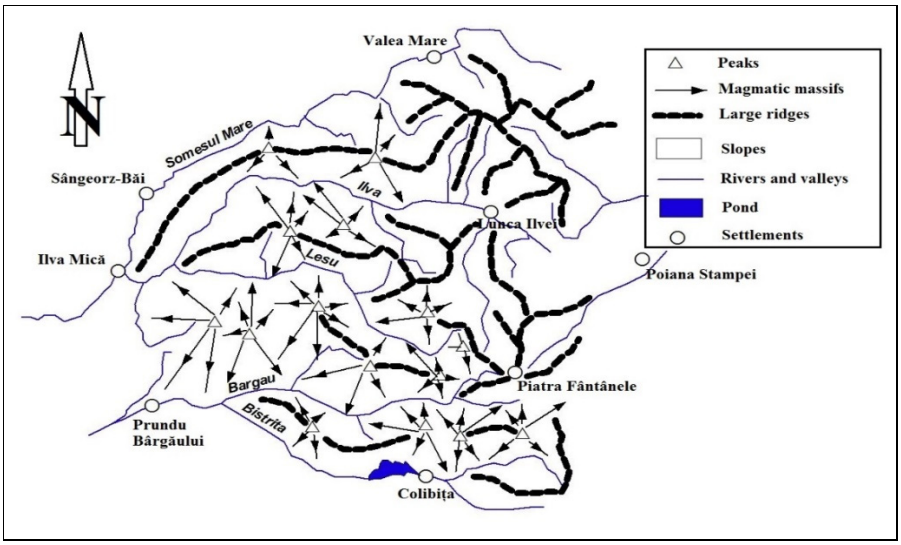

Fig. 4. The main geomorphological surfaces for winter sports and recreational activities in Bârgău Mountains

A) Geomorphological units:

a) Erosional levels:

- the northern, northeastern, eastern and southern area: Valea Ilvei-Valea Coşnei, Piatra Fântânele-Valea Ilvei-Valea Leşului, Plaiul Dosului-Brazii Buni-Strâmba (fig. 5);
- recommendation for backcountry skiing, cross-country skiing, snowshoeing, running, horse-drawn sleigh rides;

b) Magmatic massifs:

1) Northern area:

- Bucnitori, Măgura Mare, Măgura lui Arsente, Chicera Mare, Chicera Mică;
- recommendation for hiking, snowshoeing, and backcountry skiing;

2) Central area:

- Heniu, Dealul Bârgău, Dealul Pietrei, Oala, Lăzăroaia, Zimbroaia, Tăşuleasa, Răchiţeaua (fig. 6);
- recommendation for hiking, snowshoeing, running, horse-drawn sleigh rides, ski touring;

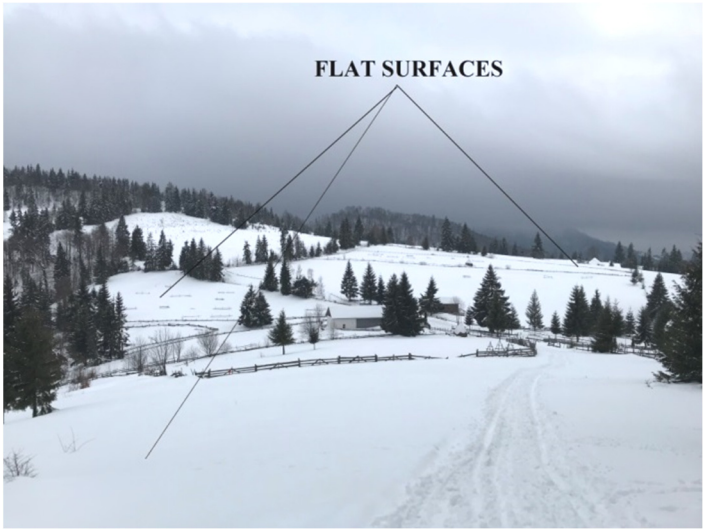

Fig. 5. Erosional levels/Flat surfaces on Ciosa Summit
(source: author)

