

HEALTH, SPORTS & REHABILITATION MEDICINE

Published since 2000 as *Palestrica of the Third Millennium - Civilization and Sport*

A quarterly of multidisciplinary study and research

© Published by The “Iuliu Haieganu” University of Medicine and Pharmacy of Cluj-Napoca
and
The Romanian Medical Society of Physical Education and Sports
in collaboration with
The Cluj County School Inspectorate

A journal rated B+ by CNCS (Romanian National Research Council) since 2007,
certified by CMR (Romanian College of Physicians) since 2003,
CFR (Romanian College of Pharmacists) since 2015 and CMDR since 2018

A journal with a multidisciplinary approach in the fields of biomedical science,
health, medical rehabilitation, physical exercise, social sciences

A journal indexed in international databases:
EBSCO, Academic Search Complete, USA
Index Copernicus, Journals Master List, Poland
DOAJ (Directory of Open Access Journals), Sweden
CiteFactor, Canada/USA
CrossRef, Lynnfield, MA (US)/Oxford (UK)

2

Vol. 20, No. 2, April-June 2019

Editorial Board

Chief Editor

Traian Bocu (Cluj-Napoca, Romania)

Deputy Chief Editors

Simona Tache (Cluj-Napoca, Romania) Ioan Onac (Cluj-Napoca, Romania)
Dan Riga (Bucure ti, Romania) Adriana Filip (Cluj-Napoca, Romania)

Bio-Medical, Health and Exercise Department

Cezar Login (Cluj-Napoca, Romania)
Adriana Albu (Cluj-Napoca, Romania)
Adrian Aron (Radford, VA, USA)
Taina Avramescu (Craiova, Romania)
Cristian Bârsu (Cluj-Napoca, Romania)
Gheorghe Benga (Cluj-Napoca, Romania)
Mihai Berteanu (Bucure ti, Romania)
Simion Bran (Cluj-Napoca, Romania)
Consuela Monica Br ilesu (Bucure ti, Romania)
Roxana Carare (Southampton, UK)
Irina H r ngu (Cluj-Napoca, Romania)
Simona Clichici (Cluj-Napoca, Romania)
Victor Cristea (Cluj-Napoca, Romania)
Anne-Marie Constantin (Cluj-Napoca, Romania)
Daniel Courteix (Clermont Ferrand, France)
Gheorghe Dumitru (Constan a, Romania)
Lorena Filip (Cluj-Napoca, Romania)
Mira Florea (Cluj-Napoca, Romania)
Satoro Goto (Chiba, Japan)
Nicolae Hâncu (Cluj-Napoca, Romania)
Anca Ionescu (Bucure ti, Romania)
Lászlo Irsay (Cluj-Napoca, Romania)
Wolf Kirsten (Berlin, Germany)
Gulshan Lal Khanna (Faridabad, India)
Valeria Laza (Cluj-Napoca, Romania)
Jordi Mañes (Valencia, Spain)
Daniela Motoc (Arad, Romania)
Radu Oprean (Cluj-Napoca, Romania)
Alina Pârvu (Cluj-Napoca, Romania)
Liviu Pop (Cluj-Napoca, Romania)
Zsolt Radak (Budapest, Hungary)
Suresh Rattan (Aarhus, Denmark)
Sorin Riga (Bucure ti, Romania)
Aurel Saulea (Chi in u, Republic of Moldavia)
oimi a Suciu (Cluj-Napoca, Romania)
Robert M. Tanguay (Quebec, Canada)
Gheorghe Tomoaia (Cluj-Napoca, Romania)
Rodica Ungur (Cluj-Napoca, Romania)
Mirela Vasilescu (Craiova, Romania)

Social sciences and Physical Activities Department

Dana B d u (Tg. Mure , Romania)
Daniela Aducovschi (Bucure ti, Romania)
Maria Alua (Cluj-Napoca, Romania)
Robert Balazsi (Cluj-Napoca, Romania)
Lorand Balint (Bra ov, Romania)
Vasile Bogdan (Cluj-Napoca, Romania)
Marius Cr ciun (Cluj-Napoca, Romania)
Mihai Cucu (Cluj-Napoca, Romania)
Remus Dumitrescu (Bucure ti, Romania)
Ioan Virgil Ganea (Cluj-Napoca, Romania)
Leon Gombo (Cluj-Napoca, Romania)
Emilia Florina Grosu (Cluj-Napoca, Romania)
Vasile Guragata (Chi in u, Republic of Moldavia)
Iacob Han iu (Oradea, Romania)
Mihai Kiss (Cluj-Napoca, Romania)
Eunice Lebre (Porto, Portugal)
Sabina Macovei (Bucure ti, Romania)
tefan Maroti (Oradea, Romania)
Ion M celaru (Cluj-Napoca, Romania)
Bela Mihaly (Cluj-Napoca, Romania)
Alexandru Mure an (Cluj-Napoca, Romania)
Ioan Mure an (Cluj-Napoca, Romania)
C t lin Nache (Nancy, France)
Enrique Navarro (Madrid, Spain)
Nicolae Neagu (Tg. Mure , Romania)
Ioan Pa can (Cluj-Napoca, Romania)
Constantin Pehoiu (Târgovi te, Romania)
Nicolae Hora iu Pop (Cluj-Napoca, Romania)
Cornelia Popovici (Cluj-Napoca, Romania)
Voichi a Rus (Cluj-Napoca, Romania)
Monica St nescu (Bucure ti, Romania)
Demostene ofron (Cluj-Napoca, Romania)
Octavian Vidu (Cluj-Napoca, Romania)
Alexandru V. Voicu (Cluj-Napoca, Romania)
Ioan Zanc (Cluj-Napoca, Romania)

Honorary Members

Univ. Prof. MD. Marius Boji ("Iuliu Ha ieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania)
Univ. Prof. MD. Mircea Grigorescu ("Iuliu Ha ieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania)
Univ. Prof. PhD. Radu Munteanu (Technical University, Cluj-Napoca, Romania)
Univ. Prof. MD. Liviu Vlad ("Iuliu Ha ieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania)

Editorial Of ce of the Journal "Health, Sports & Rehabilitation Medicine"

Street: Clinicilor no. 1
400006, Cluj-Napoca
Telephone: 0264-598575
E-mail: hesrehab@gmail.com

pISSN 2668-2303
eISSN 2668-5132
ISSN-L 2668-2303
www.jhsrm.org

Editors for English Language

Sally Wood-Lamont swood@umfcluj.ro
Denisa Marineanu margitana@yahoo.com

Marketing, PR

Cristian Potor cristipotora@gmail.com

International relations

Tudor Mîrza midor1967@gmail.com
Irina H r ngu irinnaus@yahoo.com
Mihai Kiss mishu71@yahoo.com
Cornelia Popovici popovicicornelia@yahoo.com

Website maintenance

Transmondo

Contents

ORIGINAL STUDIES

Multidisciplinary evaluation and therapeutic management of patients with ankylosing spondylitis

Alesandra Florescu, Andrei Bondari, Ana-Maria Bumbea, Otilia Rogoveanu, Bogdan tefan Bumbea, Paulina Ciurea, Anca Emanuela Mu etescu 52

The special educational needs of children from the social protection system and the usefulness of focus groups in educational programs

Corina Budin, Ruxandra Râjnoveanu, Ana Chi , Ioana Roxana Bordea, Tamas Bota, Doina Adina Todea 57

The association between dental caries, education and body mass index in a population of Romanian schoolchildren

Cosmin Tudoroni, Bogdana Adriana N sui, Monica Popa 62

Safety of ultrasound-guided botulinum toxin type A injections for patients with anticoagulant and antiplatelet background medication

Marius-Nicolae Popescu, Lumini a Dumitru, Matei Teodorescu, Alina Iliescu, Mihai Berteanu 66

Relationship between competitive anxiety and mental toughness: a latent regression analysis

R zvan Kalinin, Róbert Balázs, Imre Péntek, tefania Duic , Iacob Han iu 70

Study on locomotor skills development with practical polygon in children aged 11 to 12

Daniel-Andrei Popa, Loredana-Maria Con iu, Dana B d u 75

Approach to rehabilitation treatment of gait disorders in patients with genu recurvatum

Matei Teodorescu, Marius-Nicolae Popescu, Lumini a Dumitru, Mihai Berteanu 79

REVIEWS

Cryotherapy in athletes

Valeria Laza 85

RECENT PUBLICATIONS

Book reviews

Arthur Jason De Luigi (editor). Adaptive Sports Medicine: A Clinical Guide
Gheorghe Dumitru 92

EVENTS

The educational health prevention project in rural areas in progress

Cristian Potor , Laura Ionescu 93

The annual meeting of veteran athletes of the „U” Club-100 (25)

Traian Bocu 95

FOR THE ATTENTION OF CONTRIBUTORS

The editors 96

ORIGINAL STUDIES

Multidisciplinary evaluation and therapeutic management of patients with ankylosing spondylitis

Alesandra Florescu ¹, Andrei Bondari ², Ana-Maria Bumbea ³, Otilia Rogoveanu ³, Bogdan tefan Bumbea ⁴, Paulina Ciurea ⁵, Anca Emanuela Mu etescu ⁵

¹ Department of Rheumatology, Emergency Clinical County Hospital of Craiova, Romania

² Department of Radiology and Medical Imaging, University of Medicine and Pharmacy of Craiova, Romania

³ Department of Medical Rehabilitation, University of Medicine and Pharmacy of Craiova, Romania

⁴ Department of Orthopaedics, Emergency Clinical County Hospital of Craiova, Romania

⁵ Department of Rheumatology, University of Medicine and Pharmacy of Craiova, Romania

* All authors have equal contributions to this study

Abstract

Background. Ankylosing spondylitis is a chronic inflammatory disease, from the spondyloarthritis group, characterized by axial skeletal damage (spinal column, sacroiliac joints), peripheral joint and enthesal involvement.

Aims. The purpose of the current study is to assess the disease activity and functional indices of patients diagnosed with ankylosing spondylitis before and after non-pharmacological treatment.

Methods. The study included 30 patients with ankylosing spondylitis hospitalized between 2016-2018 in the Department of Rheumatology of the Emergency Clinical County Hospital of Craiova. Disease activity and functional indices were assessed using standardized scoring systems such as ASDAS, BASDAI and BASFI. Rehabilitation treatment was recommended to all the patients, especially to those with a predominantly axial form of ankylosing spondylitis.

Results. The minimum registered value of BASFI was 1.8, the maximum value was 9.2, with a mean value of 7.52. Individual and mean BASFI values decreased significantly ($p=0.008$) after the 3 months of combined treatment, from a mean value of 7.52 to 6.8, minimum and maximum values also decreasing from 1.8 to 1.6 and from 9.2 to 8.2, respectively.

Conclusions. The multidisciplinary approach of patients with ankylosing spondylitis is of great importance, long- and short-term studies demonstrating that both pharmacological and non-pharmacological therapies have a beneficial effect on the quality of life of ankylosing spondylitis patients.

Key words: ankylosing spondylitis, physical therapy, BASFI score, multidisciplinary approach.

Introduction

Ankylosing spondylitis (AS) is a chronic inflammatory disease, part of the spondylarthritis group, characterized by axial skeletal damage (spinal column, sacroiliac joints), peripheral joint and enthesal involvement, with frequent association of extra-articular ocular, cardiac, pulmonary, renal or neurological manifestations and the presence of human leukocyte antigen B-27 (HLA-B27) (Edavalath, 2010).

The evaluation of patients with AS is of great importance, both in terms of disease activity and quality of life. Validated and tested scoring systems have been implemented in order to monitor patients with AS, the main ones being Bath Ankylosing Spondylitis Disease Activity Score (BASDAI), Bath Ankylosing Spondylitis Functional Index (BASFI) and Ankylosing Spondylitis

Disease Activity Score (ASDAS) (Zochling, 2011).

Musculoskeletal ultrasound (MSUS) has proven its importance in the diagnosis of peripheral involvement, the evaluation of disease activity, the monitoring of response to treatment and the assessment of characteristic structural lesions in patients with peripheral arthritis, enthesitis and dactylitis (Riente et al., 2014).

Patients with peripheral joint involvement benefit from multiple therapeutic options, but for patients with spinal involvement, physical therapy is of great importance. Non-steroidal anti-inflammatory drugs (NSAIDs) are considered the first line of treatment in AS. Improvement of clinical symptomatology is reported in 75-80% of patients, 48-72 hours after initiation of NSAID treatment. The optimal effect of NSAIDs is reached approximately 2 weeks after the start of treatment, being more effective

Received: 2019, March 21; Accepted for publication: 2019, April 6

Address for correspondence: University of Medicine and Pharmacy of Craiova, 2-4 Petru Rare Street, Craiova, Romania

E-mail: anamariabumbea@yahoo.com

Corresponding author: Ana-Maria Bumbea: anamariabumbea@yahoo.com

<https://doi.org/10.26659/pm3.2019.20.2.52>

in axial disease than in peripheral disease. Some studies confirm the favorable effect of NSAIDs on the radiological progression of the disease. Other therapeutic options include conventional synthetic disease modifying anti-rheumatic drugs (DMARDs) such as sulfasalazine and biological DMARDs (Moon & Kim, 2014).

Nevertheless, ASAS/EULAR 2016 recommendations underline the beneficial effect of non-pharmacological therapies, such as exercises, sports and recreational activities, in improving the quality of life of AS patients (van der Heijde D et al., 2017).

The main objectives of physical therapy and rehabilitation in patients with AS are to reduce pain and discomfort, maintain or improve spinal mobility and muscle strength, prevent spinal cord deformities, maintain physical fitness and long-term quality of life. The therapeutic arsenal consists of orthopedic hygiene, electrotherapy, massage therapy, physical therapy, hydrothermotherapy and occupational therapy (Wendling et al., 2018).

Hypothesis

AS is a complex pathology which requires an extensive clinical, biological and imaging evaluation, a multidisciplinary approach and both pharmacological and non-pharmacological treatment in order to improve the quality of life and range of motion of patients. The purpose of the current study is to assess the disease activity of patients diagnosed with AS before and after non-pharmacological treatment.

Material and methods

Research protocol

Our study received the approval of the Ethical Committee of the University of Medicine and Pharmacy of Craiova. The patients gave their informed consent to take part in this study.

a) Period and place of the research

The study included 30 patients with AS hospitalized between 2016-2018 in the Department of Rheumatology of the Emergency Clinical County Hospital of Craiova.

b) Subjects and groups

All patients were diagnosed with AS according to the modified New York criteria, had a current or past history of peripheral and axial pain, and had not followed any previous non-pharmacological treatment protocol for the rheumatic pathology.

Our study included 30 patients, 23 males and 7 females, with minimum age 17 years, maximum age 57 years, mean age 38.36 years and mean disease duration 6.7 years.

c) Tests applied

Clinical examination, laboratory tests such as complete blood count, liver enzymes, erythrocyte sedimentation rate (ESR), C reactive protein (CRP) and MSUS were performed. Disease activity and functional indices were assessed using standardized scoring systems such as ASDAS, BASDAI and BASFI.

MSUS examinations were carried out on a MyLab25™Gold US system, using a linear multi-frequency probe of 6-18MHz. Gray-scale and power Doppler scans in longitudinal and transverse plane were performed in order to assess peripheral structural abnormalities such as

synovial proliferation graded from 0 to 3, tenosynovitis also graded from 0 to 3, the presence of joint effusion graded as mild, moderate or severe, and the presence of erosions. The examined sites were the knee, ankle, elbow and shoulder joints bilaterally.

Rehabilitation treatment was recommended to all the patients, especially to those with a predominantly axial form of AS. The exercise protocol included stretching exercises such as forward head flexion, backward extension, sideways flexion, rotation around, range of motion exercises for the peripheral joints, breathing exercises to maintain or increase chest expandability such as deep breathing, abdominal control and diaphragmatic breathing exercises, Klapp exercises for improved flexibility and postural reeducation of the vertebral column. The therapeutic protocol was performed either individually by the patient or in classes guided by a physical therapist, 3 times per week for 1 hour over a period of 3 months.

d) Statistical processing

The data of this study were analyzed using SPSS Statistics 20. The Chi-Square test was used to compare disease indices before and after rehabilitation treatment. A value of $p < 0.05$ was considered statistically significant. The results were graphically represented using Microsoft Excel 2010.

Results

The patients had the axial form of AS (17%), the peripheral form of AS (23%), or both axial and peripheral joint involvement (60%). HLA-B27 was positive in 83.33% of the patients.

All patients underwent treatment with NSAIDs. Regarding DMARDs, 86.6% of patients followed treatment with sulfasalazine, 10% of patients received a combination therapy with sulfasalazine and methotrexate, and 3.4% of patients were treated with sulfasalazine and etanercept.

ESR and CRP values are of great importance in the assessment of disease activity. Thus, the mean value of CRP was 21.90 mg/l, while the mean value of ESR was 44.63 mm/h.

Disease activity calculated using ASDAS-CRP was within the moderate range in 10% of patients, within the high range in 7% of cases and within the very high range in 83% of patients. The mean BASDAI values were 7.46, with a minimum value of 1.6 and a maximum value of 9.7. The minimum registered value of BASFI was 1.8, the maximum value was 9.2, with a mean value of 7.52 (Fig. 1).

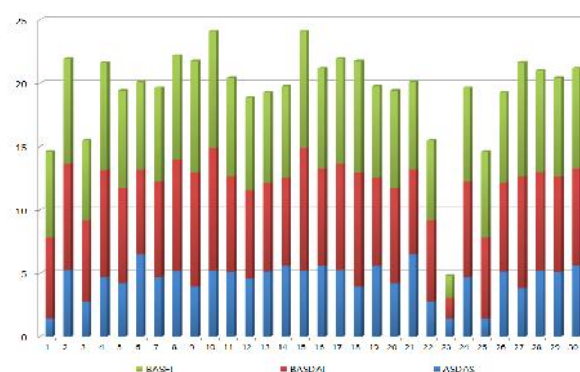


Fig. 1 – Distribution of ASDAS, BASDAI and BASFI values in the study group

A number of 240 joints consisting of bilateral knee, ankle, elbow and shoulder joints were evaluated both by clinical examination and MSUS. From a clinical point of view, tenderness on palpation or swelling was revealed in 21.66% of the examined knees, 18.33% of the ankles, 6.6% of the elbow joints and 3.3% of the scapulohumeral joints. MSUS showed evidence of inflammation in 30% of the knee joints, 25% of the examined tibiotarsal joints, 11.66% of the elbow joints and 5% of the evaluated shoulders (Figs. 2, 3).

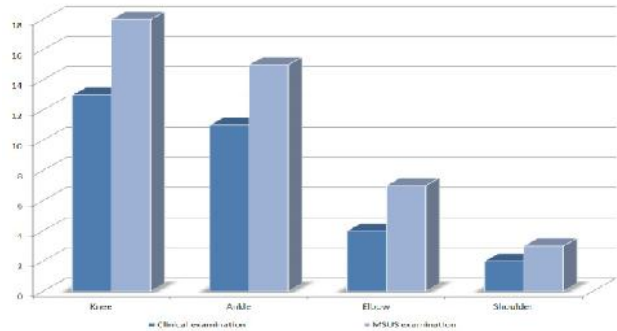


Fig. 2 – Distribution of peripheral joint involvement after clinical and ultrasound examination

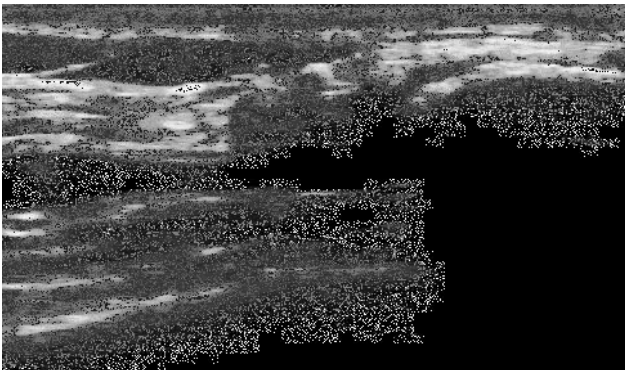


Fig. 3 – Transverse scan of the knee revealing moderate effusion of the medial parapatellar bursa

The ultrasound examination of the ankles revealed joint effusion of the anterior tibiotalar recess in 23.33% of the examined joints, synovial proliferation of the tibiotalar recess in 8.3% of joints, proliferative tenosynovitis of the anterior and posterior tibialis tendons in 6.66% of tendons, proliferative tenosynovitis of the peroneus tendons in 8.3% of tendons, and enthesitis of the Achilles tendons in 70% of the examined sites (Figs. 4, 5).

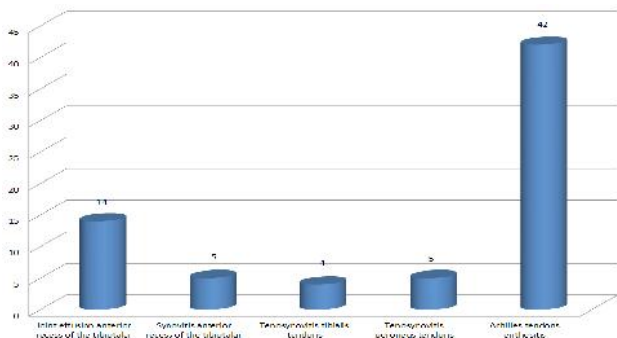


Fig. 4 – Distribution of ultrasound abnormalities in the examined ankles

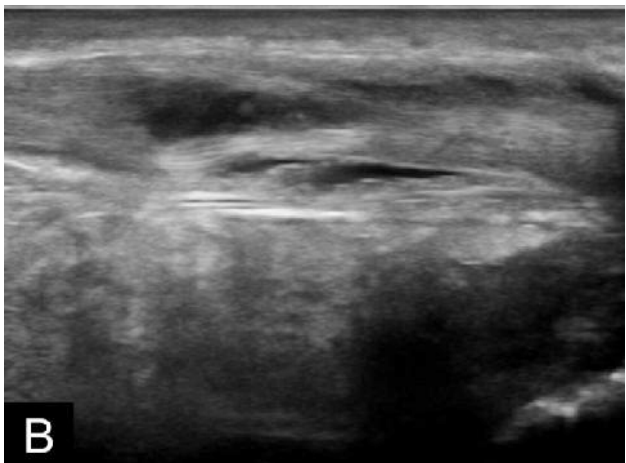


Fig. 5 – Transverse (A) and longitudinal (B) scans of the peroneus tendons showing grade 2 proliferative tenosynovitis and subcutaneous edema

Synovial proliferation in the knee compartment was found in the lateral parapatellar recess in 3.33% of joints, in the medial parapatellar recess in 6.66% of joints, and in the suprapatellar bursa in 15% of the examined knees (Fig. 6).

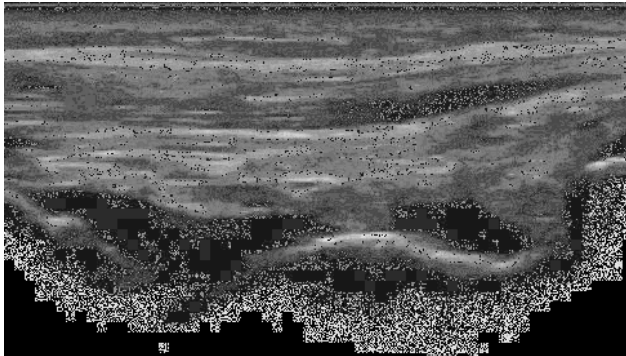


Fig. 6 – Gray-scale longitudinal scan of the ankle showing moderate synovial proliferation of the anterior recess of the tibiotalar joint

After clinical and ultrasound assessment, the patients were redirected to the Medical Rehabilitation Department for individualization of the exercise program. The patients were reassessed after 3 months of treatment with NSAIDs, DMARDs and physical therapy.

Disease activity scores and functional indices were reevaluated, ASDAS mean values being 3.87 compared with 4.51 before treatment. The mean BASDAI values were 6.95, with a minimum and maximum value of 1.4 and 8.5, respectively. The recalculated BASFI values had a minimum and maximum of 1.6 and 8.2, respectively, with a mean value of 6.8.

Individual and mean BASFI values decreased significantly ($p=0.008$) after the 3 months of combined treatment, from a mean value of 7.52 to 6.8, minimum and maximum values also decreasing from 1.8 to 1.6 and from 9.2 to 8.2, respectively (Table I).

Table I

BASFI values before and after treatment

Score	Min	Max	Mean	SD	P
BASFI	1.8	9.2	7.52	1.34	0.008
BASFI – 3 months	1.6	8.2	6.8	1.26	

Since the majority of the patients had vertebral column involvement with established structural spinal damage on radiographs, we attributed the decrease in the BASFI functional index to the combination therapy. Both NSAIDs and physical therapy aided in improving the patients' quality of life and also the range of motion, due to the fact that most exercises were focused on the preservation and improvement of spinal mobility.

Regarding the clinical and MSUS reevaluation of peripheral joints, symptomatology was diminished, although ultrasound signs of chronic inflammatory abnormalities were still present.

Discussions

The multidisciplinary approach of the AS patient has been controversial over the years. However, ASAS/EULAR included physical therapy among the 10 recommendations for the treatment of AS. Evidence revealing improvement of joint function and muscle strength, preventing postural vertebral column deformities and preserving spinal mobility, has been published over the past years (Nghiem & Donohue, 2008).

Several rehabilitation programs have been tested for efficacy in the management of patients with AS. Current recommendations state that combined physical therapy exercises should be centered on the patient and individualized programs should be conducted in order to preserve the optimal functional parameters of the peripheral joints and vertebral column. Pharmacological therapy has been proven to reduce the inflammatory and destructive process at the joint level, while rehabilitation therapy overlaps it, providing improvement in mobility and certain functional parameters. Physical exercises should be continued even after remission is achieved (Dagf nrud et al., 2011).

Orthopedic hygiene of the AS patient is considered of great importance; recommendations such as sleeping on a flat bed without a pillow in order to maintain a proper sleeping posture or lying and sleeping in a prone position have many advantages for the maintenance of a relatively normal posture in patients with AS (Feldtkeller et al., 2013).

Exercise programs, whether home-based or supervised individual and group exercises, have proven to be more effective than no physical therapy at all. However, supervised exercises and combination therapy have demonstrated superiority to home-based exercises and physical treatment alone, respectively (Dagf nrud et al., 2008).

AS is a disease that mostly affects people of young and working age, thus making home-based exercises the therapy of choice for this group of patients. Beneficial effects on spinal mobility, chest expansion and, in consequence, breathing and the quality of life of AS patients have been demonstrated after the implementation of home-based exercises (Aytekin et al., 2012).

New types of exercises such as the Global Posture Reeducation method have been tested, showing superior results to conventional exercise programs in improving the quality of life in AS patients (Teodori et al., 2011).

Although this is the era of biological therapy, some studies on groups of patients treated with tumor necrosis factor inhibitors and also combination treatment, both tumor necrosis factor inhibitors and physical exercises, have been conducted, demonstrating an increase in functional capacity and improvement of joint range of motion in patients treated with combination therapy, rather than biological therapy alone (Yigit et al., 2013).

Studies conducted on patients treated with biological therapy and also physical exercise programs proved that combining pharmacological and non-pharmacological therapies determined a significant decrease in disease activity scores and functional indices, mainly BASDAI and BASFI, as shown in our study. It is stated that a proper educational and behavioral program may have promising results in patients receiving pharmacological treatment (Lubrano et al., 2006).

Another study on patients with axial spondyloarthritis demonstrated that after a 2-week intensive rehabilitation program, the self-reported disease activity, taking into consideration both BASDAI and BASFI, improved by almost 30% (Eppeland et al., 2013).

A recently conducted study emphasized the role of stretching exercises, walking and aerobics in patients with AS, demonstrating a significant improvement in BASFI, BASDAI and ASDAS after 6, 12 and 24 weeks of rehabilitation therapy. There was no difference regarding the improvement of indices in the two studied groups, irrespective of the recommended exercise protocol (Jennings et al., 2015).

Conclusions

1. The multidisciplinary approach of patients with ankylosing spondylitis is of great importance, long- and short-term studies demonstrating that both pharmacological and non-pharmacological therapies have a beneficial effect on the quality of life of AS patients.

2. Although the results of our study are supported by numerous literature studies, we believe that the development of a standardized exercise program is important and further studies have to be conducted in order to determine the best course of treatment in AS patients and to prevent debilitating structural damage.

Conflict of interests

The authors declare that they have no conflict of interests.

References

- Aytekin E, Caglar NS, Ozgonenel L, Tutun S, Demiryontar DY, Demir SE. Home-based exercise therapy in patients with ankylosing spondylitis: effects on pain, mobility, disease activity, quality of life, and respiratory functions. *Clin. Rheumatol.* 2012;31(1):91-97. doi: 10.1007/s10067-011-1791-5.
- Dagfnrud H, Halvorsen S, Vollestad NK, Niedermann K, Kvien TK, Hagen KB. Exercise programs in trials for patients with ankylosing spondylitis: do they really have the potential for effectiveness? *Arthritis Care Res.* 2011;63(4):597-603. doi: 10.1002/acr.20415.
- Dagfnrud H, Kvien TK, Hagen KB. Physiotherapy interventions for ankylosing spondylitis. *Cochrane Database Syst. Rev.* 2008;(4):CD002822. doi: 10.1002/14651858.CD002822.pub3.
- Edavalath M. Ankylosing spondylitis. *J Ayurveda Integr Med.* 2010;1(3):211-214. doi: 10.4103/0975-9476.72619.
- Eppeland SG, Diamantopoulos AP, Soldal DM, Haugeberg G. Short term in-patient rehabilitation in axial spondyloarthritis - the results of a 2-week program performed in daily clinical practice. *BMC Res Notes.* 2013;6(1):185. doi: 10.1186/1756-0500-6-185.
- Feldtkeller E, Lind-Albrecht G, Rudwaleit M. Core set of recommendations for patients with ankylosing spondylitis concerning behaviour and environmental adaptations. *Rheumatol. Int.* 2013; 33(9):2343-2349. doi: 10.1007/s00296-013-2727-y.
- Jennings F, Oliveira HA, de Souza MC, Cruz Vda G, Natour J. Effects of Aerobic Training in Patients with Ankylosing Spondylitis. *J Rheumatol.* 2015;42(12):2347-2353. doi: 10.3899/jrheum.150518.
- Lubrano E, D'Angelo S, Parsons WJ, Serino F, Tanzillo AT, Olivieri I, Pappone N. Effects of a combination treatment of an intensive rehabilitation program and etanercept in patients with ankylosing spondylitis: a pilot study. *J Rheumatol.* 2006; 33(10):2029-2034.
- Moon KH, Kim YT. Medical Treatment of Ankylosing Spondylitis. *Hip Pelvis.* 2014;26(3):129-135. doi: 10.5371/hp.2014.26.3.129.
- Nghiem FT, Donohue JP. Rehabilitation in ankylosing spondylitis. *Curr Opin Rheumatol.* 2008;20(2):203-207. doi: 10.1097/BOR.0b013e3282f56868.
- Riente L, Carli L, Delle Sedie A. Ultrasound imaging in psoriatic arthritis and ankylosing spondylitis. *Clin Exp Rheumatol.* 2014;32(1 Suppl 80):S26-S33.
- Teodori RM, Negri JR, Cruz MC, Marques AP. Global Postural Re-education: a literature review. *Rev Bras Fisioter.* 2011;15(3):185-189.
- van der Heijde D, Ramiro S, Landewé R, Baraliakos X4, Van den Bosch F, Sepriano A, Regel A, Ciurea A, Dagfnrud H, van Gaalen F, Géher P, van der Horst-Bruinsma I, Inman RD, Jongkees M, Kiltz U, Kvien TK, Machado PM, Marzo-Ortega H, Molto A, Navarro-Compán V, Ozgocmen S, Pimentel-Santos FM, Reveille J, Rudwaleit M, Sieper J, Sampaio-Barros P, Wiek D, Braun J. 2016 update of the ASAS-EULAR management recommendations for axial spondyloarthritis. *Ann Rheum Dis.* 2017 Jun;76(6):978-991. doi: 10.1136/annrheumdis-2016-210770.
- Wendling D, Lukas C, Prati C, Claudepierre P, Gossec L, Goupille P, Hudry C, Miceli-Richard C, Molto A, Pham T, Saraux A, Dougados M. 2018 update of French Society for Rheumatology (SFR) recommendations about the everyday management of patients with spondyloarthritis. *Joint Bone Spine.* 2018;(3):275-284. doi: 10.1016/j.jbspin.2018.01.006.
- Yigit S, Sahin Z, Demir SE, Aytac DH. Home-based exercise therapy in ankylosing spondylitis: short-term prospective study in patients receiving tumor necrosis factor alpha inhibitors. *Rheumatol. Int.* 2013;33(1):71-77. doi: 10.1007/s00296-011-2344-6.
- Zochling J. Measures of symptoms and disease status in ankylosing spondylitis: Ankylosing Spondylitis Disease Activity Score (ASDAS), Ankylosing Spondylitis Quality of Life Scale (ASQoL), Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), Bath Ankylosing Spondylitis Functional Index (BASFI), Bath Ankylosing Spondylitis Global Score (BAS-G), Bath Ankylosing Spondylitis Metrology Index (BASMI), Dougados Functional Index (DFI), and Health Assessment Questionnaire for the Spondylarthropathies (HAQ-S). *Arthritis Care Res (Hoboken).* 2011;63(Suppl 11):S47-S58. doi: 10.1002/acr.20575.

The special educational needs of children from the social protection system and the usefulness of focus groups in educational programs

Corina Budin ^{1,2}, Ruxandra Râjnoveanu ¹, Ana Chi ¹, Ioana Roxana Bordea ³, Tamas Bota ⁴,
Doina Adina Todea ¹

¹ Department of Pneumology, “Iuliu Haieganu” University of Medicine and Pharmacy Cluj-Napoca, Romania

² Clinical County Hospital Târgu Mureș, Pneumology, Romania

³ “Iuliu Haieganu” University of Medicine and Pharmacy, Department of Oral Rehabilitation, Oral Health and Dental Office Management, Cluj-Napoca, Romania

⁴ Emergency County Hospital Târgu Mureș, Romania

* All authors have equal contributions to this study

Abstract

Background. Due to their particular social status, institutionalized minors have been permanently deprived of the same opportunities of children in the general population. The poor socio-economic conditions of their natal family and/or the family in which they grew up lead them to drop out of school and to start a job that consists mainly of physical labor.

Aims. The aim of this study was to select a group of foster care teenagers able to correctly disseminate the information about smoking among their colleagues.

Methods. During the years 2016-2017, we developed an educational project for minors institutionalized in the Professional Maternal Assistance System.

Results. The rural area group consisted of 114 children, with a mean age of 16 years (45% male, 55% female). The urban area group consisted of 198 children with a mean age of 16.8 years (39% male, 61% female). Smokers were represented by 26% in the rural area group and 33% in the urban area group.

Conclusions. The “focus group” sought to achieve the goal and the initial objectives, but not through a monologue action to which the adherence of youngsters was statistically proven to be low, but by an active involvement of the students through which they systematically became the trainers of their colleagues, were responsible, prepared, accumulated experience and information in a collegial manner that would give all those involved an interactive experience with beneficial effects both in the near future and for the long term. The poll unanimously expressed a positive response to the fact that the information was sent to them by lecturers of their own age, and not adults, so they felt free to respond freely to the questions asked.

Key words: smoking, focus group, foster care, youth.

Introduction

Worldwide, there are 143 million children separated from their families, and about 95% of them are institutionalized in the Professional Maternal Assistance System (1).

In Romania, in the early 1990s, a child protection system was set up, where about 100,000 children were institutionalized in large-scale placement centers. Over the past 25 years, remarkable progress has been made in the child social protection system in Romania, with the reduction of large-scale placement centers and the increase in the number of children in the foster family system, as it

has been proven over time that large-scale orphanages have adverse effects on the physical and mental development of minors (2). The current trend is to take care of minors as small as possible in the childcare system, ideally from their young childhood (3).

According to the National Institute of Statistics data of 2015, there are 57,229 minors in the social protection system in Romania. The impact of the reform in the child protection system in Romania is obvious, so that statistics show a significant decrease in the number of institutionalized minors in the residential system, and implicitly a decrease in the number of these placement units. National statistics

Received: 2019, April 15; Accepted for publication: 2019, April 22

Address for correspondence: Str. Victor Babeș No 15, Cluj-Napoca, Romania

E-mail: roxana.bordea@gmail.com

Corresponding author: Ioana Roxana Bordea, roxana.bordea@gmail.com

<https://doi.org/10.26659/pm3.2019.20.2.57>

of 2016 also show that 34,300 children, 66% respectively, are institutionalized in family-type services, of which 34% are in the Professional Maternal Assistance System, 25% live with relatives and 7% live with family friends (3); Courtney & Iwaniec, 2009.

Moreover, 17% (9000 children) are institutionalized in small residential locations, as follows: 4% in apartments, 4% in locations with facilities for children with disabilities, 9% in family homes for children without disabilities. Unfortunately, 17%, 9000 children respectively, are in transition centers (1); Braciszewski & Colby, 2015. There is a wide variation in the age of children in the social protection system in Romania. These are aged between 0-26 years; 53% are male and 46% are female.

Relative to age, 56% of children are aged between 10 and 17 years. Regarding the place of origin, 43% come from rural areas and 56% from urban areas (Braciszewski & Colby, 2015; Ahmadi-Monteclavo et al., 2016).

The distribution of ethnicity among institutionalized minors differs from that of the general population. Thus, the percentage of Roma children in the social protection system (10.3%) is double the percentage of Roma children in the general population (Courtney & Iwaniec, 2009; Ahmadi-Monteclavo et al., 2016). Similarly, the percentage of children of Romanian ethnicity in the social protection system is 54%, while in the general population of Romanians it is 79.1%.

Children with disabilities represent a significant proportion of institutionalized children (29%). Of these, 6% are under 1 year old, and 43% are aged between 18 and 26 years or over 26 years old (1).

Due to their particular social status, institutionalized minors have been permanently deprived of the same opportunities of children in the general population.

Raised in foster families that change many times during their lifetime, these children grow up without developing confidence in their own strength, without even dreaming that a normal life is something that can be achieved. They are likely to be forced by circumstances to lose hope of finishing their studies or becoming intellectuals, although they often do not have a lower level of intelligence. The poor socio-economic conditions of their natal family and/or the family in which they grew up lead them to drop out of school and to start a job that consists mainly of physical labor (Ryan & Deci, 2000).

Their success often depends on the relationship they have with their foster parents. The more they create a stronger sense of security and trust, the better are their chances of success in the future. This is the satisfaction of one of the primary needs described by Maslow in its pyramid of needs. According to this theory, satisfying needs is essential for a harmonious global development of the individual. Primary needs are physical/water and food, the need for safety, the need for love and belonging, the need for self-esteem and the need for self-actualization (Ahmadi-Monteclavo et al., 2016).

To ensure a safe family environment, a close relationship between the minor and the foster mother must be created. Unfortunately, maternal assistants often have an average level of education, and the amount of knowledge they can pass on to minors is minimal. According to the

law and the contractual system with the General Child Protection Department (DGASPC), they should satisfy the first 2 steps of the pyramid of Maslow's needs: children's physical needs and feeling of safety. If the relationship is good between the child and the maternal assistant, the need for love and membership is also satisfied, although these children often bear the stigma of the first childhood trauma, being maltreated or even physically or emotionally abused by either their natural parents or previous foster parents (Greeson et al., 2011; Eggertsen, 2008).

Hypothesis

The aim of this study was to select a group of foster care teenagers able to correctly disseminate the information about smoking among their colleagues, by increasing the level of knowledge regarding tobacco addiction and developing communication skills.

On the other hand, through information disseminated by foster care teenagers from the focus groups, the secondary assumptions of the study were: 1. There are more smoking teenagers in urban areas than smokers in rural areas 2. Adolescents from non-smoking families have a lower incidence of smoking. 3. Adolescents from poor social environments have an increased incidence of smoking.

Material and methods

Research protocol

a) Period and place of the research

During the years 2016-2017, we developed an educational project with the support of the ELDAD Târgu Mures Association in partnership with the Romanian Society of Pneumology - the Tabacology Section, and the General Directorate for Child Protection (DGASPC) Mureș and Cluj. The study also benefited from the Approval of the Ethics Commission of the „Iuliu Hatieganu” University of Medicine and Pharmacy Cluj-Napoca, number 443/ November 2016.