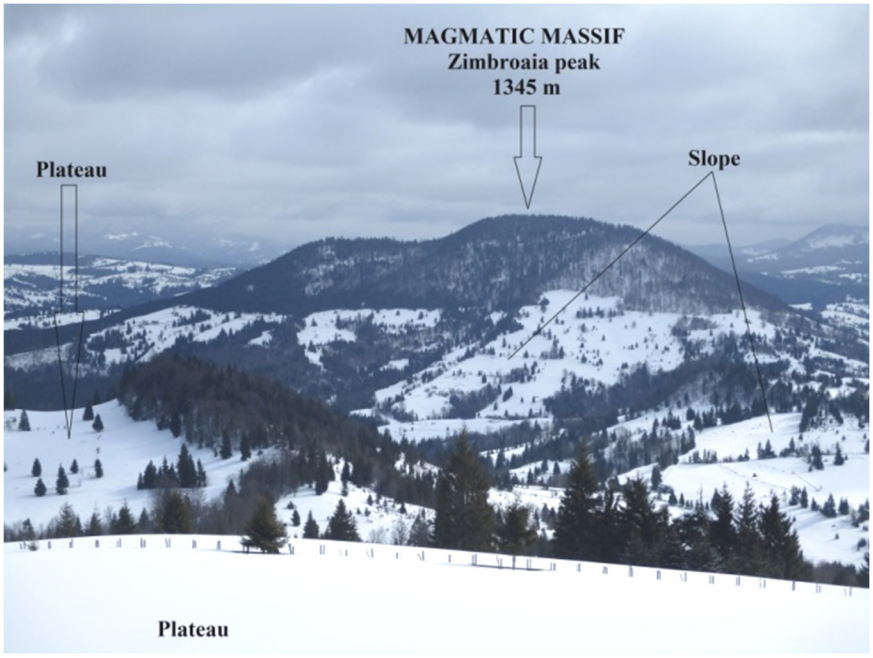

Fig. 6. Magmatic massif and surfaces around it
(source: author)

c) Southern area:
- Căsaru-Măguriţa-Arşiţa-Dealul Ariilor;
- Cornu-Buba;
- Dealul Puşcă-Ariniş-Arşiţa Mare-Bridirei;
- recommendation for hiking, snowshoeing, ski touring;

B) Functional landforms units:

a) Peaks:

- are distinguished by a thick layer of snow, sometimes affected by blizzard (60-300 cm), which is kept until April;
- recommendation for hiking and viewpoints: Heniu, Oala, Căsaru, Măgura Neagră, Dealul Blajei etc.;

b) Summits:

- characterized by a sufficiently thick layer of snow (30-80 cm), forest and agricultural roads;
- recommendation for hiking, ski touring, cross-country skiing, running, horse-drawn sleigh rides;
- distribution: the areas of Valea Ilvei-Valea Coşnei, Piatra Fântânele-Valea Ilvei-Valea Leşului, and Plaiul Dosului-Brazii Buni-Strâmba (fig. 7);

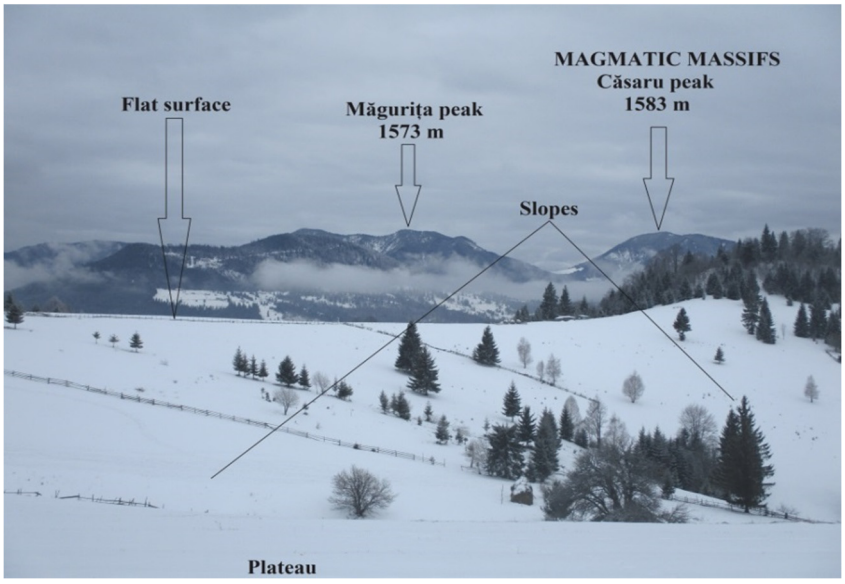

Fig. 7. Flat surfaces on Prislop summit
(source: author)

c) Slopes:

- presents a thick layer of snow (30-120 cm), which is stored for a long time on the surfaces facing north, northeast, and northwest, and on many forest and agricultural roads;
- recommendation for hiking, snowshoeing, and ski touring (fig. 8).

d) Valleys:

- have a sufficiently thick layer of snow (30-60 cm), and numerous forest and agricultural roads;
- recommendation for hiking, horse-drawn sleigh rides, cross-country skiing, ski touring, and running.

Fig. 8. Hiking on Dealul Blajei
(source: author)

Regarding the competitions that are organized within the Bârgău Mountains, we mention the most important ones, held in the winter of 2022, respectively:

1. Cross-country skiing and biathlon festival (fig. 9):

- February, 10th edition;
- location: Piatra Fântânele, Păşunea Rusului;
- participants: 100 (children, juniors, seniors, veterans);
- cross-country skiing competition.

Fig.9. Cross-country skiing and biathlon festival at Piatra Fântânele poster (source: https://www.observatorbn.ro/2022/02/04/festival-de-schi-fond-si-biatlon-la-piatra-fantanele-in-acest-weekend/)

2. The competition of sleighs pulled by dogs Drumul Romanilor:

- January, 5th edition;
- location: Piatra Fântânele, Păşunea Rusului and Drumul Romanilor;
- participants from several European countries (Croatia, Austria, Hungary, Bulgaria, Poland, Switzerland, Slovakia).

Conclusions

Based on the data presented, it results that the Bârgău Mountains area has a high snow potential if the winters are characterized by specific intense phenomena, respectively heavy snow and low temperatures for a longer

period of time. The snow conditions, associated with the permissive relief (large undulating surfaces, dominated by intrusive magmatic massifs) recommend this area for many recreational sports activities (hiking, snowshoeing, cross-country skiing, cross-country skiing, horse-drawn sleigh rides) and even competitive (cross-country skiing, sledding, dog pulling), which is an important factor for the tourist development of the region.

In this context, it is required that the county authorities (Bistriţa-Năsăud County Council, Bistriţa-Năsăud County School Inspectorate) and local authorities (the town halls of Tiha Bârgăului, Bistriţa Bârgăului, Prundu Bârgăului, Ilva Mică, Poiana Ilvei, Măgura Ilvei, Ilva Mare, Lunca Ilvei, Leşu, Rodna, and Şanţ communes), as well as various organizations (sports associations, tourist associations, social and ecological associations) with interests in tourism, or local providers of tourist services to develop strategies for planning and tourism capitalization of the Bârgău Mountains.

Such an approach is more than necessary, because in the localities of the Bârgău Mountains, which have tourist pensions, and in the related resorts (Sângeorz Băi, Colibiţa, Piatra Fântânele) many visitors arrive, who in the absence of attractive facilities and activities opt for short stays.

REFERENCES

Bîca, I., (2012). Arealul turistic Piatra Fântânele-Măgura Calului, Ed. Argonaut, Cluj-Napoca.

Beniston, M. (1997). Variations of Snow Depth and Duration in the Swiss Alps Over the Last 50 Years: Links to Changes in Large-Scale Climatic Forcings. In: Diaz, H.F., Beniston, M., Bradley, R.S. (eds). Climatic Change at High Elevation Sites. Springer, Dordrecht. Retrieved 10 January 2022.

Bigano, A., Goria, A., Hamilton, J.M., (2005). The Effect of Climate Change and Extreme Weather Events on Tourism, *SSRN Electronic Journal.* Retrieved 10 January 2022.

Brugnot, G., (2017). Recent Progress and New Applications of the Dynamics of Avalanches, *Journal of Glaciology, Cambridge University Press*, Volume 26, Issue 94, pp. 515 – 516. Retrieved 12 January 2022.

Elsasser, H., Messerli, P., (2001). The Vulnerability of the Snow Industry in the Swiss Alps, *Mountain Research and Development*, 21(4):335-339. Retrieved 12 January 2022.

Fang, Y., Scott, D., Steiger, R., (2021), The impact of climate change on ski resorts in China, *International Journal of Biometeorology*, 65 (5), pg. 677. Retrieved 20 January 2022.