All subjects expressed their consent for participation in the study. The consent was signed by both the legal guardian and the Director of the General Directorate for Child Protection.

Table I
Research design

Research Phase	Development and Implementation
Phase 1	Interactive audio-visual presentations on tobacco consumption. Anonymous questionnaires were completed.
Phase 2	Focus groups were formed on the basis of volunteering. During one year, we worked with 4-5 groups, with a pneumologist and a representative of the organizers.
Phase 3	The results of focus group activity were materialized by organizing a medical symposium where the presentations were given by foster care minors. A period of follow-up of their evolution followed.

b) Subjects and groups

This project was intended for minors institutionalized in the Professional Maternal Assistance System (AMP). The subject was smoking with clearly defined objectives: motivating the participants to remain non-smoking and discouraging the experimentation of tobacco use, determining the teenagers who were already smokers to quit smoking, educating minors and their family and

school environment with regard to the consequences of active and passive smoking on their health and those around them, medical-behavioral counseling for quitting smoking. The age of the participants ranged from 10 to 18 years (Table I).

c) Tests applied

In order to ensure the continuity of the information provided in the initial presentations, several focus groups were formed. These “focus groups” had the initiative to give subsequent presentations on preselected themes, all of which were part of the global topic: smoking. The follow-up program lasted 12 months and, after the dissemination of the action by working groups, ended with a symposium attended by all the participating groups. Focus group participants were selected mainly on the basis of volunteering, but also of DGASPC recommendations, age and address.

Adherence to these working groups, considered the organizational core for their colleagues, was strictly voluntary, and minors could always withdraw from the project.

d) Statistical processing

All the data were coded and introduced into Excel sheet, and the results were expressed as frequency and percentage using MedCalc Statistical Software version 16.8 (MedCalc Software bvba, Ostend, Belgium; <https://www.medcalc.org>; 2016).

Results

After the focus groups were formed, presentations were performed by these volunteers in the high schools they attended and in the general schools from which they graduated. We, the initiators of this project, accompanied them both physically and by providing the necessary logistics for these events. The audience consisted of 312 school children from Mureș, Cluj and Bistrița-Năsăud counties, from both urban and rural areas (Table II).

Table II

Characteristics of the study group

Indicators	Urban	Rural
Number of participants	198	114
Mean age	16.8	16
Females (%)	61	55
Males (%)	45	39
Smokers (%)	33	26
Cigarettes/day (mean value)	12	9

The rural area group consisted of 114 children, with a mean age of 16 years (45% male, 55% female). The urban area group consisted of 198 children with a mean age of 16.8 years (39% male, 61% female).

In the rural area, the number of non-smokers was 84 (74%) and that of smokers 30 (26%), with an average of 9 cigarettes/day. In the urban area, the number of non-smokers was 133 (67%) and that of smokers 65 (33%), with an average of 12 cigarettes/day. Regarding the age of onset of smoking, out of a total of 298 respondents to this question, most of them started smoking in the 13-14 age group (Fig. 1).

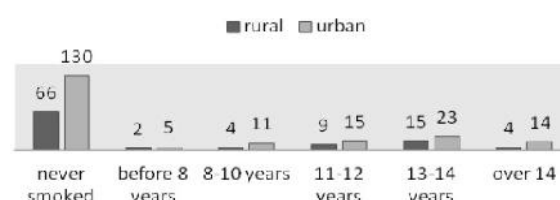


Fig. 1 - Age of smoking onset (number of responders)

Regarding exposure to passive smoking, our study demonstrated an increased exposure to passive smoking at home in the countryside, while in the case of passive smoking at school, the exposure was higher in urban areas (Fig. 2).

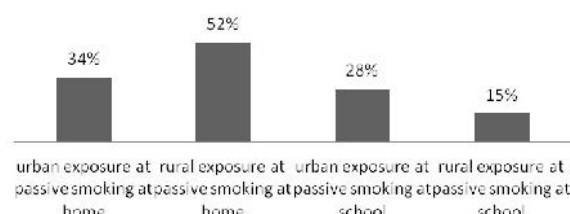


Fig. 2 – Exposure to passive smoking

This stage was necessary to build the self-confidence of these institutionalized minors, who approached the information provided by us, undertook the criticism and applied the necessary corrections.

The pupils in the target audience were also given an open question feedback form to complete, and they unanimously expressed a positive response to the fact that the information was sent to them by lecturers of their own age, and not adults, so they felt free to respond freely to the questions asked.

Regarding their future perception about smoking, a majority percentage of the total population (urban and rural) declared that they would not smoke in the future. For those who answered they did not know what their smoking attitude would be, these educational programs need to be sustained and continued (Fig. 3).

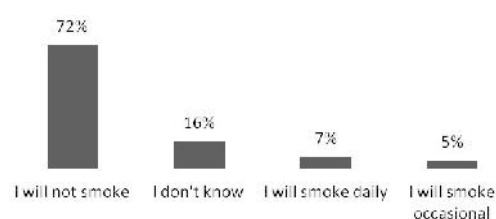


Fig. 3 – Smoking behavior in the future after the presentations

This educational program culminated with the symposium organized on 31 May 2017, on the occasion of the World No Tobacco Day, in partnership with the Romanian Society of Pneumology.

In this event, 6 young people institutionalized in the AMP system participated. They gave PowerPoint presentations, after assiduous training prior to the event. The success of this symposium was generated by the large number of teenagers from the Social Assistance system, but especially of students from Târgu Mureș high

schools. Approximately 300 adolescents listened to the 6 talks on the topic of smoking given by volunteer focus group speakers, as well as to the psychological debate on addictions conducted by a clinical psychologist.

Discussions

The “focus group” sought to achieve the goal and the initial objectives, but not through a monologue action to which the adherence of youngsters was statistically proven to be low, but by an active involvement of the students through which they systematically became the trainers of their colleagues, were responsible, prepared, accumulated experience and information in a collegial manner that would give all those involved an interactive experience with beneficial effects both in the near future and for the long term.

The idea to work individually, to give presentations as the main authors was on the one hand a factor favoring the adherence of minors to these working groups, but on the other hand it was a negative factor, this environment probably inspiring fear of not being able to cope with the challenge or not being sufficiently prepared.

The originality of this project resides in the challenge that these young people addressed for the first time: to be speakers, to be lecturers alongside physicians, on an official stage in front of 300 students in their city.

Although literature studies evidence the association between social protection and low rates of school progress, the cause of these poor learning outcomes is unclear (Budin et al., 2018; Greeson et al., 2011). The system itself is considered to be responsible on the one hand, and on the other hand, childhood and adolescence maltreatment or other circumstances to which these children were subjected throughout their experiences (Greeson et al., 2011; Gruber et al., 1996; Ryan & Deci, 2000). Although literature data show an increased incidence of smoking in adolescents from poor social backgrounds, this hypothesis was not demonstrated in our group.

According to the National Strategy for the Protection and Promotion of the Rights of the Child 2014-2020, the National Strategy for Social Inclusion and Poverty Reduction 2015-2020, and the Partnership Agreement for the 2014-2020 Programming Period, organizational and educational measures should be initiated for the abandoning families of children, families at the deepest poverty level or with a precarious socio-cultural status.

An international study conducted in 2018 provided consistent results with these premises, showing that the percentage of institutionalized minors who have suffered various types of ill-treatment and who have succeeded in promoting high school is 15% lower than in the general population.

In a study conducted in Transylvania on a group of institutionalized minors, the results showed that more than 1 out of 10 children and adolescents in the social protection system smoked a cigarette before the age of 10, and another 17% declared that they started smoking between 11 and 14 years of age (Hudson & Nandy, 2012; Lockwood et al., 2015). Therefore, almost a third of this social class initiates smoking before the age of 15, which justifies the tendency of targeting prevention campaigns to

this age group (Lorand et al., 2016; Vremaroiu-Coman et al., 2018; Todea et al., 2013).

The literature data on youth included in social protection programs are limited and need to be extended by well-conducted studies coupled with concrete scientific support and legislative and administrative measures tailored to each studied group (Shpiegel et al., 2017).

Conclusions

In the light of these events, we consider that everyone is entitled to a chance. And these young people, although coming from a social protection system and carrying this stigma throughout their lives, are not in the least inferior to those who grew up in a family with natural parents. Their level of intelligence permits an investment in this respect, and the results will not delay to appear.

Working with them was strenuous; it was difficult to teach them to be disciplined, to convince them that they needed to go home with good results, to provide them with the necessary logistics.

Conflicts of interests

None of the authors of the manuscript has any conflicts of interest related to the presented work.

Acknowledgments

The project is part of the main project ANF (“Azi Nu Fumez” – “Today I don’t smoke”), developed by the ELDAD Association of Targu Mures in partnership with the Romanian Society of Pneumology and “Iuliu Haieganu” University of Medicine and Pharmacy Cluj-Napoca.

References

- Ahmadi-Montecalvo H, Owens S, DePasquale S, Abildso CG. Tobacco and Other Drug Use among Foster Care Adolescents in West Virginia. *Am J Health Behav.* 2016;40(5):659-666. doi:10.5993/AJHB.40.5.13.
- Vremaroiu-Coman A, Alexescu TG, Negrean V, Milaciu MV, Buzoianu AD, Ciurmean L, Todea DA. Ethical aspects of smoking cessation among the population from Transylvania. *Balneo Res J.* doi:http://dx.doi.org/10.12680/balneo.2018.191. 2018; 9(3):254-259.
- Braciszewski JM, Colby SM. Tobacco use among foster youth: Evidence of health disparities. *Child Youth Serv Rev.* 2015;58:142-145. doi:10.1016/j.childyouth.2015.09.017.
- Budin CE, Marginean C, Bordea IR, Enache LS, Enache EL, Grigorescu BL, Biro L, Rusu E, Nemes RM, Todea DA. The Influence of Smoking on Nicotine Exposure Biomarkers and Inflammatory Profile Among Foster Care Teenagers, Romania. *Rev CHIM.* 2018; 69(12):3659-3663.
- Courtney ME, Iwaniec D. *Residential Care of Children: Comparative Perspectives.* Oxford University Press. Oxford, New York, 2009.
- Eggertsen L. Primary factors related to multiple placements for children in out-of-home care. *Child Welfare* 2008;87(6):71-90.
- Greeson JK, Briggs EC, Kisiel CL, Layne CM, Ake GS 3rd, Ko SJ, Gerrity ET, Steinberg AM, Howard ML, Pynoos RS, Fairbank JA. Complex trauma and mental health in children and adolescents placed in foster care: findings from the National Child Traumatic Stress Network. *Child Welfare* 2011;90(6):91-108.

- Gruber E, DiClemente RJ, Anderson MM, Lodico M. Early drinking onset and its association with alcohol use and problem behavior in late adolescence. *Prev Med* 1996;25(3):293-300. doi:10.1006/pmed.1996.0059.
- Hudson AL, Nandy K. Comparisons of substance abuse, high-risk sexual behavior and depressive symptoms among homeless youth with and without a history of foster care placement. *Contemp Nurse* 2012;42(2):178-186. doi: 10.5172/conu.2012.42.2.178.
- Lockwood KK, Friedman S, Christian CW. Permanency and the Foster Care System. *Curr Probl Pediatr Adolesc Health Care*. 2015;45(10):306-315. doi: 10.1016/j.cppeds.2015.08.005.
- Lorand FI, Zoltan A, Lorand S, Peter B, Foley KL. Tobacco use among children in Romanian foster care homes. *Eur J Public Health*. 2016;26(5):822-826. doi:10.1093/eurpub/ckw044.
- Ryan RM, Deci EL. Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. *Am Psychol*. 2000;55(1):68-78. doi: 10.1037/110003-066X.55.1.68.
- Shpiegel S, Sussman S, Sherman SE, El Shahawy O. Smoking Behaviors Among Adolescents in Foster Care: A Gender-Based Analysis. *Subst Use Misuse*. 2017;52(11):1469-1477. doi: 10.1080/10826084.2017.1285315.
- Todea DA, Suatean I, Coman AC, Rosca LE. The Effect of Climate Change and Air Pollution on Allergenic Potential of Pollens. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*. 2013;41(2): 646-650. doi:https://doi.org/10.15835/nbha4129291.
- Websites**
- (1) Copiii-din-sistemul-de-protectie-a-copilului_UNICEF_ANPDCA_BM_2016.pdf. Available from: http://www.unicef.ro/wp-content/uploads/Copiii-din-sistemul-deprotectie-a-copilului_UNICEF_ANPDCA_BM_2016.pdf. Accessed online: 22 March 2018.
 - (2) UNICEF Office of Research - Innocenti. 2017 Results Report, Florence, 2018. Available at: <https://www.unicef-irc.org/publications/series/innocenti-publications/?page=3>. Accessed online: March 2019.
 - (3) WHO | Adolescents: health risks and solutions. Available at: <https://www.who.int/news-room/fact-sheets/detail/adolescents-health-risks-and-solutions>, 2018. Accessed online: March 2019.

The association between dental caries, education and body mass index in a population of Romanian schoolchildren

Cosmin Tudoroni, Bogdana Adriana N. sui, Monica Popa

“Iuliu Hatieganu” University of Medicine and Pharmacy Cluj-Napoca, Romania

Abstract

Background. Obesity and caries are common conditions in childhood and can have significant implications in children's wellbeing. Evidence into their association remains conflicting.

Aims. The aim of this study was to assess dental caries prevalence in relation with the body mass index and dental health behaviors in a population of schoolchildren.

Methods. We used a cross-sectional study among 650 schoolchildren from Cluj-Napoca, with the mean age 15.39 ± 3.2 years. Weight and height were self-reported in the questionnaire (converted to Body Mass Index centiles, according to WHO growth charts). Caries were assessed by using the sum of the number of teeth that were decayed, missing or filled (DMFT index). A questionnaire was used to obtain information about sociodemographic characteristics of the children, oral hygiene and dietary habits. Data were analyzed by using StatsDirect v.2.7.2, T test and Mann Whitney test to compare variables. The results with $p < 0.05$ were considered significant.

Results. The dmft/DMFT index was higher in rural than in urban areas (3.16 ± 1.93 vs. 3.09 ± 2.26 , $p > 0.05$). Parents of children from urban areas had a higher education than parents from rural areas ($p < 0.0001$). The mean BMI was higher in children from rural areas than those from urban areas ($p = 0.03$). Our results indicated that the dmft/DMFT index was not affected by the BMI index, at this age ($p > 0.05$).

Conclusions. Our study highlights the need for education of schoolchildren regarding oral health, diet and lifestyle, including changes in physical activity and food quality to prevent obesity and dental caries, both in children and later in adulthood.

Key words: caries, body mass index, oral health habits.

Introduction

Oral diseases, especially dental caries, are still mainly prevalent in developing countries, affecting people irrespective of the race, socioeconomic status or age (Touger-Decker & van Loveren, 2003). Dental caries is a multifactorial disease attributed to both modifiable risk factors, such as dietary factors, water fluoride levels, tooth brushing frequency, and non-modifiable risk factors such as socioeconomic status and previous caries experience (Anil & Anand, 2017).

The literature provides evidence for the coexistence of obesity and dental caries, as they have common risk factors including consumption of free sugars and socioeconomic deprivation (Te Morenga et al., 2012; Locker, 2000). Overweight and dental caries are attributed to complex behavioral and societal factors which include the genetic component, increased media exposure through television and computer games, overall calorie intake along with increased intake of sugary foods and beverages, physical activity, habits of both oral and personal hygiene. Various literature data support evidence of the coexistence of

the two conditions in the same individuals and populations, but with variations (Moynihan & Kelly, 2014).

In low-income countries, the cost of traditional restorative treatment of dental disease would probably exceed the available resources for health care. Dental health promotion and preventive strategies are clearly more affordable and sustainable. Although not life-threatening, dental diseases have a detrimental effect on quality of life through childhood to old age, having an impact on self-esteem, eating ability, nutrition and health. In modern society, a significant role of teeth is to enhance appearance.

The amount of dental decay is measured using the dmft/DMFT index, accounting for the number of teeth or tooth surfaces in a person's mouth that are decayed, missing or filled as a result of caries in primary/permanent dentition (Petersen, 2003).

Hypothesis

Literature data are contradictory regarding the relation between obesity and overweight and prevalence of dental caries, due to the same risk factors of both diseases. The objective of this study was to assess the correlation between

Received: 2019, February 25; Accepted for publication: 2019, March 8

Address for correspondence: “Iuliu Hatieganu” University of Medicine and Pharmacy, Cluj-Napoca, Louis Pasteur Str. No. 6, Hygiene Discipline

E-mail: nasuibogdana@yahoo.ro

Corresponding author: Bogdana Adriana N. sui; nasuibogdana@yahoo.ro

<https://doi.org/10.26659/pm3.2019.20.2.62>

dental caries and modifiable risk factors, such as the body mass index in children.

Material and methods

The study was approved by the Bioethics Committee of the "Iuliu Hatieganu" University of Medicine and Pharmacy (No. 287/19.06.2017), and the children's parents agreed to fulfill the questionnaire with a view to the publication of results for scientific purposes.

Research protocol

a) *Period and place of the research.* In order to achieve the aim of our study, we conducted a cross-sectional study in three schools in Cluj-Napoca from March to June 2017. Cluj-Napoca is a city with about 325,000 inhabitants, situated in the North-West of Romania.

b) *Subjects and groups.* A total of 650 subjects, aged between 5-19 years (minimum 7 years, maximum 19 years), were selected to participate in this study.

c) *Tests applied.* We calculated the DMFT index of the children according to the WHO definition. Oral clinical examination was performed by a dentist according to the oral status evaluation methodology recommended by WHO. Radiographs were not taken. A dental assistant recorded the results of the dentist's examination.

The research team applied a structured questionnaire to the participants of the study. The questionnaire investigated demographic data, behavioral factors and food intake in order to determine the link between dental caries and these variables. For the group aged 5 to 14 years, the questionnaires were filled by the parents. A written informed consent was given by the parents of the children participating in the study. Students and parents were informed that the questionnaire was confidential and that participation was voluntary. The response rate was 89%. The body mass index (BMI) was calculated by the formula $BMI = \text{Weight (kg)} / \text{Height}^2 (\text{m}^2)$. The weight and height were self-reported in the questionnaire. We calculated the DMFT index of the children depending on the BMI categories in order to determine the relation between overweight and obesity and prevalence of dental caries.

The BMI value obtained was then plotted on age and gender specific percentile curves provided by the World Health Organization (WHO), and the children were categorized into four groups based on their BMI percentiles as follows (1):

- Underweight children group with a BMI-for-age less than the 5th percentile;
- Normoweight children group with a BMI-for-age greater than or equal to the 5th percentile and less than the 85th percentile;
- Overweight children group with a BMI-for-age greater than or equal to the 85th percentile and less than the 95th percentile;
- Obese children group with a BMI-for-age greater than or equal to the 95th percentile.

d) Statistical processing

Data were analyzed using StatsDirect v.2.7.2 software, with OpenEpi v.3.03 application and Excel (Microsoft Office 2010). Continuous variables were described using mean and standard deviation. The Chi-square test was used to compare proportions. In the case of a normal distribution

of variables we used the T test, and in the case of an uneven distribution of variables we used the nonparametric Mann-Whitney (U) test. Results with $p < 0.05$ were considered statistically significant.

Results

The mean age of the sample was 15.39 ± 3.2 years, with a mean age of males 13.71 ± 3.49 years, and of females 15.77 ± 2.38 years ($p < 0.001$) (data are not presented in the table). The mean DMFT index was higher in rural areas than in urban areas, but the results were not statistically significant (Table I).

Our study showed that schoolchildren from rural areas had a higher body mass index than children from urban areas. The results evidenced a high percentage of children who made an appointment to the dentist only when they were in pain; 42.38% schoolchildren from rural areas indicated that they saw the dentist only when in pain compared to 33.86% children from urban areas (data are not presented in the table). However, a great proportion of children used fluoridated toothpaste and reported tooth brushing twice per day (Table I).

Table I
Baseline characteristics of the sample

Variable	p value	
Male (%)	22.5	
Female (%)	77.5	
Urban (%)	67.7	
Rural (%)	32.3	
Mean age (years)	15.39±3.2	
Mean DMFT urban	3.09±2.26	0.28
Mean DMFT rural	3.16±1.93	
Mean BMI males (kg/m ²)	20.6±4.15	0.29
Mean BMI females (kg/m ²)	20.8±3.36	
Mean BMI urban (kg/m ²)	20.56±3.69	0.03
Mean BMI rural (kg/m ²)	21.15±3.20	
Dental health and care		
Mean DMFT	3.14±2	
Mean DMFT males	3.42±1.73	0.001
Mean DMFT females	3.05±2.21	
Tooth brushing		
After every meal (%)	7.1	
2/day (%)	70.9	
1/day (%)	20.1	
Sometimes I forget (%)	1.9	
Every evening (%)	66.3	
Toothpaste with f uoride (%)	75.2	
Toothpaste without f uoride (%)	24.8	
Dentist visits		
Once every 6 months (%)	16.62	
Once/year (%)	42.77	
In pain (%)	36.62	
Never (%)	4.00	

Generally, in the urban sample of the children, most of the mothers had university studies compared to mothers from rural areas, who had high school education. Parents from urban areas had a higher education level than parents from rural areas ($\chi^2 p < 0.0001$, fathers - $R_s = 0.19$; mothers - $R_s = 0.21$, both $p < 0.0001$) (Table II).

Table II
Parents' education

Variable	Total No. (%)	Urban No. (%)	Rural No. (%)
Age (years)	15.31 ± 2.8	15.01 ± 3.06	15.92 ± 2.04
Area of residence	650 (100)	440 (67.69)	210 (32.31)
Mother's education			
Primary	7 (1.08)	3 (0.68)	4 (1.90)
Secondary	34 (5.23)	10 (2.27)	24 (11.43)
High school	244 (37.54)	152 (34.55)	92 (43.81)
Trade school	146 (22.46)	105 (23.86)	41 (19.52)
University	219 (33.69)	170 (38.64)	49 (23.33)
Father's education			
Primary	13 (2.00)	7 (1.59)	6 (2.86)
Secondary	32 (4.92)	15 (3.41)	17 (8.10)
High school	301 (46.31)	189 (42.95)	112 (53.33)
Trade school	122 (18.77)	80 (18.18)	42 (20.00)
University	182 (28.00)	149 (33.86)	33 (15.71)

Following calculation of the DMFT index depending on BMI categories, the results of the study evidenced no differences in children's caries between urban and rural areas (Table III). We compared the results of the DMFT index of normoweight (N) children to overweight children (S), normoweight children to obese children (O) and overweight children to obese children (O) (Table III).

Table III
The mean DMFT according to BMI categories

	DMFT	Mean ±SD	p
Sample	Normoweight (N)	3.15±2.09	N-S 0.99
	Overweight (S)	2.99±1.65	N-O 0.45
	Obese (O)	3.38±1.69	S-O 0.38
Urban	Normoweight	3.19±1.97	N-S 0.51
	Overweight	2.93±1.67	N-O 0.81
	Obese	3.14±1.68	S-O 0.57
Rural	Normoweight	3.08±2.33	N-S 0.41
	Overweight (S)	3.08±1.64	N-O 0.19
	Obese	5.00±0	S-O 0.56
Male	Normoweight	3.62±1.71	N-S 0.05
	Overweight (S)	2.38±1.46	N-O 0.17
	Obese	2.33±1.15	S-O 0.89
Female	Normoweight	3.02±2.17	N-S 0.14
	Overweight (S)	3.24±1.66	N-O 0.11
	Obese	4.00±1.73	S-O 0.21

On the other hand, our study evidenced that the majority of the children (87.69%) had the body mass index included in the normoweight category according to WHO growth charts (Table IV).

Table IV
Distribution of the sample depending on body weight

Variable	Normoweight (No/percentage)	Overweight (No/percentage)	Obese (No/percentage)
Female	448 (68.92%)	51 (7.85%)	5 (0.77%)
Male	122 (18.77%)	21 (3.23%)	3 (0.46%)
Total	570 (87.69%)	72 (11.08%)	8 (1.23%)

Discussion

Dental diseases considerably impact self-esteem and the quality of life and are expensive to treat. The objective of this study was to determine the DMFT index in the children population of Cluj-Napoca and to characterize the factors that can have possible effects on DMFT.

The WHO and FDI global oral health goals for the year 2000 were to lower DMFT in children aged 12 years below 3 (Petersen, 2003). In Romania, the DMFT index in 1995 was 3.8 compared to 5 in 1985. The findings of our study showed a moderate DMFT index in the selected sample, taking into account the fact that the children live in a region of Romania with high access to dental services. Despite this access, the results showed that a great proportion of the selected children visit the dentist only when in pain (36.62%). This behavior would lead to severe dental disease and an increase in the risk of painful symptomatology.

Dental caries is a chronic condition that is strongly associated with socioeconomic status. Socioeconomic status includes the educational background, income and the residence area, and is considered to be one of the strongest determinants of caries in children (Chi et al., 2014; Koksall et al., 2011). Educational level, as a traditional SES variable, affects the type of job and income, and consequently, access to preventive measures such as tooth cleaning, health service use and a low-carbohydrate diet (Engelmann et al., 2016). Like other studies, the present study evidenced differences in education between parents from urban and rural areas (Funieru et al., 2014; Borges et al., 2012). This will affect the related attitude towards oral health, including appointments to the dentist.

On the other hand, socioeconomic status is a predictor of obesity. This is in agreement with many studies showing that children in deprived areas are more likely to be obese than their peers in less deprived areas (Paisi et al., 2008). The lack of money means that parents opt to purchase cheaper food for their children that tends to be higher in fat and sugar than more expensive food (Granville-Garcia et al., 2008; Reilly et al., 2009; Timonen et al., 2010; Modeer et al., 2010).

Like other studies (Alswat et al., 2016; Shivakumar et al., 2014; Chen et al., 2018), the results of our study do not support the relation between overweight and obesity and prevalence of dental caries in the selected sample. Given the progressive nature of obesity and caries, it is possible that an association between the two does not manifest until later in life. Thus, the young age of the participants in this study may have contributed to the lack of an observed association between the two conditions.

Limitations

The present study was limited by its cross-sectional design. The second potential limitation of our study may be the reported biases in the questionnaire, which may have influenced our findings. The third limitation may be the selection of the sample from a developed area of the country with a high income and educational level, and opportunities to address to a school dental practice. This access to dental services may improve the oral health status of the children.

Conclusions

1. The findings of our study evidenced the need for better education of parents and children regarding behaviors related to dental health in order to reduce dental caries prevalence.

2. There is also a need for education regarding diet and lifestyle, including changes in physical activity and food quality to prevent obesity and dental caries, both in children and later in adulthood.

Conflicts of interest

There are no conflicts of interest.

Acknowledgements

The article uses results from the first author's doctoral thesis, which is in progress at the "Iuliu Hatieganu" University of Medicine and Pharmacy in Cluj-Napoca.

References

- Alswat K, Mohamed WS, Wahab MA, Aboelil AA. The Association Between Body Mass Index and Dental Caries: Cross-Sectional Study. *J Clin Med Res.* 2016;8(2):147-152. doi: <http://dx.doi.org/10.14740/jocmr2433w>.
- Anil S, Anand PS. Early Childhood Caries: Prevalence, Risk Factors and Prevention. *Front Pediatr.* 2017;5:157-164. doi: 10.3389/fped.2017.00157.
- Borges HC, Garbín CA, Saliba O, Saliba NA, Moimaz SA. Socio-behavioral factors influence prevalence and severity of dental caries in children with primary dentition. *Braz Oral Res.* 2012;26(6):564-570.
- Chen D, Zhi Q, Zhou Y, Tao Y, Wu L, Lin H. Association between Dental Caries and BMI in Children: A Systematic Review and Meta-Analysis. *Caries Res.* 2018; 52(3):230-245. doi: 10.1159/000484988.
- Chi DL, Masterson EE, Carle AC, Mancl LA, Coldwell SE. Socioeconomic status, food security, and dental caries in US children: mediation analyses of data from the National Health and Nutrition Examination Survey, 2007-2008. *Am J Public Health.* 2014;104(5):860-864. doi: 10.2105/AJPH.2013.301699.
- Engelmann JL, Tomazoni, Oliveira F, Marta Dutra Machado MD, Thiago A M.. Association between Dental Caries and Socioeconomic Factors in Schoolchildren - A Multilevel Analysis. *Brazilian Dental Journal.* 2016;27(1):72-78. doi: 10.1590/0103-6440201600435
- Funieru C, Twetman S, Funieru E, Dumitrache AM, Sfeatu RI, Baicus C. Caries experience in schoolchildren in Bucharest, Romania: The PAROGIM study. *J Public Health Dent.* 2014; 74(2):153-158. <https://doi.org/10.1111/jphd.12039>.
- Granville-Garcia AF, de Menezes VA, de Lira PI, Ferreira JM, Leite-Cavalcanti A. Obesity and Dental caries among preschool children in Brazil. *Rev Salud Publica.* 2008;10(5):788-795.
- Koksal E, Tekcicek M, Yalcin SS, Tugrul B, Yalcin S, Pekcan G. Association Between anthropometric measurements and dental caries in Turkish school children. *Cent Eur J Public Health.* 2011; 19(3):147-151. doi: 10.21101/cejph.a3648.
- Locker D. Deprivation and oral health: a review. *Community Dent Oral Epidemiol.* 2000;28(3):161-169.
- Modeer T, Blomberg CC, Wondimu B, Julihn A, Marcus C. Association between obesity, flow rate of whole saliva, and dental caries in adolescents. *Obesity (Silver Spring).* 2010;18(12):2367-2373. doi: 10.1038/oby.2010.63.
- Moynihan PJ, Kelly SA. Effect on caries of restricting sugars intake: systematic review to inform WHO guidelines. *J Dent Res.* 2014;93(1):8-18. doi: 10.1177/0022034513508954.
- Paisi M, Kay E, Kaimi I, Witton R, Nelder R, Potterton R, Laphorne D. Obesity and caries in four-to-six year old English children: a cross-sectional study. *BMC Public Health.* 2018;18(1):267. doi: 10.1186/s12889-018-5156-8.
- Petersen PE. The World Oral Health Report 2003: Continuous improvement of oral health in the 21st century – the approach of the WHO Global Oral Health Programme. *Community Dent Oral Epidemiol.* 2003;31(Suppl 1):3-24.
- Reilly D, Boyle CA, Craig DC. Obesity and dentistry: a growing problem. *Br Dent J.* 2009;207(4):171-175. doi: 10.1038/sj.bdj.2009.717.
- Shivakumar S, Srivastava A, Shivakumar G. Body Mass Index and Dental Caries: A Systematic Review. *Int J Clin Pediatr Dent.* 2018;11(3):228-232. doi: 10.5005/jp-journals-10005-1516..
- Te Morenga L, Mallard S, Mann J. Dietary sugars and body weight: systematic review and meta-analysis of randomised controlled trials and cohort studies. *BMJ.* 2012;346:e7492. doi: 10.1136/bmj.e7492.
- Timonen P, Niskanen M, Suominen-Taipale L, Jula A, Knuuttila M, Ylostalo P. Metabolic syndrome, periodontal infection, and dental caries. *J Dent Res.* 2010;89(10):1068-1073. doi: 10.1177/0022034510376542.
- Touger-Decker R, van Loveren C. Sugars and dental caries. *Am J Clin Nutr.* 2003;78(4):881S-892S. doi:10.1093/ajcn/78.4.881S.

Websites

- (1) The WHO Child growth charts. Available from: <https://www.who.int/childgrowth/standards/en/>. Accessed online: 22 January 2019.

Safety of ultrasound-guided botulinum toxin type A injections for patients with anticoagulant and antiplatelet background medication

Marius-Nicolae Popescu^{1,2}, Lumini a Dumitru^{1,2}, Matei Teodorescu^{1,2}, Alina Iliescu^{1,2}, Mihai Berteanu^{1,2}

¹ “Carol Davila” University of Medicine and Pharmacy Bucharest, Romania

² Medical Rehabilitation Department of the Elias Emergency University Hospital, Bucharest, Romania

Abstract

Background. TXB-A injections are the first-line treatment of many movement disorders, and the safety of doing them is essential to the effectiveness of therapy.

Aims. Evaluation of safety of TXB-A guided injections in upper limb spasticity of post-stroke patients.

Methods. The study group comprised 60 patients distributed in 3 subgroups of 20 based on background medication administered in post-stroke management: 20 patients in the antiplatelet background subgroup, 20 patients in the subgroup of anticoagulant background medication, and 20 without anticoagulant/antiplatelet background medication. From the 60 patient group, based on the number of TXB-A injection cycles, 3 other subgroups were produced: 20 patients performed 3 injection cycles, 20 performed 2 cycles, and 20 completed a single injection cycle.

Every patient received a total dose of 1000 UI of TXB-A. After each set of local injections, ultrasounds were performed at the injection site searching for local hematomas. The moments evaluated were: T0 (the initial time – injection time), T1 (one month after the injection), T2 (3 months from T0 or 2 months from T1), T3 (1 month after T2), T4 (3 months after T2 or 2 months after T3) and T5 (1 month after T4).

Results. The lowest p value of the 3 possible comparisons of the anticoagulant, antiplatelet, no anticoagulant/antiplatelet group of patients was 0.856, showing a purely random distribution of adverse effects manifested by local hematomas following ultrasound guided injections.

Conclusions. Multiple cycles of US guided TXB-A injections with a minimum 3-month frequency between injections do not increase the risk of local haematomas.

Key words: botulinum toxin type A, ultrasound guided injections, safe treatment.

Introduction

The US guided TXB-A effectiveness in the treatment of upper limb spasticity after a stroke is well established (Grigoriu et al., 2015; Popescu et al., 2018). Several guidelines and many experienced practitioners recommend TXB-A injections as a first-line treatment option, not only in spasticity, but in many other movement disorders (1); (Thibaut et al., 2018).

Although the largest use of TXB-A is still in the treatment of neurological disorders manifested by abnormal, excessive or inadequate muscle contractions, the use of TXB-A continues to extend and includes the treatment of a variety of ophthalmic, gastrointestinal, urologic, orthopedic, dermatological, dental diseases and the treatment of pain-related syndromes (Dutta et al., 2016).

Its growing use in many pathologies makes it one of the most versatile medicines of our time, covering almost all the specialties of medicine. Although it is considered effective and safe, there are still many limitations, such as injection-related discomfort, a relatively short period of action and high cost (Simpson et al., 2016).

The adverse effects of treatment with TXB-A are minor and important systemic side effects are very rare. In most cases, local pain at the injection site and local muscle weakness of nearby muscles from toxin spread are the most reported (Marciniak et al., 2019; Gracies et al., 2015).

To prevent antibody formation and implicitly failure of therapy, it is recommended to inject the lowest effective dose, to prevent short injection intervals and to alternatively use different TXB-A serotypes (Truong et al., 2013).

A variety of techniques and guidance methods can

Received: 2019, March 15; Accepted for publication: 2019, March 25

Address for correspondence: Marius-Nicolae Popescu, “Carol Davila” University of Medicine and Pharmacy Bucharest, Medical Rehabilitation Department of the Elias Emergency University Hospital, Romania, No. 17, M r ti Av.

E-mail: marius_drm1987@yahoo.com

Corresponding author: Marius-Nicolae Popescu; marius_drm1987@yahoo.com

<https://doi.org/10.26659/pm3.2019.20.2.66>

be used to identify the target spastic muscles. Palpation and anatomical landmarks, electromyography (EMG), electrical stimulation (ES) and ultrasound (US) are most commonly used by clinicians for guiding TXB-A injections (Tok et al., 2011).

US is a well-established, reliable guidance method that offers real-time, high-resolution images, and provides a detailed picture of a muscle: location, depth, target trajectory, other structures (nerves, vessels, organs) in the region of interest. It is less expensive, more accessible and convenient than other image-based guidance methods such as MRI, CT or fluoroscopy. A US machine with a 7.5 MHz linear transducer can ensure a quality resolution for both superficial and deep muscles (Willenborg et al., 2002).

Hypothesis

TXB-A is a first-line treatment option for focal spasticity after a stroke, and the accuracy in the transmission of the substance to the target muscles can influence the outcomes. The purpose of this study is to quantify the local adverse effects at the injection site after TXB-A guided injections and to establish if US is a reliable and safe guidance method.

Objectives

a) Correlations between higher and lower doses of TXB-A administered to a muscle and the appearance of local adverse effects

b) Correlations between patient background medication in stroke management: antiplatelet/anticoagulant and appearance of adverse effects following TXB-A guided injections

c) Assessing the safety of US in guiding local injections with TXB-A

Material and methods

Research protocol

a) Period and place of the research

The observational study was performed in the Rehabilitation Department of the Elias University Hospital in the period September 2017 - March 2018. The study was approved by the Ethics Committee of the Elias University Hospital (08.08.2017), according to the Good Practice Guidelines. All 60 patients who participated in the study gave their consent to the use and publication of the results for research purposes.

b) Subjects and groups

The study group was formed by 60 patients with upper limb spasticity, who were divided into 2 subgroups (250 IU versus 333 IU), based on the doses injected in the wrist and finger flexors. Patients receiving 250 IU were injected in 4 muscles, while those receiving 333 IU were injected in 3 muscles.

The 60 patients of the group were distributed in another 3 subgroups of 20 based on the background medication administered in post-stroke management: 20 patients in the antiplatelet background subgroup, 20 patients in the subgroup of anticoagulant background medication, and 20 patients without anticoagulant/antiplatelet background medication. Of the 60 patient group, based on the number

of TXB-A injection cycles, 3 other subgroups were formed: 20 patients performed 3 injection cycles, 20 performed 2 cycles, and 20 completed a single injection cycle. Each patient received a total dose of 1000 IU of TXB-A.

c) Tests applied

After each set of local injections, ultrasound was performed at the injection site searching for local hematoma. The moments evaluated were: T0 (the initial time - injection time), T1 (one month after the injection), T2 (3 months after T0 or 2 months after T1), T3 (1 month after T2), T4 (3 months after T2 or 2 months after T3) and T5 (1 month after T4).

d) Statistical processing

The Mann-Whitney *U* test was used to statistically process the results.

The objective was to check whether the injection cycles had a contribution in the appearance of hematomas, measured in the 3 groups created based on the background medication. A comparison was made based on the number of injected muscles. We recall that according to the injection sessions, patients were grouped into three categories: one cycle, two or three cycles. Patients were divided depending on the number of injected muscles, on the dose administered into a muscle, respectively: the 1000 IU were distributed in 3 or 4 muscles, i.e. 333 IU/muscle or 250 IU/muscle.

For example, a patient with 3 injection cycles and 4 injected muscles was actually injected 12 times. One with one injection cycle and 3 injected muscles was injected 3 times. These are actually the top and bottom limits of our data on cumulative injections, so we will compare the independent groups between them based on the background medication categories. The data is considered scale type because 0 has a meaning (no hematoma encountered).

Results

The objective of the study was to show that local injections of TXB-A under ultrasound guidance are safe regardless of the anticoagulant or antiplatelet medication used by the patient in the background treatment. Thus, we gathered the number of local injections performed in each of the 3 patient groups and analyzed the appearance of hematomas within a group of patients and between the 3 groups formed.

It can be seen that there is no statistical difference between those who did not receive additional background medication, those who received anticoagulants and those who received antiplatelets. This shows that regardless of the number of injections received, adverse effects are not influenced. Regarding the cumulative number of injected muscles, 120, 156 or 144, the total number of hematomas was 9, which were randomly distributed, 4 in the anticoagulant group, 3 in the antiplatelet group, 2 in the group of patients with no background medication.

The results are presented in Tables I to III.

Discussions

This study shows that neither the dose injected in a muscle nor the number of injection sessions or injected muscles affects the appearance of hematoma, regardless of the type of background medication used. This contributes to

Table I

Statistical comparison of the number of hematomas after local injection: no background medication group/antiplatelet group.

Patient groups	No. of hematomas	No. of muscles injected	No. of patients	Average	Median	Standard deviation	Comparative test	p-value
No background medication	2	120	18	0.11	0	0.323	Mann-Whitney U	0.878
Antiplatelet	3	156	21	0.14	0	0.359		

Table II

Statistical comparison of the number of hematomas after local injection: no background medication group/anticoagulant group.