Gonseth, C., (2013). Impact of snow variability on the Swiss winter tourism sector: implications in an era of climate change, *Climatic Change*, 119 (2), pg. 307. Retrieved 21 January 2022.

Hallmann, Kirstin & Feiler, Svenja & Müller, Sabine & Breuer, Christoph. (2012). The interrelationship between sports activities and the perceived winter sports experience. *Journal of Sport Tourism*, 17, 145-163. retrieved 27 January 2022.

Hammond, J.C., Saavedra, F.A., Kampf, S.K., (2018). Global snow zone maps and trends in snow persistence 2001–2016. International Journal of Climatology 38(12), pg. 4369. retrieved 02 February 2022.

Martin Falk, M., Lin, X., (2021). Time-varying impact of snow depth on tourism in selected regions. *International Journal of Biometeorology*, 65, pp.645–657. Retrieved 05 February 2022.

Marty, C., (2013). Climate change and snow cover in the European Alps. In: The Impacts of Skiing and Related Winter Recreational Activities on Mountain Environments (pp.33-44), Publisher: Bentham, Editors: Ronaldo A., Rixen C. Retrieved 11 April 2022.

Moen, J., Fredman, P., (2007). Effects of Climate Change on Alpine Skiing in Sweden. *Journal of Sustainable Tourism* 15 (4), pg. 418. Retrieved 20 February 2022.

Naum, T. & Butnaru, E. (1984). *Munţii Bârgăului*. Bucureşti: Ed. Sport-Turism.

Neuvonen, M., Sievänen, T., Fronzek, St. (2015). Vulnerability of cross-country skiing to climate change in Finland – An interactive mapping tool, Journal of Outdoor Recreation and Tourism 11, pg. 64. Retrieved 05 March 2022.

Nicholls, S., (2006). Climate change, tourism and outdoor recreation in Europe. *Managing Leisure,* 11(3), pg. 151. Retrieved 06 March 2022.

Petrović, M., (2013). Sport and Recreation Influence upon Mountain Area and Sustainable Tourism Development. *Journal of Environmental and Tourism Analysis*, pp. 81-90. Retrieved 10 March 2022.

Pütz, M., Gallati, D., Kytzia, S., (2011). Winter Tourism, Climate Change, and Snowmaking in the Swiss Alps: Tourists' Attitudes and Regional Economic Impacts, Mountain Research and Development 31(4), pg. 357. Retrieved 15 March 2022.

Rixen, Ch., Teich, M., Lardelli, C., Gallati, D., Pohl, M., Pütz, M., Bebi, P., (2011). Winter Tourism and Climate Change in the Alps: An Assessment of Resource Consumption, Snow Reliability, and Future Snowmaking Potential, Mountain Research and Development, Vol. 31, No. 3, pp. 229-236. Retrieved 20 March 2022.

Rosselló-Nadal, J., (2014). How to evaluate the effects of climate change on tourism, Tourism Management 42, pg. 334. Retrieved 27 March 2022.

Rusu, E., (1998). Munţii Bârgăului. Studiu fizico-geografic, Ed. Univ. Al. I. Cuza, Iaşi.

Scott, D., McBoyle, G., (2007). Climate change adaptation in the ski industry, Mitigation and Adaptation Strategies for Global Change 12(8), pg. 1411. Retrieved 20 April 2022.

Scott, D., Dawson, J., Jones, B., (2008). Climate change vulnerability of the US Northeast winter recreation–tourism sector, Mitigation and Adaptation Strategies for Global Change 13(5-6), pg. 577. retrieved 22 April 2022.

Steiger, R., Scott, D., Abegg, B., (2019). A critical review of climate change risk for ski tourism, Current Issues in Tourism 22(11), pg. 1343. Retrieved 28 April 2022.

Weaver, D., (2011). Can sustainable tourism survive climate change? Journal of Sustainable Tourism 19(1), pg. 5. Retrieved 15 March 2022.

Zeng, X., Broxton, P., Nicholas Dawson, N., (2018). Snowpack Change From 1982 to 2016 Over Conterminous United States, Geographical Research Letter, Volume 45, Issue 23, Pages 12, 940-12,947. Retrieved 28 April 2022.