Patient groups	No. of hematomas	No. of muscles injected	No. of patients	Average	Median	Standard deviation	Comparative test	p-value
No background medication	2	120	18	0.11	0	0.323	Mann-Whitney U	0.856
Anticoagulant	4	144	21	0.19	0	0.512		

Table III

Statistical comparison of the number of hematomas after local injection: antiplatelet group/anticoagulant group.

Patient groups	No. of hematomas	No. of muscles injected	No. of patients	Average	Median	Standard deviation	Comparative test	p-value
Antiplatelet	3	156	21	0.14	0	0.359	Mann-Whitney U	0.950
Anticoagulant	4	144	21	0.19	0	0.512		

the safety with which injections can be delivered under US guidance: the lowest p-value of the 3 comparisons/possible combinations was 0.856, meaning that the distribution of hematomas was purely random.

In many recent studies, it has been shown that the use of US guidance for local injections of TXB-A increases efficiency and accuracy (Jabbari, 2016). It is well established that US guidance along with electrical stimulation guidance offers the most effective local technique of injection (Walker et al., 2015), but although US does not provide information on muscle activity, it provides information about muscle size and the degree of local fibrosis, very important aspects in making the decision to inject, ensuring increased safety for the intervention (Malloy et al., 2002).

Taking into account that TXB-A is not a curative treatment of spasticity, and the effect generally lasts between 2 and 4 months, patients with spasticity requiring the repeat of the injections after this period, we consider this study to be very important because it shows that multiple sessions with a minimum period of 3 months between them do not cause local adverse effects.

In addition, in a recent study (Trompetto et al., 2017), the authors showed that the low immunogenicity of current TXB-A products allows more frequent injection intervals than every 3 months, toxin-directed antibody formation is not related to the dosage and frequency of injections, and the most frequent adverse effects after TXB-A treatment are local, at the site of injection.

The role of US in administering TXB-A should be emphasized because, especially in the case of the upper limb, we encounter a multitude of anatomical variations of the muscles such as the inconstant presence of the palmaris longus muscle, the Gantzer variation of the flexor pollicis

longus muscle, vascular-nerve variations such as Martin-Gruber anastomosis, all of which are disturbing factors in local TXB-A administration, and may cause injection errors resulting in local adverse effects (Olewnik et al., 2017).

Conclusions

1. Multiple cycles of US guided TXB-A injections with a minimum 3-month interval between injections do not increase the risk of local hematoma.

2. The presence of antiplatelet, anticoagulant background medication does not increase the risk of local adverse effects after TXB-A injections under ultrasound guidance.

3. The present study suggests that local TXB-A injections under ultrasound guidance in patients with upper limb spasticity after stroke are safe in the doses used in this study.

Conflicts of interest

Nothing to declare.

References

- Dutta SR, Passi D, Singh M, Singh P, Sharma S, Sharma A. Botulinum toxin the poison that heals: A brief review. *Natl J Maxillofac Surg* 2016;7(1):10-16. doi: 10.4103/0975-5950.196133.
- Gracies JM, Brashear A, Jech R, McAllister P, Banach M, Valkovic P, Walker H, Marciniak C, Deltombe T, Skoromets A, Khatkova S, Edgley S, Gul F, Catus F, Bois De Fer B, Vilain C, Picaut P. Safety and efficacy of abobotulinumtoxin A for hemiparesis in adults with upper limb spasticity after stroke or traumatic brain injury: A double-blind randomised

- controlled trial. *Lancet Neurol*. 2015;14(10):992-1001. doi: 10.1016/S1474-4422(15)00216-1.
- Grigoriu AI, Dinomais M, Remy-Neris O, Brochard S. Impact of injection-guiding techniques on the effectiveness of botulinum toxin for the treatment of focal spasticity and dystonia: a systematic review. *Arch Phys Med Rehabil*. 2015;96(11):2067-2078 e1. doi: 10.1016/j.apmr.2015.05.002.
- Jabbari B. History of botulinum toxin treatment in movement disorders. *Tremor Other Hyperkinet Mov (NY)* 2016;6:394. DOI:10.7916/D81836S1.
- Malloy FM, Shill HA, Kaelin-Lang A, Karp BI. Accuracy of muscle localization without EMG: implications for treatment of limb dystonia. *Neurology*. 2002;58(5):805-807. doi:10.1212/wnl.58.5.805.
- Marciniak C, Munin MC, Brashear A, Rubin BS, Atul T. Patel, Slawek J, Hanschmann A, Hiersemenzel R, Elovic EP. IncobotulinumtoxinA Efficacy and Safety in Adults with Upper-Limb Spasticity Following Stroke: Results from the Open-Label Extension Period of a Phase 3 Study, *Adv Ther*. 2019;36(1):187-199. doi: 10.1007/s12325-018-0833-7.
- Olewnik Ł, Wysiadecki G, Polgaj M, Podgórski M, Jezierski H, Topol M. Anatomical variations of the palmaris longus muscle including its relation to the median nerve - a proposal for new classification. *BMC Musculoskelet Disord BMC series - open, inclusive and trusted*. 2017;18(1):539. doi: 10.1186/s12891-017-1901-x.
- Popescu MN, S vulescu S, Dumitru L, Dinu H, Teodorescu M, Mustafa E, Berteau M. Effects of botulinum toxin type A on spasticity and hand function. *Palestrica Third Mill - Civiliz Sport* 2018;19(2):86-91. doi: 10.26659/pm3.2018.19.2.86.
- Simpson DM, Hallett M, Ashman EJ, Comella CL, Green MW, Gronseth GS, Armstrong MJ, Gloss D, Potrebic S, Jankovic J, Karp BP, Naumann M, So YT, Yablon SA. Practice guideline update summary: botulinum neurotoxin for the treatment of blepharospasm, cervical dystonia, adult spasticity, and headache: report of the Guideline Development Subcommittee of the American Academy of Neurology. *Neurology*. 2016;86(19):1818-1826. doi: 10.1212/WNL.0000000000002560.
- Thibaut A, Wannez S, Deltombe T, Martens G, Laureys S, Chatelle C. Physical therapy in patients with disorders of consciousness: Impact on spasticity and muscle contracture. *NeuroRehabilitation*. 2018;42(2):199-205. doi: 10.3233/NRE-172229.
- Tok F, Özçakar L, Safaz , Alaca R. Effects of Botulinum toxin A on the muscle architecture of stroke patients: An Ultrasonographic Study. *J Rehabil Med* 2011;43(11):1016-1019. doi: 10.2340/16501977-0876.
- Trompetto C, Marinelli L, Mori L, Puce L, Pelosin E, Serrati C, Fattapposta F, Rinalduzzi S, Currà A. Do flexible inter-injection intervals improve the effects of botulinum toxin A treatment in reducing impairment and disability in patients with spasticity? *Medical Hypotheses*, 2017;102:28-32. doi:10.1016/j.mehy.2017.03.011
- Truong DD, Gollomp SM, Jankovic J, LeWitt PA, Marx M, Hanschmann A, Fernandez HH; Xeomin US Blepharospasm Study Group. Sustained efficacy and safety of repeated incobotulinumtoxinA (Xeomin®) injections in blepharospasm. *J Neural Transm (Vienna)*. 2013;120(9):1345-1353. doi: 10.1007/s00702-013-0998-9.
- Walker HW, Lee MY, Bahroo LB, Hedera P, Charles D. Botulinum toxin injection techniques for the management of adult spasticity. *PM R*. 2015;7(4):417-427. doi: 10.1016/j.pmrj.2014.09.021.
- Willenborg MJ, Shilt JS, Smith BP, Estrada RL, Castle JA, Koman LA. Technique for iliopsoas ultrasound-guided active electromyography directed botulinum A toxin injection in cerebral palsy. *J Pediatr Orthop* 2002;22(2):165-168.

Websites

- (1) Royal College of Physicians, Spasticity in adults: management using botulinum toxin. National Guidelines. 2009, London Available at: [https://www.kcl.ac.uk/lsm/research/divisions/cicelysaunders/attachments/Spasticity in adults management using botulinum toxin National guidelines.pdf](https://www.kcl.ac.uk/lsm/research/divisions/cicelysaunders/attachments/Spasticity%20in%20adults%20management%20using%20botulinum%20toxin%20National%20guidelines.pdf). Accessed online: July 6, 2017.

Relationship between competitive anxiety and mental toughness: a latent regression analysis

R zvan Kalinin ¹, Róbert Balázsi ², Imre Péntek ², tefania Duic ², Iacob Han iu ¹

¹ Faculty of Physical Education and Sport, “Babe -Bolyai” University, Cluj-Napoca, Romania

² Faculty of Psychology and Educational Sciences, “Babe -Bolyai” University, Cluj-Napoca, Romania

All authors have equal contributions to this study.

Abstract

Background. One of the most discussed relationships in sports psychology is the relationship between competitive anxiety and sport performance. Competitive anxiety was found to be influenced by individual factors. An important psychological concept found to be related to competitive anxiety is mental toughness, which is defined as the superior mental qualities of an athlete that sustain success and excellence in sports.

Aims. The aim of the present study was to investigate the relationship between mental toughness and competitive anxiety among athlete students.

Methods. Participants were 140 athletes from secondary sport schools, handball players, aged between 13 to 19 years ($m = 15.97$, $SD = 1.622$). Self-reports were obtained from all athletes regarding their mental toughness (Sport Mental toughness Questionnaire) and their competitive anxiety (Sport Anxiety Scale-2). Data were analyzed using Structural Equation Modeling framework.

Results. Correlation between Sport Mental Toughness scales ranged between $r=.289$ and $r=.489$. Correlation for Sport Anxiety Scale dimensions ranged between $r=.418$ and $r=.633$, all of them being positive. Standardized path indicator between Sport Mental Toughness and Sport Anxiety Scale was $-.843$, which explains almost 71% of the latent endogenous variance ($R^2=.711$).

Conclusions. The results of the current study highlighted the relationship between mental toughness and competitive anxiety.

Key words: mental toughness, competitive anxiety, latent regression analysis.

Introduction

“Competitive trait anxiety is a personality disposition, akin to (trait) test anxiety, that reflects an individual’s tendency to perceive threat and experience stress in situation that involve sport competition” (Lewthwaite & Scanlan, 1989). Athletes with higher levels of competitive anxiety experience states involving irrational fear or transient physical and psychological tension more frequently and more intensely in situation than athletes with lower levels of competitive anxiety (Amanendra et al., 2018). According to Martens (1977), anxious athletes believe that necessary cognitive resources are not available to meet the challenges posed by the environment. As a result of this imbalance between demands and cognitive resources, they will experience higher levels of stress and anxiety.

One of the most discussed relationships in sports psychology is the relationship between competitive anxiety

and sport performance (Woodman & Hardy, 2001). Due to the impact that anxiety and negative emotions may have on athletes’ performance, this research topic has attracted much attention (Neil et al., 2007; Mellalieu et al., 2006). Burton (1990) suggests that an athlete’s experiences related to anxiety symptoms must not necessarily be perceived as detrimental to performance. Mahoney & Avenier (1977) and Parfitt et al. (1990) maintain that anxiety-related symptoms can help some athletes in terms of mental preparation and performance, although some researchers disagree with the definition of anxiety that facilitates performance, arguing that this premise was fundamentally confused with negative emotions and that a number of top anxiety researchers mislabeled positive emotions as “anxiety” (Burton 1990). Despite some opinions that anxiety cannot facilitate sports performance, over 40 studies examining this direction were published in research journals, making the direction one of the most prominent areas in competitive anxiety literature

Received: 2019, April 4; Accepted for publication: 2019, April 22

Address for correspondence: Faculty of Psychology and Educational Sciences, Babe -Bolyai University, Cluj-Napoca, Romania, No. 37, Republicii Str.

E-mail: robertbalazsi@psychology.ro

Corresponding author: Róbert Balázsi; robertbalazsi@psychology.ro

<https://doi.org/10.26659/pm3.2019.20.2.70>

(Hanton et al., 2008).

Competitive anxiety was found to be influenced by individual factors, such as achievement goal orientations (Amit, 2016). Research has highlighted that ego-orientation goals are positively associated with performance anxiety, while mastery or task orientation is negatively related to performance anxiety. Similarly, studies found that high performance anxiety is associated with ego-oriented motivation settings, focusing on optimizing and comparing oneself with others, while lower performance anxiety is associated with mastery (task)-oriented climates (Smith et al., 2006). Research results showed a negative relationship between self-esteem and trait anxiety (Brown, 1998; Wylie, 1979; Smith et al., 2006).

Mental toughness (MT) is one of the most important psychological constructs underlying sport performance. Sport mental toughness is defined as the superior mental qualities of an athlete (Gucciardi et al., 2009). In recent years, the concept of MT has been seen as a major pillar of sport performance. The recognition of MT as a psychological construct that sustains success and excellence in sports has led to the need to better understand this concept, as well as to develop incentives and training strategies based on it (Clough et al., 2002; Crust, 2007; Jones et al., 2007; Loehr, 1986; Cowden & Meyer-Weitz, 2016).

MT is defined as “a personal capacity to produce consistently high levels of subjective (e.g. personal goals or strivings) or objective performance (e.g. sales, race time, GPA) despite everyday challenges and stressors as well as significant adversities” (Gucciardi et al., 2014).

Regarding the relationship between MT and stress, stress appraisal, coping and coping effectiveness during competition, higher levels of MT were associated with more problem-focused coping, less emotion-focused and avoidance coping.

There are numerous descriptive and intervention studies that evidence the relationship between MT and competitive anxiety. Hossein et al. (2016) found a significant correlation between MT subscales: confidence, commitment, challenge, control and trait anxiety. A negative correlation between MT and competitive anxiety was also reported by other studies (Algani et al., 2018; Miftakhul, 2018). Intervention studies showed that competitive anxiety can be reduced by increasing mental toughness. Truelove (2014) found that psychological skills associated with MT (such as goal setting, positive self-talk, mental imagery, and relaxation techniques) positively influence pre-competition anxiety and the self-confidence level.

Moreover, some authors (Schaefer et al., 2016; Kaiseler et al., 2009) try to explain the relationship between MT and competitive anxiety, through other important psychological constructs, such as the motivation profiles of athletes, or coping mechanisms. Schaefer et al. (2016) highlights that golfers who scored high on both autonomous and controlled forms of motivation reported lower levels of competition anxiety. Furthermore, golfers who scored high on both autonomous and controlled forms of motivation reported higher levels of MT. Two of the hypotheses of this study were: a. *golfers with motivation profiles higher in autonomous motivation will report lower levels of competition anxiety* and b. *golfers with*

motivation profiles higher in autonomous motivation will report higher levels of mental toughness; in both cases only partial confirmation was evident, because golfers high in autonomous motivation were also high in controlled forms of motivation. Golfers scoring high on MT also reported experiencing less competition anxiety, thus, MT was found to mediate a negative association between motivation and competition anxiety, which confirms a third hypothesis.

Coping effectively with the competitive context was found to be influenced by coping strategies (Kaiseler et al., 2009). Bolger & Zuckerman (1995) maintain that personality traits such as MT may influence the coping process both directly through the choice of the coping strategy and indirectly through the stressor type encountered and its appraisal. Nicholls et al. (2008) reported that a high level of MT is associated with problem or approach coping strategies (mental imagery, effort expenditure, thought control, and logical analysis), but less use of avoidance coping strategies (distancing, mental distraction, and resignation); also they analyzed the relationship between MT and optimism and pessimism, and reported moderate to high correlations between total MT and the six subscales of optimism, whereas negative correlations were found for MT and pessimism.

There are also some studies that failed to find any relation between competitive anxiety and mental toughness. A study conducted by Cowden et al. (2014) on psychological predictors of mental toughness, using reports of tennis coaches and athletes, found a non-significant correlation between competitive anxiety traits and mental toughness. Following the same line of argument, Tahmasebi et al. (2012) conducted a study investigating the relationship between emotional intelligence, competitive anxiety and mental toughness. They reported a significant negative relationship between emotional intelligence and competitive anxiety, a positive significant relationship between MT and emotional intelligence, and no relationship between MT and competitive anxiety.

The existing research regarding the relationship between MT and competitive anxiety offers a mixed picture. There are studies that sustain such a relationship, while other studies failed to replicate these results. Given the existing research context, our study aims to test the correlation between MT and competitive anxiety, using a latent variable approach (Fig. 1), given that the correlation or regression coefficient established at latent level represents a better estimation of the true score, compared to manifest variable correlations.

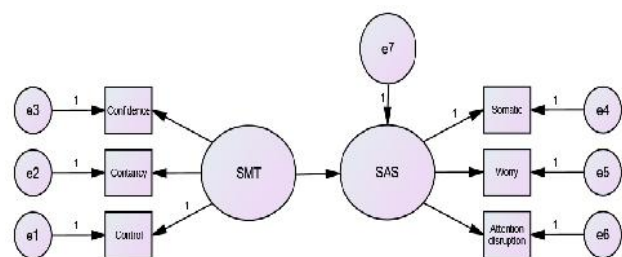


Fig. 1 – The hypothetical model of determination between MT (SMT - Sport Mental Toughness) and competitive anxiety (SAS – Sport Anxiety Scale)

Hypothesis

Based on the conceptualization by Gucciardi et al. (2014), we predicted that athletes with higher levels of mental toughness tend to interpret problems as challenges and even under adverse circumstances are less anxious.

Material and methods

Research protocol

a) Period and place of the research

This research took place between January 17, 2019 and April 20, 2019, in Cluj-Napoca. Six groups of 25 handball athletes came on different days for data collection. We preferred to work with smaller groups to explain the research requirements more easily and to make it easier to supervise them in order to prevent them from talking to each other.

b) Subjects and groups

The sample in this study consisted of 140 participants, young handball players from secondary sports schools. Their age ranged from 13 to 19 years. There were 92.9% females and 7.1% males. Overall mean age was $m = 15.97$ ($SD = 1.622$), females ($M = 16.06$, $SD = 1.66$) being significantly ($t(138) = 1.986$, $p = .049$) older than males ($M = 15$, $SD = 0.055$). Participation in this study was on a voluntary basis. A total of 147 ratings were obtained, 7 participants were dismissed, given the high rate of missing responses (over 80%).

c) Tests applied

The following tools were used:

Sport Mental Toughness Questionnaire (SMTQ) (Sheard et al., 2009) is a global measure of MT with 14 items designed on three subscales: confidence, constancy and control. Participants respond to items using a 4-point Likert scale, ranging from (1) not at all true, to (4) very true. Sample items include “I have unshakeable confidence in my ability” (Confidence); “I get distracted easily and lose my concentration” (Constancy); and “I get anxious by events I did not expect or cannot control” (Control).

Sport Anxiety Scale-2 (Smith et al., 2006) is a questionnaire that assesses the competitive trait anxiety experienced by athletes before or during competition. The scale has 21 items and measures responses for three factors: somatic anxiety, worry and concentration disruption, based on a four-point Likert scale for the responses, ranging from one (not at all) to four (very much).

Procedure

Following the informed consent obtained from each participant, they were asked to complete the two self-report measures, namely *Sport Mental Toughness Questionnaire* and *Sport Anxiety Scale-2*. Data collection took place in a group setting, at coaches' convenience, during a team meeting or practice session. In both instances, the completed questionnaire was collected immediately after it was filled out. The research assistant administering the questionnaire read the provided instructions verbatim and appropriate measures were taken to ensure anonymity.

d) Statistical processing

Overall fit of the model with the data was assessed by many fit indices: the root mean square error of approximation (RMSEA, <0.08), comparative fit index

(CFI, >0.90), and Tucker Lewis index (TLI, >0.90) (Cheung & Rensvold, 2002; Fabrigar et al., 1999; Hu & Bentler, 1999). Confidence intervals (90%) for RMSEA were provided. A relative Chi-square (Chi-square/degree of freedom, CMIN/DF) was calculated to judge the discrepancy of the model, when the sample size was large. Wheaton et al. (1977) suggested that a value less than 5 could be interpreted as good fit, while Carmines & McIver (1981) considered a CMIN/DF ratio in the range of 2 to 1 or 3 to 1 as an indicator of an acceptable fit. Univariate and bivariate descriptive statistics were conducted using IBM SPSS 23 (SPSS Inc., Chicago, IL, USA), and SEM (Structural Equation Modeling) analysis was conducted using AMOS 21 (Arbuckle, 2012). All correlations and path coefficients were statistically significant at $\alpha = 0.05$ level.

Results

Descriptive, skewness and kurtosis: statistical assumptions were tested prior to using parametric statistics. Data were checked for normality, skewness and kurtosis. Skewness indicators varied between skewness=.243 and skewness=-.374. Similar results were found for kurtosis indicators; their values varied between kurtosis=-.847 and kurtosis=.267. All the estimated confidence intervals for population skewness and kurtosis included zero, a result that could be interpreted as a non-significant deviation from zero. Univariate descriptive statistical indicators are presented in Table I.

Table I
Univariate descriptive statistics of SMT and SAS-2 scale score (N=140)

Variable	Min.	Max.	Mean	Std. Deviation
SMT - Confidence	8.00	23.00	17.22	2.69
SMT - Constancy	6.00	14.00	9.80	1.55
SMT - Control	4.00	16.00	9.71	2.39
SAS-2 - Somatic Anxiety	5.00	16.00	8.71	2.47
SAS-2 - Worry	5.00	20.00	12.43	3.64
SAS-2 - Attention Disruption	5.00	14.00	8.38	2.32

Bivariate correlation: Pearson product-moment correlations examining the relationship between MT and SAS-2 subscales are presented in Table II. Correlation between Sport Mental Toughness scales ranged between $r = .289$ and $r = .489$. All correlation indices were positive, given that neither scale includes reversed items. Correlation for Sport Anxiety Scale dimensions ranged between $r = .418$ and $r = .633$, all of them being positive. We found a medium to strong negative relationship between Sport Mental Toughness and Sport Anxiety Scale scores, ranging between $r = -.086$ and $r = -.568$. There was only one non-significant correlation, between Confidence and Somatic Anxiety subscales (Table II).

Testing for latent structural regression: the results of full SEM analysis showed an excellent fit of the model to the data, $\chi^2(df = 8) = 17.85$, $\chi^2/df = 2.231$, RMSEA = .094 (90% CI for RMSEA = .034-.151), CFI = .96, TLI = .924. The latent regression path coefficient was found to be significant, $\beta = -.694$ ($SE = .138$), $CR = -5.044$ ($p = 0.001$). The standardized path indicator was $-.843$, which explains almost 71% of the latent endogenous variance ($R^2 = .711$).

Table II

Bivariate descriptive statistics for SMT and SAS-2 scale score (N=140)

Variable	1	2	3	4	5	6
1 SMT - Confidence	1					
2 SMT - Constancy	.342**	1				
3 SMT - Control	.289**	.429**	1			
4 SAS-2 - Somatic Anxiety	-.086	-.179*	-.418**	1		
5 SAS-2 - Worry	-.377**	-.357**	-.568**	.555**	1	
6 SAS-2 - Attention Disruption	-.307**	-.414**	-.480**	.418**	.633**	1

Table III

Unstandardized and standardized factor loadings of the full SEM model (N=140)

Variable	Unstandardized factor loadings	Standard error	CR	p	Standardized factor loadings	R ²
SMT						
Control	1.000	-	-		.758	.575
Confidence	.670	.147	4.569	0.001	.453	.205
Constancy	.473	.086	5.484	0.001	.554	.307
SAS-2						
Somatic Anxiety	1.000	-	-		.604	.365
Worry	2.146	.305	7.031	0.001	.882	.778
Attention Disruption	1.127	.171	6.577	0.001	.727	.529

Table III shows the results of analyses for testing the measurement component of the SEM model. As shown, all standardized factor loadings were above 0.3, indicating a good local fit of the measurement models.

Discussions

Competitive anxiety was found to be one of the most important individual factors that influence sport performance. Competitive anxiety affects performance through physiological and cognitive mechanisms and also interferes with emotion regulation processes (Neil et al., 2007; Mellalieu et al., 2006; Burton, 1990). Competitive anxiety is influenced by a lot of individual factors such as the psychological coping mechanism, motivation, and more recently it was found to be related to mental toughness.

Research regarding the relationship between MT and competitive anxiety is somehow puzzling (Hanton et al., 2008). There are correlational and experimental studies that offer empirical support to the relationship between anxiety and MT (Mahoney & Avenier, 1977; Parfitt et al. 1990). At the same time, studies failed to find any relationship between these two variables (Cowden et al., 2014). Confirming a research hypothesis depends on a multitude of methodological (e.g. scale reliability, discriminant validity of the scales, etc.) and statistical factors (e.g. standard error of estimates). Such factors could explain some fluctuation of the estimated correlations and could be factors that affect the chance of replication (Fabrigar et al., 1999).

Our study tried to control some of these methodological factors using a latent regression approach. One main advantage of SEM modeling, compared to correlations estimated at a manifest variable level, is that it is not affected by measurement errors (Cheung & Rensvold, 2002). By estimating correlations between latent scores, instead of manifest variables, we are estimating relationships between true scores (Arbuckle, 2012).

Using a cross-sectional descriptive design, we tested a latent regression model, having the MT latent variable as a predictor and sport anxiety as a criterion. We found that the measurement model of both scales has an acceptable fit to data. More importantly, we found a significant regression coefficient between these two latent variables; mentally tough athletes tend to be less anxious. This result fits the existing conceptual definition of MT. According to these findings, mentally tough individuals are characterized by high levels of control, commitment and constancy, even under adverse circumstances, and tend to interpret problems as challenges (Gucciardi et al., 2014). This type of motivational and cognitive approach could explain why mentally tough athletes usually experience less anxiety (Schaefer et al., 2016). Formulating in terms of anxiety, mentally tough individuals are less inclined to interpret ambiguous information or high-pressure competitive situations as threatening and to respond with dysfunctional thoughts and maladaptive behavior (Hossein et al., 2016).

Our results offer more empirical support to our research hypothesis that MT would influence competitive anxiety. This would suggest that being in control of one's emotions might be of benefit to athletes while competing (Kaiseler et al., 2009).

Conclusions

1. CFA analysis showed that Sport Metal Toughness Questionnaire is a self-report instrument with sound psychometric characteristics.

2. The obtained results of latent regression analysis support the influence of mental toughness, as a personality trait-like individual characteristic, on competitive anxiety. As a consequence, any intervention that will increase athletes' mental toughness will also indirectly contribute to reducing the sport anxiety level.

Conflicts of interests

The authors declare that there is no conflict of interest.

Acknowledgements

The present research paper is part of a larger research project that investigates the concept of mental toughness and the possibilities to increase mental toughness in sport. All authors have equally contributed to the elaboration of the research design, data collection and writing of the research paper.

References

- Algani PW, Yuniardi MS, Masturah AN. Mental Toughness Dan Competitive Anxiety Pada Atlet Bola Voli. *J Imiah Psikologi Terapan*, 2018;6(1):93-101.
- Amanendra M, Gurmeet S, Himanshu H. Mental toughness and competitive anxiety between high and low performer's football players. *Int J Physiol Nutr Phys Educ*. 2018;3(1):938-941.
- Amit K. A study on mental toughness and sports competition anxiety for male and female basketball players. *Int J Phys Educ Sports Health*. 2016;3(2):379-381.
- Arbuckle JL. Users Guide. IBM® SPSS® Amos 21. Available at: ftp://public.dhe.ibm.com/software/analytics/spss/documentation/amos/21.0/en/Manuals/IBM_SPSS_Amos_Users_Guide.pdf, 2012.
- Bolger, N, Zuckerman A. A framework for studying personality in the stress process. *J Pers Soc Psychol*. 1995;69(5):890-902.
- Burton D. Multimodal stress management in sport: current status and future directions. In Jones G, Hardy L (Eds.) *Stress and performance in sport*. Chichester, UK: Wiley. 1990, 171, 201.
- Brown JD. *The self*. New York: McGraw-Hill, 1998.
- Carmines EG, McIver JP. Analyzing Models with Unobserved Variables: Analysis of Covariance Structures. In Bohrnstedt GW, Borgatta EF (Eds.). *Soc Measure: Current Issues* 1981,65-115. Beverly Hills: Sage Publications, Inc.
- Cheung GW, Rensvold RB. Evaluating Goodness-of-Fit Indexes for Testing Measurement Invariance. *Struct Equ Mod*. 2002;9(2):233-255. doi:10.1207/S15328007SEM0902_5.
- Clough P, Earle K, Sewell D. Mental toughness: The concept and its measurement. In I. Cockerill (Eds.). *Solutions in sport psychology*. London, England: Thomson. 2002,32-45.
- Cowden RG, Fuller DK., Anshel MH. Psychological Predictors of Mental Toughness in Elite Tennis: An Exploratory Study in Learned Resourcefulness and Competitive Trait Anxiety. *Percept Motor Skills*. 2014;119(3):661-678. doi: 10.2466/30.pms.119c27z0.
- Cowden R.C., Meyer-Weitz.A. Sports Mental Toughness Questionnaire: Evaluation for use in South African competitive tennis. *J Sport Behav*. 2016;39(4):372-384.
- Crust L. Mental toughness in sport: A review. *Int J Sport Exerc Psychol*. 2007;5(3):270-290. doi:10.1080/1612197X.2007.9671836.
- Fabrigar LR, Wegener DT, MacCallum RC, Strahan EJ. Evaluating the use of exploratory factor analysis in psychological research. *Psychol Meth*. 1999; 4(3):272-299. <http://dx.doi.org/10.1037/1082-989X.4.3.272>.
- Gucciardi DF, Gordon S, Dimmock JA. Advancing mental toughness research and theory using personal construct psychology. *Int Rev Sport Exerc Psychol*. 2009;1(2):54-72. doi: 10.1080/17509840802705938.
- Gucciardi DF, Hanton S, Gordon S, Mallett CJ, Temby P. The Concept of Mental Toughness: Tests of Dimensionality, Nomological Network, and Traitness. *Jl Person*. 2014;83(1):26-44. doi:10.1111/jopy.12079.
- Hanton S, Neil R, Mellalieu SD. Recent developments in competitive anxiety direction and competition stress research. *Int Rev Sport Exerc Psychol*. 2008;1(1):45-57. doi: 10.1080/17509840701827445.
- Hossein A, Mohd RF, Soumendra S, Anwar HH, Muzaimi M. Relationship Between Mental Toughness and Trait Anxiety in Sports. *Int J Pharm Bio Sci*. 2016;7(3): 275-281.
- Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct Equ Mod: Multidisc J*. 1999;6 (1):1-55. doi:10.1080/10705519909540118.
- Jones G, Hanton S, Connaughton D. A framework of mental toughness in the world's best performers. *Sport Psychol*. 2007;21(2):243-264. doi:10.1123/tsp.21.2.243.
- Kaiseler M, Polman R, Nicholls A. Mental toughness, stress, stress appraisal, coping and coping effectiveness in sport. *Pers Individ Dif*. 2009;47(7):728-733. <https://doi.org/10.1016/j.paid.2009.06.012>.
- Loehr J. *Mental toughness training for sports: Achieving athletic excellence*. Lexington, MA: Stephen Greene Press, 1986.
- Lewthwaite R, Scanlan TK. Predictors of competitive trait anxiety in male youth sport participants. *Med. Sci. Sports Exerc*. 1989;21(2):221-229.
- Mahoney M.J, Avenier M. Psychology of the elite athlete: an exploratory study. *Cogn Ther Res*. 1977;1(2):135-141. doi: 10.1007/BF01173634.
- Martens R. *Sport Competition Anxiety Test*. Champaign, IL: Human Kinetics, 1977.
- Mellalieu SD, Hanton S, Fletcher D. A competitive anxiety review: recent directions in sport psychology research. In Hanton S, Mellalieu SD (Eds). *Literature reviews in sport psychology*. Hauppauge NY: Nova Science. 2006, 1-145.
- Miftakhul J, Lina H, Nabila N, Widohardhono R. Anxiety and Mental Toughness Among Athlete Students. *Adv Social Sci, Educ Hum Res*. 2nd Int Conf Educ Innov (ICEI 2018). Vol. 212, 2018.
- Neil R, Fletcher D, Hanton S, Mellalieu SD. Re-conceptualizing competition stress in sport performers. *Sport Exerc Psychol Rev*. 2007;3(2):23-29.
- Nicholls AR., Polman RCJ, Levy AR, Backhouse SH. Mental toughness, optimism, pessimism, and coping among athletes. *Pers Individ Dif*. 2008;44(5):1182-1192.
- Parf tt G, Jones G, Hardy L. Multidimensional anxiety and performance. In Jones G, Hardy L. (Eds.) *Stress and performance in sport*. Chichester, UK:Wiley. 1990, 43, 80.
- Schaefer J, Vella SA, Allen MS, Magee CA. Competition Anxiety, Motivation, and Mental Toughness in Golf. *J App Sport Psychol*. 2016;28(3):309-320. doi: 10.1080/10413200.2016.1162219.
- Sheard M, Golby J, van Wersch A. Progress toward construct validation of the Sports Mental Toughness Questionnaire (SMTQ). *Eur J Psychol Asses*. 2009;25(3):186-193. doi: 10.1027/1015-5759.25.3.186
- Smith RE, Smoll FL, Cumming SP, Grossbard JR. Measurement of multidimensional sport performance anxiety in children and adults: The Sport Anxiety Scale-2. *J Sport Exerc Psychol*. 2006;28(4):479-501. <http://dx.doi.org/10.1123/jsep.28.4.479>.
- Tahmasebi BS, Mirheydari SBG, Kaviri Z, Shaheini S. The Survey of Relationship and Comparison: Emotional Intelligence, Competitive Anxiety and Mental Toughness Female Super League Basketball Players. *Procedia - Soc Behav Sci*. 2012;46:1440-1444. doi: 10.1016/j.sbspro.2012.05.317.
- Truelove AA. *Mental Toughness Training Intervention for Collegiate Track and Field Athletes*. Electronic Thesis and Dissertation Repository. 2303. 2014, <https://ir.lib.uwo.ca/etd/2303>.
- Wheaton B, Muthen B, Alwin DF, Summers G. Assessing Reliability and Stability in Panel Models. *Sociol Method*. 1977;8(1):84-136. doi:10.2307/270754.
- Woodman T, Hardy L. Stress and anxiety. In Singer R, Hausenblas HA, Janelle CM (Eds.) *Handbook of research on sport psychology*. New York: Wiley. 2001, 290-318.
- Wylie RC. *The self-concept* (Vol. 2). Lincoln, NE: University of Nebraska Press. 1979.

Study on locomotor skills development with practical polygon in children aged 11 to 12

Daniel-Andrei Popa, Loredana-Maria Coniu, Dana Badău

Department M2, University of Medicine, Pharmacy, Sciences and Technology, Târgu Mureș, Romania

Abstract

Background. Movements such as walking, running, leaping, jumping, skipping, climbing and crawling are generally considered to be fundamental locomotor skills.

Aims. The aim of this research is to highlight the efficiency of using practical routes to develop the locomotor skills in children aged 11 to 12.

Methods. The research comprised a total of 50 students from “Mihai Viteazul” School, Targu-Mures, who were divided into two equal groups: Group I - students who developed locomotor skills with practical routes selected and implemented in the didactic process, and Group II - students who developed locomotor skills by specific methods of physical education repeated in isolation. The travel time (minutes and seconds) of two practical routes: route A consisting of 12 stations and route B consisting of 11 stations, and the technical level of the following motor skills: balance, jumping, crawling and climbing were registered. **Results.** Regarding the execution of the practical route A, Group I registered 2.11 and Group II 2.16. Group I recorded higher values in the technical skills assessment test compared to group II, the differences being: 0.560 balance, 0.200 jumping, 0.360 crawling, 0.400 climbing. Regarding the execution of the practical route B, Group I registered 1.54 and Group II 2.05. Group I recorded higher values in the technical skills assessment test compared to group II, the differences being: 0.640 balance, 0.200 jumping, 0.360 crawling, 0.200 climbing. In all tests, the values registered were superior to the standard ones, being statistically significant for $p < 0.0001$.

Conclusions. The findings confirm the hypothesis: by using the practical routes in physical education classes, the level of locomotor skills will be optimized.

Key words: physical education, motor skills, locomotion, children.

Introduction

Total-body movements in which the body is propelled in an upright posture from one point to another in a roughly horizontal or vertical direction are called locomotor skills. Fundamental locomotor skills are represented by walking, running, leaping, jumping, skipping, climbing and crawling (David & Frances, 2003).

Humans need their locomotor and non-locomotor skills for purposeful and controlled movement through the environment. All these skills are basic to many activities such as games, dancing and gymnastic activities (David & Frances, 2003). It is well known that locomotor and non-locomotor skills do not develop automatically. Fundamental locomotor movements have phylogenetic (hereditary) bases for the appearance of the initial of several fundamental locomotor movements, and the development to the mature stage depends on ontogenetic (environmental) factors (David & Frances, 2003).

Motor skills are part of the overall ability that enables the successful execution of movements regardless of

whether those are specificities acquired by training or not (Kureli et al., 1975).

Motor skills represent gestures acquired through external intervention, heteronomy (learning in the didactic context), which can be guided, under formal organization (physical education lessons, sports training lessons) or non-formal (various leisure activities, recreation, ensembles and sports circles), by people with specialized professional skills (educators, teachers, sports instructors) (Neagu, 2010).

A major problem in our society is represented by the daily inactivity of young children. A lot of studies have demonstrated a connection between children's activities, their future health status and the trend of progressive inactivity and obesity among children (Sallis, 2000; Krebs & Jacobson, 2003).

Children's motor development can influence the acquisition of other developmental functions such as functional skills, but also cognitive or perceptual skills (Piek et al., 2008).

Received: 2019, May 26; Accepted for publication: 2019, May 28

Address for correspondence: University of Medicine, Pharmacy, Sciences and Technology of Târgu Mureș, Gheorghe Marinescu Str. No. 38, 540139, Romania

E-mail: dana.badau@umfst.ro

Corresponding author: Dana Badău, dana.badau@umfst.ro

<https://doi.org/10.26659/pm3.2019.20.2.75>

Didactic content influences the proper development of motor skills. The exercises must be chosen with the purpose of achieving the development of specific skills, particularly in the selection of children for various sports branches; otherwise, the achievement of the desired goal is unreal (Pejić, 2002). A person without enough daily physical activity can fail to develop fundamental motor skills during primary school years or to learn specialized movement skills (Payne & Isaacs, 2007; Akbari et al., 2009).

Also, a great number of children do not get enough physical activity during puberty, which can contribute to poor somatic and functional development (Dencker, 2007; Westerståhl et al., 2003). It is important to increase physical activity in order to avoid cardiovascular diseases, metabolic and nutritional imbalances, and to promote harmonious body development (Riddoch et al., 2004). Several studies, including the European Youth Heart Study, report increased obesity and cardiovascular disease risk factors in children who are physically inactive (Andersen et al., 2006). For children, fundamental motor skills represent an important factor in motivating them to be physically active and to take part in different social activities. Children with impaired coordination are at risk of becoming solitary and isolated on the school playground because they are not capable of keeping up with those who have properly developed fundamental motor skills (Smyth & Anderson, 2000).

Polygon is a good way to develop motor skills efficiently and can be applied in school physical education. Polygon has the role of developing motor skills by performing a certain number of motor task exercises involving balance, climbing, jumping and crawling, in which the children need to overcome different kinds of obstacles in the shortest possible period of time (Marinkovic et al., 2016).

Objectives

The aim of this research is to highlight the efficiency of using various and complex practical polygons in order to develop the locomotor skills of children aged 11 to 12.

Hypothesis

The hypothesis of this study is that by using various complex practical polygons in the didactic process, the level of development of locomotor skills will be optimized.

Material and methods

Research protocol

All participants provided an informed consent before entering the study protocol.

a) Period and place of the research

This study took place in April-May 2019, at “Mihai Viteazul” School gym.

Between 1-30 April 2019, a polygon was applied to the experimental group, for a period of 8 lessons, while the control group performed standard classes without a polygon.

The groups were tested between 20-25 May 2019, at “Mihai Viteazul” School gym.

b) Subjects and groups

The research included a total of 50 students, aged 11 to 12, from “Mihai Viteazul” School, Targu-Mures, who were divided into two equal groups: an experimental group – students who developed locomotor skills by practical routes selected and implemented in the didactic process, and a control group – students who developed locomotor skills by specific physical education methods repeated in isolation.

c) Tests applied

The travel time (minutes and seconds) of two practical routes: A consisting of 12 stations and B consisting of 11 stations was registered, as well as the technical level of the following motor skills: balance, jumping, crawling and climbing. Each student was individually assessed, and the best execution out of two attempts was recorded.

d) Statistical processing

Statistical indicators calculated: arithmetic average (X), standard deviation (SD), Student t-test using Graphpad 7 Prism software.

Results

Regarding the execution of the practical polygon A, the experimental group registered 2.11 min, and the control group 2.16 min. The experimental group recorded higher values in the technical skills assessment test compared to the group control, the differences being: 0.560 balance, 0.200 jumping, 0.360 crawling, 0.400 climbing (Table I). In all tests, the registered values were superior to the standard ones, being statistically significant for $p < 0.0001$.

Table I
Descriptive statistic of the results for polygon A

Groups	Index	Time	Crawling	Climbing	Balance	Jumping
Experimental group	Average	2.111	9.640	9.680	9.520	9.720
	SD	0.2456	0.4899	0.4761	0.5859	0.4583
	t (df 24)	42.99	98.39	101.7	81.24	106.1
	Coef. of variability	11.63%	5.082%	4.918%	6.155%	4.715%
	p	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Control group	Average	2.164	9.280	9.280	8.960	9.520
	SD	0.2698	0.6782	0.5416	0.7895	0.5099
	t (df 24)	40.10	68.41	85.67	56.74	93.35
	Coef. of variability	12.47%	7.309%	5.836%	8.812%	5.356%
	p	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

t – value of Student test; p – level of statistical significance; SD – standard deviation

Table II

Descriptive statistic of the results for polygon B

Groups	Index	Time	Crawling	Climbing	Balance	Jumping
Experimental group	Average	1.544	9.640	9.680	9.560	9.680
	SD	0.3153	0.4899	0.4761	0.5831	0.4761
	t (df 24)	31.43	98.39	101.7	81.98	101.7
	Coef. cient of variability	15.91%	5.082%	4.918%	6.099%	4.918%
	p	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Control group	Average	2.050	9.280	9.480	8.920	9.480
	SD	0.3033	0.6782	0.5099	0.7024	0.5859
	t (df 24)	33.79	68.41	92.96	63.50	80.89
	Coef. cient of variability	14.80%	7.309%	5.379%	7.874%	6.181%
	p	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

t – value of Student test; p – level of statistical significance; SD – standard deviation

Regarding the execution of the practical polygon B, the experimental group registered 1.58 and the control group 2.05. The experimental group recorded higher values in the technical skills assessment test compared to the group control, the differences being: 0.640 balance, 0.200 jumping, 0.360 crawling, 0.200 climbing. In all tests, the registered values were superior to the standard ones, being statistically significant for $p < 0.0001$ (Table II).

Discussions

The results of our study fit into the trends demonstrated in previous studies on how to develop locomotor skills through complex organizational modalities such as application of polygons designed in accordance with age-specific and physical education.

The main benefit of practical polygons and all kind of dynamic plays consists of an acceleration of motor skill acquisition depending on the complexity and difficulty of the polygons (Berghänel et al., 2015; Hardy et al., 2012). Children with a good level of motor skills will have a better capacity to engage in different physical activities than those with less developed motor skills (Williams et al., 2008; Clif et al., 2009).

Expanding motor skills and promoting an active lifestyle with positive connotations on quality of life and health represent the main objectives of physical education focused on the development of a proactive behavior starting in childhood (Badau, 2017; Moldovan et al., 2010).

Training programs specific to physical education in school, focusing on fundamental motor skill development through various learning experiences, organized in different forms and delivered by physical education specialists, can contribute in a significant way to improving motor capacity, especially in the childhood period (Morgan et al., 2013; Van Capelle et al., 2016).

Conclusions

1. The findings confirm the hypothesis: by using the practical routes in physical education classes, the level of locomotor skills will be optimized.

2. Locomotor skills such as running, skipping, hopping, sliding, climbing and crawling should be learned at an early age and progressively developed as a basis for

future complex motor skills.

3. The learning process has to be a continuous process, and the improvement of locomotor skills underlies the practice of most physical and sports activities.

4. Motor polygons are highly effective, especially in physical education, having an important physical and mental impact on children.

Conflicts of interest

Nothing to declare.

References

- Akbari H, Abdoli B, Shafzadeh M, Khalaji H, Hajhosseini S, Vahid Ziaee V. The effect of traditional games in fundamental motor skill development in 7-9 year-old boys. *Iran J Pediatr* 2009;19(2):123-129.
- Andersen LB, Haaro M, Sardinha LB, Froberg K, Ekelund U, Brage S, Anderssen SA. Physical activity and clustered cardiovascular risk in children: a cross-sectional study. *The European Youth Heart Study. Lancet*. 2006;368(9532):299-304. doi:10.1016/S0140-6736(06)69075-2
- Badau A. Study of somatic, motor and functional effects of practicing initiation programs in water gymnastics and swimming by students of physical education and sports. *Physical education of students*, 2017;21(4):158-164. doi:10.15561/20755279.2017.0402
- Berghänel A, Schülke O, Ostner J. Locomotor play drives motor skill acquisition at the expense of growth: A life history trade-off. *Sci Adv*. 2015;1(7):e1500451. doi:10.1126/sciadv.1500451.
- Clif DP, Okely AD, Smith LM, McKeen K. Relationships between fundamental movement skills and objectively measured physical activity in preschool children. *Pediatr Exerc Sci*. 2009;21(4):436-449.
- David L, Frances C. D. *Developmental Physical Education for All Children*. 4th Edition. Champaign, Illinois: Human Kinetics, 2003.
- Dencker M. *Daily Physical Activity. Body Fat and Aerobic Fitness in Children*. (Doctoral Thesis). Lund: Department of Clinical Sciences. Ingegerd Ericsson 2007, 16.
- Hardy LL, Reinten-Reynolds T, Espinel P, Zask A, Okely AD. Prevalence and correlates of low fundamental movement skill competency in children. *Pediatrics*. 2012;130(2):e390-e398. doi: 10.1542/peds.2012-0345.

- Krebs NF, Jacobson MS. Am Acad Pediatrics, Committee Nutr. Prevention of pediatric overweight and obesity. *Pediatrics*. 2003; 112(2):424-430. doi:10.1542/peds.112.2.424.
- Kureli N, Momirovi K, Stojanovi M, Šturm J, Radojević, Viski -Štalec N. The structure and development of morphological and motor dimensions in youth. Belgrade: Faculty of Physical Education. Doctoral Dissertation Series 2007:69.
- Marinkovic D, Pavlović S, Korovljević D, Dimitrić G, Bogdanovski M. Sport polygon - does it improve fundamental motor skills in children? Conference: Exercise and Quality of Life, Novi Sad: University of Novi Sad, Faculty of Sport and Physical Education. 2016;3:58.
- Moldovan E, Enoiu RS, Zinnes AG. The Role of Outdoor Education Activities in Defining a Healthy Lifestyle. *Bulletin of the Transilvania University of Brasov, Series VIII: Art and Sport*, 2012; 5(54)2:101-108.
- Morgan PJ, Barnett LM, Clif DP, Okely AD, Scott HA, Cohen KE, Lubans DR. Fundamental movement skill interventions in youth: a systematic review and meta-analysis. *Pediatrics*. 2013;132(5):e1361-e1383. doi: 10.1542/peds.2013-1167.
- Neagu N. Teoria activităților motrice umane, University Press. Târgu Mureș, 2010.
- Payne V, Isaacs LD. Human Motor Development: a Lifespan Approach. 7th Ed. OH: Blacklick, McGraw Hill Companies; 2007, 281-307.
- Pejić A. Orientation to sporting activities based on morphological and motor attributes of children. 3rd International Scientific Conference "Kinesiology – New Perspectives". Zagreb. 2002:114-118.
- Piek JP, Dawson L, Smith LM, Gasson N. The role of early fine and gross motor development on later motor and cognitive ability. *Hum Mov Sci*. 2008;27(5):668-681. doi: 10.1016/j.humov.2007.11.002.
- Riddoch CJ, Andersen LB, Wedderkopp N, Harro M, Klasson-Heggebo L, Sardinha LB, Cooper AR, Ekelund U. Physical activity levels and patterns of 9-and 15-yr-old European children. *Med Sci Sports Exerc*. 2004;36(1):86-92. DOI:10.1249/01.MSS.0000106174.43932.92.
- Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sport Exerc*. 2000;32(5):963-975.
- Smyth MM, Anderson H I. Coping with clumsiness in the school playground: Social and physical play in children with coordination impairments. *Br J Dev Psychol*. 2000;18(3):389-413. <https://doi.org/10.1348/026151000165760>. doi: 10.1348/026151000165760
- Van Capelle A, Broderick CR, van Doorn N, E Ward R, Parmenter BJ. Interventions to improve fundamental motor skills in pre-school aged children: A systematic review and meta-analysis. *J Sci Med Sport*. 2017;20(7):658-666. doi: 10.1016/j.jsams.2016.11.008.
- Westerstahl M, Barnekow-Bergvist M, Hedberg G, Jansson E. Secular trends in sports: participation and attitudes among adolescents in Sweden from 1974 to 1995. *Acta Paediatr* 2003;92(5):602-609.
- Williams HG, Pfeiffer KA, O'Neill JR, Dowda M, McIver KL, Brown WH, Pate RR. Motor skill performance and physical activity in preschool children. *Obesity (Silver Spring)*. 2008;16(6):1421-1426. doi: 10.1038/oby.2008.214.

Approach to rehabilitation treatment of gait disorders in patients with genu recurvatum

Matei Teodorescu^{1,2}, Marius-Nicolae Popescu^{1,2}, Lumini a Dumitru^{1,2}, Mihai Berteanu^{1,2}

¹ “Carol Davila” University of Medicine and Pharmacy Bucharest

² Medical Rehabilitation Department of the Elias Emergency University Hospital, Romania

Abstract

Background. The definition of genu recurvatum is the presence of more than 5° hyperextension of the knee. Biomechanically, genu recurvatum appears during the stance phase, with the ground reaction force line passing anterior to the knee. From a practical point of view, retraining the gait in patients with genu recurvatum is relatively complex because of diverse etiologies.

Aims. To present multiple approaches of rehabilitation strategies and their outcomes for treating patients with genu recurvatum.

Methods. We performed a systematic literature review in different databases, PubMed, Science Direct, using the following key words: “genu recurvatum”, “knee hyperextension”, “rehabilitation”.

Results. Ten articles met our selection criteria. Three assessed retraining methods (functional electric stimulation or electrogoniometric feedback), five articles focused on orthoses and two articles on botulinum toxin.

Conclusions. Genu recurvatum has a multifactorial etiology mechanism such as spasticity, muscle weakness and many others, and among post-stroke patients almost half of them develop genu recurvatum. Genu recurvatum is a disability factor, affecting gait, the quality of life of patients, generating pain and increasing the risk of fall-related injuries.

Key words: genu recurvatum, rehabilitation, stroke.

Introduction

The definition of genu recurvatum is the presence of more than 5° hyperextension of the knee (Appasamy et al., 2015). Biomechanically, genu recurvatum appears during the stance phase, with the ground reaction force line passing anterior to the knee. Genu recurvatum increases the stance phase duration and promotes gait asymmetry (Woolley, 2001; Bleyenheuft et al., 2010).

From a practical point of view, retraining the gait pattern in patients with genu recurvatum is relatively complex because of diverse etiologies (Bleyenheuft et al., 2010).

Among hemiparetic post-stroke patients, genu recurvatum affects between 40 and 68% of them (Ota et al., 2010). In patients with post-stroke genu recurvatum, the gradual knee hyperextension can cause limitation of functional mobility and joint pathology (Cooper et al., 2012).

From a pathophysiological point of view, different causes of genu recurvatum have been described:

- knee extensor weakness, in which the patient maintains a hyperextension of the knee, keeping the ground reaction force anterior to the knee, preventing the normal lower limb from collapsing. The same mechanism is used by patients with quadriceps weakness after peripheral

paralysis (neuropathy);

- knee extensor spasticity, causing an abnormal extension of the knee during the stance phase;

- gluteal muscle weakness, promoting a forward pelvic tilt, hyperlordosis of the lumbar spine, increased hip flexion and compensatory knee hyperextension;

- knee flexor weakness;

- ankle dorsiflexion range of motion reduction, due to spasticity and/or retraction of the posterior structures of the leg, in which the reduction of ankle dorsiflexion promotes the knee in a hyperextension position due to its inability to move the tibia anteriorly during the stance phase. To avoid this type of hyperextension, the patient has to adopt an equinus gait pattern;

- spasticity and/or retraction of posterior musculo-tendinous structures of the leg restricts the advance of the tibia, generating a hyperextension of the knee (Bleyenheuft et al., 2010).

Loss of proprioception in the lower limb, mostly in post-stroke patients, has also been associated with genu recurvatum, because the patients direct their knee into hyperextension during the late swing phase, locking the knee in extension, or by leaning their trunk forward at heel strike, preventing the collapse of the joint (Ota et al., 2010).

Received: 2019, February 12; Accepted for publication: 2019, March 10

Address for correspondence: Matei Teodorescu, “Carol Davila” University of Medicine and Pharmacy Bucharest, Medical Rehabilitation Department of the Elias Emergency University Hospital, Romania, No. 17, M r ti Av.

E-mail: mateiteodorescu@gmail.com

Corresponding author: Matei Teodorescu; mateiteodorescu@gmail.com

<https://doi.org/10.26659/pm3.2019.20.2.79>

Weak ankle plantar flexors, in particular the gastrocnemius, may have an important role in the presence of knee hyperextension (Cooper et al., 2012).

Material and method

We performed a literature review in different databases: PubMed, Science Direct, using the following key words: *genu recurvatum*, *knee hyperextension*, *stroke*, *rehabilitation*.

Results

Using external devices such as ankle-foot orthosis (AFO), knee orthosis (KO), knee-ankle-foot-orthosis (KAFO), several studies have described the importance of these types of devices for managing patients with genu recurvatum.

In patients with genu recurvatum and foot drop of the ankle, AFOs are largely used, improving the gait pattern and gait speed (Gok et al., 2003). Early stance knee moments in post-stroke patients with genu recurvatum have been improved using an articulated AFO (Fatone et al., 2009).

AFOs have been shown to be effective for the treatment of genu recurvatum in stroke patients when the main cause is spasticity or contracture of the triceps surae muscle (Jagadamma et al., 2010).

In a study on post-stroke patients associating genu recurvatum (n=6), using an articulated ankle-foot orthosis whose plantar flexion resistance was adjustable at four levels using 4 different spring rates (S1–S4), the authors investigated the individual responses to plantar flexion resistance of this device on knee joint kinematics and kinetics, evaluating clinical tests such as: Timed-Up and Go Test (TUG), Modified Ashworth Scale (MAS) of the affected ankle, Manual Muscle Testing (MMT) of the ankle and knee joints, and gait analysis using a Bertec split-belt treadmill and gait parameters from the leg with the AFO in each subject, peak ankle plantar flexion angle, peak ankle dorsiflexion moment, peak knee extension angle and peak knee flexion moment in the second rocker of stance (Kobayashi et al., 2016).

Table I

The range and mean (SD) of ankle and knee joint angle and moment parameters under four spring conditions (S1, S2, S3 and S4) of the ankle-foot orthosis

Knee	Peak knee extension angle	
	Range (°)	Mean (SD) (°)
S1	(-20.51, -2.62)	-10.41 (6.75)
S2	(-18.75, -0.57)	-8.67 (6.39)*
S3	(-17.80, 2.71)	-7.11 (7.55)*
S4	(18.85, 7.54)	-4.92 (9.27)*

An asterisk (*) indicates a significant difference at $P < 0.05$ from S1 with the *post-hoc* Wilcoxon signed-rank test.

Abbreviations: SD, standard deviation

Their results suggested that by individually adjusting the amount of plantar flexion resistance of an articulated AFO under four spring conditions, genu recurvatum in patients with stroke could be improved (Table I). The ankle and knee joint angle and moment parameters showed statistically significant differences among the spring conditions of

the AFO. However, individual analyses showed that the responses to the changes in the plantar flexion resistance of the AFO were not necessarily linear and unique to each subject (Kobayashi et al., 2016).

Knee orthoses (KOs) are prescribed to control genu recurvatum and to provide mediolateral stability (Frontera & DeLisa, 2010). An 8-week prospective, randomized, controlled study on 31 post-stroke patients with chronic symptoms and knee hyperextension was conducted, evaluating the effect of a hinged soft knee orthosis on the gait pattern and symmetry.

Multiple measurements such as spatiotemporal gait parameters and symmetry of the paretic knee angle, muscle activation patterns evaluated with and without the orthosis, were made. In addition, the Berg Balance Scale (BBS), 6-Minute Walk Test, 10-Meter Walk Test (10 MWT), and Timed Up and Go Test were used (Portnoy et al., 2015) (Table II).

Their results showed that improved BBS scores after the subjects ambulated for 4 weeks with the orthosis may indicate a reduced risk of falling, improving quality of life and other fall-related injuries.

Significant improvements in the 10MWT, 6MWT, and TUG scores were also seen. Specifically, in the 6MWT, the increase in distance was greater than 20 m for 13 subjects (41.9%) and greater than 50 m for 8 subjects (25.8%). In the TUG, 7 subjects (22.6%) improved their timing by more than 23%. Additionally, 21 subjects (67.7%) increased their gait velocity by more than 0.1 m/s, as calculated from the 10MWT. In ten subjects (32.3%), gait velocity increased in the 10MWT by at least 0.16 m/s, which is the minimally clinically important difference in stroke patients (Portnoy et al., 2015).

The use of a KAFO in chronic post-stroke hemiplegic subjects (N = 11) resulted in a significant reduction in the knee hyperextension angle when measured by gait analysis (Table III) (Boudarham et al., 2013).

Gait velocity was significantly greater in the KAFO condition than in the control condition (+21%). Stride length and cadence were also significantly greater in the KAFO condition (+15% and +11% respectively). There was no significant difference between the two conditions for step width. Step length of the non-paretic limb was greater in the KAFO condition (14%) and the swing phase duration of the paretic limb was significantly shorter in the KAFO condition (-29%) (Boudarham et al., 2013).

In the stance phase, the peak knee extension (knee hyperextension) of the paretic limb was significantly lower in the KAFO condition compared to the control condition. Peak hip flexion and peak ankle dorsiflexion were significantly greater in the KAFO condition, whereas peak ankle plantar flexion was significantly lower. There were no significant differences between conditions for peak hip extension (or peak knee flexion of the paretic limb or for any of the kinematic parameters of the non-paretic limb) (Boudarham et al., 2013).

As expected, KAFO significantly decreased the primary outcome measure: knee hyperextension of the paretic limb (from -16.2 (11.9)° to -7.6 (7.4)°) during the stance phase. However, the genu recurvatum was not totally resolved (Boudarham et al., 2013).

Table II

Mean and standard deviation of the Berg Balance Scale, 6-Minute Walk Test, 10-Meter Walk Test, Timed Up and Go Test, spatiotemporal gait data, symmetry indices, and the sagittal angle of the paretic knee while the subjects (n =31) walked at baseline without the knee orthosis and after 1 month of ambulating with the orthosis

Indicators	Without the Knee Orthosis		With the Knee Orthosis	
	Mean (Median value)	SD	Mean (Median value)	SD
BBS	36.8	11.4	39.4	10.9
6MWT, m	182.1	102.6	212.1	123.6
10MWT, s	22.9 (18.0)	16.6	21.3 (15)	16.6
TUG, s	26.3 (18)	17.6	23.5 (18)	15.5
Velocity, m/s	0.38 (0.32)	0.25	0.45 (0.44)	0.31
Cadence, steps/min - Temporal data, s	68.7 (75.4)	23.5	73.2 (72.9)	32.1
Stride time	2.37 (1.63)	2.69	2.05 (1.67)	1.28
Step time	1.16 (0.82)	1.24	1.00 (0.83)	0.62
Stance duration	1.83 (1.26)	2.49	1.55 (1.16)	1.30
Swing duration	0.50	0.12	0.50	0.12
Double support	0.73 (0.36)	1.59	0.49 (0.28)	0.52
Single support - Temporal data, % GC	0.50	0.12	0.50	0.12
Stance duration	72.1 (69.4)	9.3	70.7 (69.2)	8.9
Swing duration	27.9 (30.6)	9.3	29.3 (30.8)	8.9
Double support	22.6 (19.3)	10.1	21.7 (18.1)	11.3
Single support	27.8 (31.8)	9.6	29.3	8.6
Stride length	62.4	26.3	69.4	32.8
Step length	32.8	14.1	34.8	14.5
Base width	15.4 (14.7)	6.3	16.2 (15.7)	7.1
Foot progression, degree SI	12.8	9.4	13.3	10.2
Step time	37.2 (32.6)	32.6	36.8 (29.2)	32.8
Stance duration	15.3 (13.9)	11.9	16.0 (13.8)	13.9
Swing duration	34.5	21.5	33.1	15.4
Double support	43.4 (25.4)	41.7	49.5 (36.1)	47.1
Step length	48.2 (23.9)	56.1	39.4 (19.4)	48.5
Base width - Sagittal angle of the paretic knee	18.6 (9.7)	35.2	20.2 (12.7)	18.4
Maximum	32.7	12.4	40.5	12.7
Minimum	8.2 (9.7)	7.2	10.1	9.5
At preswing		10.6	24.9	9.5

Abbreviations: SD, standard deviation; BBS, Berg Balance Scale; 6MWT, 6-Minute Walk Test; 10MWT, 10-Meter Walk Test; TUG, Timed Up and Go Test; GC, gait cycle

Table III

Spatiotemporal and kinematic parameters

Spatiotemporal parameters	Without KAFO		With KAFO	
	Non-paretic side	Paretic side	Non-paretic side	Paretic side
Stance phase duration (%)	78.6 [75.8 (10.2)]	62.3 [62.6 (7.3)] ^c	68.9 [72.3 (8.4)]	59.5 [62.2 (6.2)] ^c
Swing phase duration (%)	21.4 [24.2 (10.2)]	37.7 [37.4 (7.3)] ^c	31.1 [27.7 (8.4)]	40.5 [37.8 (6.2)] ^c
Stance phase duration (s)	0.94 [1.26 (0.70)]	0.77 [1.01 (0.53)] ^c	0.88 [1.08 (0.71)]	0.75 [0.91 (0.58)] ^c
Swing phase duration (s)	0.36 [0.33 (0.10)]	0.60 [0.59 (0.20)] ^c	0.37 [0.36 (0.10)]	0.48 [0.46 (0.20)] ^{c,a}
Stance phase				
Peak hip extension (°)	-2.7 [-4.6 (12.8)]	-2.6 [-3.0 (10.4)]	-7.2 [-7.5 (10.5)]	-0.9 [-2.9 (8.4)]
Peak hip flexion (°)	40.1 [41.5 (9.2)]	28.7 [26.9 (10.0)] ^c	41.2 [38.9 (11.2)]	31.3 [30.6 (9.3)] ^{c,a}
Peak knee extension (°)	7.0 [5.1 (7.4)]	-11.8 [-16.2 (11.9)] ^c	0.6 [2.2 (6.1)]	-7.8 [-7.6 (7.4)] ^{c,a}
Peak knee flexion (°)	35.3 [40.0 (9.1)]	9.1 [13.2 (9.5)] ^c	37.4 [38.3 (6.4)]	14.7 [14.5 (9.3)] ^c
Peak ankle plantar flexion (°)	0.1 [-0.8 (7.6)]	-12.1 [-13.4 (9.7)] ^c	1.0 [0.2 (7.2)]	-3.1 [-5.3 (5.1)] ^{c,a}
Peak ankle dorsiflexion (°)	19.4 [18.3 (7.1)]	0.9 [1.4 (10.4)] ^c	21.0 [19.4 (5.4)]	8.1 [8.2 (5.3)] ^{c,a}
Swing phase				
Peak hip extension (°)	14.5 [7.6 (17.0)]	8.9 [7.2 (12.1)]	5.5 [4.3 (12.3)]	4.7 [4.2 (12.3)]
Peak hip flexion (°)	41.9 [42.5 (10.1)]	32.8 [31.9 (9.5)]	42.7 [41.9 (11.5)]	30.1 [32.8 (9.3)]
Peak knee extension (°)	26.0 [22.7 (15.2)]	0.6 [1.7 (6.7)] ^c	17.4 [15.3 (11.9)] ^b	6.8 [5.5 (7.5)] ^{c,a}
Peak knee flexion (°)	69.0 [64.2 (9.8)]	28.0 [26.9 (16.2)] ^c	68.2 [64.9 (9.7)]	29.5 [28.9 (16.8)] ^c
Peak ankle plantar flexion (°)	8.7 [11.0 (6.3)]	-3.8 [-3.6 (8.1)] ^c	11.9 [11.4 (7.1)]	2.8 [2.6 (5.3)] ^{c,a}
Peak ankle dorsiflexion (°)	-7.3 [-3.5 (10.0)]	-11.4 [-13.3 (8.5)] ^c	-6.9 [-6.1 (9.2)]	-2.6 [-2.4 (4.5)] ^a
Velocity	0.48 [0.57 (0.36)]		0.80 [0.73 (0.34)] ^a	
Stride length (m)	0.82 [0.78 (0.33)]		1.06 [0.92 (0.35)] ^a	
Cadence (step/min)	72.0 [79.2 (25.4)]		65.1 [88.9 (23.4)] ^a	
Width length (cm)	22.3 [21.8 (6.3)]		20.4 [20.9 (5.5)]	
Step length non-paretic limb (m)	0.36 [0.35 (0.18)]		0.44 [0.40 (0.20)] ^b	
Step length paretic limb (m)	0.46 [0.42 (0.16)]		0.52 [0.48 (0.15)]	

Median values for the gait parameters of non-paretic and paretic limbs, without and with KAFO (mean and standard deviation in brackets). ^a Significant difference between the two conditions for the paretic limb (P<0.05). ^b Significant difference between the two conditions for the non-paretic limb (P<0.05). ^c Significant difference between the two limbs (P<0.05).

Despite the fact that a degree of genu recurvatum remained, the mean decrease of around 8° of hyperextension during stance confirmed that the KAFO evaluated in this study is clinically useful for the reduction of genu recurvatum in hemiplegic patients (Boudarham et al., 2013).

The changes in spatiotemporal parameters were mainly due to a decrease in the genu recurvatum during the stance phase and to an increase in paretic limb ankle dorsiflexion during both phases (Boudarham et al., 2013).

In a case series study on hemiparetic post-stroke patients with genu recurvatum, multiple types of orthotic devices were used (ankle-foot orthosis ± heel lift, hinged AFO with an adjustable posterior stop ± heel lift, AFO with dual-channel ankle joint ± heel lift), including KAFO with or without knee joint and injection with botulinum toxin A in case of plantar flexor spasticity (Appasamy et al., 2015).

If the aforementioned measures did not adequately manage the patient's GR, a KAFO with or without knee joints was provided to control the knee and prevent GR. KAFO was prescribed when the aforementioned interventions failed to adequately reduce GR and placed the subject at risk for the development of sagittal plane deviations in the future. One subject who had a severe Achilles tendon contracture required a KAFO after GR failed to improve with botulinum toxin A injections and distal orthotic modifications, including heel lifts. A second subject required a KAFO after a hinged AFO with an APS failed to reduce GR in the setting of a severe proprioceptive deficit at the knee (Appasamy et al., 2015).

In the case of patients with GR associated with pain, a retrospective study (27 patients with 31 knee-ankle-foot orthoses) was conducted on patients who had been fitted with KAFOs in order to alleviate posterior knee pain resulting from GR. Patients included in the study were classified under 3 headings: upper motor neuron pathologies (stroke, multiple sclerosis, Neuro-Behçet's disease, compressive medullary tumors from T1 to T5, spastic hemiparesis after surgery on an epidermoid cyst in the 4th ventricular cavity, Strumpell-Lorrain disease), lower motor neuron pathologies (poliomyelitis, Charcot-Marie-Tooth disease, post-radiotherapy plexitis in L3–S1, Becker's disease, and traumatic musculoskeletal lesions (articular destruction after multiple falls, articular destruction after motorcycle accidents: posterior knee luxation, gunshot to the femur) (Requier et al., 2018).

The mean time spent wearing the orthosis per 24 h was 9.8 h (SD 4.4; range: 2–17) (Requier et al., 2018).

The main outcome was scored using a verbal numeric pain rating scale (VNRS), giving a score out of 100 (where 0 means “no pain at all” and 100 means “worst imaginable pain”) and a verbal rating scale (VRS), where each response option consisted of descriptions of pain. Scores were attributed to the various responses corresponding to different levels of pain intensity: “no pain”, “mild pain”, “moderate pain”, “severe pain”, and “extreme pain”. Secondary outcomes were rated with the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST) (Requier et al., 2018).

After fitting the knee-ankle-foot orthosis, the median VNRS pain score decreased from 85/100 to 25/100 and the

description of pain on VRS decreased from “extreme” to “mild”. The QUEST total score was 4.0. Using a KAFO showed an important improvement in reducing genu recurvatum and alleviating pain (Requier et al., 2018).

Treating a painful genu recurvatum with a knee-ankle-foot orthosis reduced the pain efficiently regardless of patients' diagnosis, and high scores were obtained for patient satisfaction (Requier et al., 2018).

To evaluate the electrical muscle activity and inspect the neuromuscular control system, electromyographic signal or EMG is used (Frontera & DeLisa, 2010).

In Biofeedback (BF) retraining, EMG is the most used form to down-train hyperactive muscles or up-train weak muscles in patients with various sensorimotor deficits, thus further improving patients' control over joints (Frontera & DeLisa, 2010).

Joint angle BF can be efficient for improving joint movement control, even more than EMGBF. When active joint motion is present but limited in patients with neuromotor deficits, compared to EMGBF, joint angle BF might be promising for effective and expeditious recovery of joint control. In addition, angle BF is indicated when the goal of training is the regulation of joint movement, such as correction of genu recurvatum or the control of movement with appropriate timing and coordination (Frontera & DeLisa, 2010).

A prospective, no control group study was conducted on 15 patients; 11 of them performed a full program using multichannel functional stimulation, and only 8 of them had post-stroke knee hyperextension in the stance phase (3–48 months after stroke). The stimulated muscles were the ankle dorsiflexors and flexors, knee flexors and extensors and hip extensors or abductors, and a qualitative gait analysis was made. After the full program ended, 7 of 8 patients had improved knee hyperextension (Stanic et al., 1978).

In the case of electrogoniometric feedback retraining, a prospective, no control group study evaluating the number of beeps after therapy was carried out. After 20 days of electrogoniometric feedback retraining, of which 15 with a physiotherapist and 5 days without one, a decrease in the number of beeps was seen (Hogue & McCandless, 1983).

It is well known that spasticity represents an important disability factor in patients with cerebral palsy. Many studies demonstrated the efficacy of botulinum toxin A (BtA) for the treatment of spasticity affecting the lower limb. In the case of spastic cerebral palsy, genu recurvatum was linked to an equinus deformity (Davis et al., 2000).

A well-known mechanism that explains the influence between equinus deformity and knee extension during the stance phase is that of plantar flexion-knee extension couple (PFKE couple). Authors have demonstrated a correlation during the stance phase of gait between knee extension and ankle plantar flexors (Baddar et al., 2002). Injection of botulinum toxin A into the triceps surae muscles is a well-accepted treatment in the case of dynamic equinus deformity (Baddar et al., 2002). The presence of gastrocnemius and soleus muscle shortening, which occurs in high degrees of spasticity, favors the development of equinus foot and genu recurvatum (Simon et al., 1978; Aiona & Sussman, 2004; Svehli et al., 2010).

Using BtA to reduce the shortening caused by

spasticity of the surae muscles could alleviate the knee hyperextension, despite no increase in knee flexion during the early and midstance phase. Unfortunately, the development of genu recurvatum in subjects with equinus foot is not yet fully understood (Baddar et al., 2002). In a retrospective study, which included 13 children (five female, eight male) with spastic diplegic cerebral palsy, the mean age of the patients was 5 years, before the injection. Examination was performed using a three-dimensional (3-D) gait analysis and clinical examination before BtA injections and at 6 and 18 weeks after BtA injections, according to a standardized protocol (Klotz et al., 2013).

After 18 weeks post-BtA injection into the calf muscles, a reduction of genu recurvatum was observed although patients maintained a mean knee hyperextension of 6.2° (Klotz et al., 2013).

Although maximum dorsiflexion during the stance phase improved at 6 weeks post-BtA treatment (maximum ankle dorsiflexion before treatment was -3.0°, SD, 14.3°; at 6 weeks, maximum ankle dorsiflexion was 6.2°, SD, 14.2°; $p < 0.05$), genu recurvatum did not improve during the stance phase at 6 or 18 weeks post-injection. A significant improvement of knee hyperextension (6.2°) was seen, but genu recurvatum was present in most patients in the stance phase between baseline and 18 weeks after BtA treatment (Table IV) (Klotz et al., 2013).

Table IV

Knee kinematics before and 6 and 18 weeks after BtA injection

Kinematics	Before injections		6 weeks after injections		18 weeks after injections	
	Maximum angle	SD	Maximum angle	SD	Maximum angle	SD
Ankle dorsiflexion in the stance phase	-3.0°	14.3°	6.2*	14.2°	4.5°	10.4°
Ankle dorsiflexion during the gait cycle	1.9°	13.7°	7.2*	10.7°	4.8°	9.8°
Genu recurvatum during midstance	12.4°	9.4°	10.2°	11.4°	6.2°	6.0°

BtA = botulinum toxin; * significant difference ($p < 0.05$ in t-test) compared with the values before injection.

No significant differences were observed at 18 weeks with the numbers available and, as mentioned, the improvements in equinus did not result in relevant improvement of knee hyperextension with the numbers available. None of the patients showed an equinus deformity greater than 20°. Eighteen weeks after the BtA injection, there was significant improvement in ankle dorsiflexion (Klotz et al., 2013).

Discussions

Despite the multiple etiologies of genu recurvatum, almost all rehabilitation approaches show an improvement of it, mainly by using orthotic devices. Using an AFO for reducing genu recurvatum in post-stroke patients with spastic triceps surae or a drop foot etiology has been demonstrated to be efficient. However, in patients with severe knee recurvatum, caused by spasticity or weakness of the knee extensor muscles, the AFO may not be

effective (Woolley, 2001). Also, using an adjusted non-articulated AFO-footwear combination and an articulated AFO with plantar flexion stop was effective in alleviating genu recurvatum (Jagadamma et al., 2010).

In the case of knee orthosis, more than 50% of the subjects increased their gait velocity and stride length while walking with the orthosis, while the differences were not statistically significant. In addition, no significant differences were found in the gait symmetry indices. Temporal parameters were the least affected by the orthosis (Portnoy et al., 2015).

In the instance of knee-ankle-foot-orthosis (KAFO), studies have recommended the usage of this orthotic device for persons who have genu recurvatum with sagittal plane deviations of more than 20° (Fish & Kosta, 1998). KAFOs were initially developed to counteract quadriceps weakness in patients with poliomyelitis (Genêt et al., 1998). Indeed, this type of orthosis mechanically reduces genu recurvatum by preventing knee hyperextension during the stance phase of the gait cycle through a stop in the metal joint, without interfering with knee flexion during the swing phase (Farncombe, 1980; Morinaka et al., 1982; Morinaka et al., 1984).

However, KAFOs are bulky and noticeable, and although they are effective in controlling the knee, they have a significant weight, cosmetic drawbacks, and lack of patient compliance (Bleyenheuft et al., 2010).

Although the onset time of genu recurvatum has not yet been described, in patients with chronic genu recurvatum, using KAFOs showed an important improvement in reducing genu recurvatum and alleviating pain (Boudarham et al., 2013; Requier et al., 2018). Despite the fact that a degree of genu recurvatum remained, the decrease in hyperextension during stance confirmed that KAFO is clinically useful for the reduction of genu recurvatum in hemiplegic patients (Boudarham et al., 2013).

In the case of BtA efficacy on genu recurvatum, studies (Baddar et al., 2002; Klotz et al., 2013) demonstrated a relation between equinus foot and genu recurvatum, mainly in spastic diplegia. After treatment with BtA injection, an improvement of ankle dorsiflexors was seen; nevertheless, genu recurvatum did not show an important improvement at 6 or 18 weeks. Authors took into consideration other causes of genu recurvatum because in most patients, knee hyperextension was maintained. Gastrocnemius muscle weakness induced by BtA injection may explain why genu recurvatum gait did not improve (Klotz et al., 2013).

In post-stroke patients with genu recurvatum of spastic etiologies, studies remain to be conducted on the efficacy of BtA, with or without the usage of an orthosis.

Regarding physical therapy and other physiotherapy rehabilitation treatments, no studies were performed on patients with genu recurvatum irrespective of the etiology.

A few questions remain to be answered: first, the onset of genu recurvatum has not yet been established; secondly, can genu recurvatum be prevented in post-stroke patients in their early gait training; thirdly, once genu recurvatum is present, could it be delayed using multiple rehabilitation approaches, preventing the complications that might occur.

Conclusions

1. Genu recurvatum has a multifactorial etiology mechanism such as spasticity, muscle weakness, and many others. Among post-stroke patients, almost half of them develop genu recurvatum.

2. The use of orthoses was shown to result in a reduction of genu recurvatum despite the etiology, especially in the case of KAFO.

3. Studies show a reduction of genu recurvatum regardless of the management strategies.

4. The association of genu recurvatum and spastic equinus gait, although present in patients with cerebral palsy, has been demonstrated and injection with BtA shows important benefits.

5. In post-stroke patients with lower limb spasticity associated with equinus foot and genu recurvatum, no studies have investigated the effects of BtA.

6. There are no recent studies describing prevention strategies for genu recurvatum.

7. Genu recurvatum is a disability factor, affecting the gait, the quality of life of patients, generating pain and increasing the risk of fall-related injuries.

Conflicts of interest

Nothing to declare.

Acknowledgement

No acknowledgements.

References

- Aiona MD, Sussman MD. Treatment of spastic diplegia in patients with cerebral palsy: Part II. *J Pediatr Orthop B*. 2004;13(3):S13-S38.
- Appasamy M, De Witt ME, Patel N, Yeh N, Bloom O, Oreste A. Treatment strategies for genu recurvatum in adult patients with hemiparesis: a case series. 2015;7(2):105-112. doi: 10.1016/j.pmrj.2014.10.015.
- Baddar A, Granata K, Damiano DL, Carmines DV, Blanco JS, Abel MF. Ankle and knee coupling in patients with spastic diplegia: effects of gastrocnemius-soleus lengthening. *J Bone Joint Surg Am*. 2002;84(5):736-744.
- Bleyenheuft C, Bleyenheuft Y, Hanson P, Deltombe T. Treatment of genu recurvatum in hemiparetic adult patients: a systematic literature review. *Ann Phys Rehabil Med* 2010;53(3):189-199. doi: 10.1016/j.rehab.2010.01.001.
- Boudarham J, Zory R, Genet F, Vigné G, Bensmail D, Roche N, Pradon D. Effects of a knee-ankle-foot orthosis on gait biomechanical characteristics of paretic and nonparetic limbs in hemiplegic patients with genu recurvatum. *Clin Biomech (Bristol, Avon)* 2013;28(1):73-78. doi: 10.1016/j.clinbiomech.2012.09.007.
- Cooper A, Alghamdi GA, Alghamdi MA, Altowaijri A, Richardson S. The relationship of lower limb muscle strength and knee joint hyperextension during the stance phase of gait in hemiparetic stroke patients. *Physiother Res Int*. 2012;17(3):150-156. doi: 10.1002/pri.528.
- Davis EC, Barnes MP. Botulinum toxin and spasticity. *J Neurol Neurosurg Psychiatry*. 2000;69(2):143-147. doi:10.1136/jnnp.69.2.143.
- Farncombe PM. The Swedish knee cage. Management of the hyperextended hemiplegic knee. *Physiotherapy*. 1980;66(1):33-34.
- Fatone S, Gard SA, Malas BS. Effect of ankle-foot orthosis alignment and foot-plate length on the gait of adults with poststroke hemiplegia. *Arch Phys Med Rehabil*. 2009;90(5):810-818. doi: 10.1016/j.apmr.2008.11.012.
- Fish DJ, Kosta CS. Genu recurvatum: Identification of three distinct mechanical profiles. *J Prosthet Orthot* 1998;10(2):26-32.
- Frontera WR, DeLisa JA (eds). *De Lisa's Physical Medicine & Rehabilitation. Principles and Practice*. Vol. I. 5th ed. (Two Vol Set (Rehabilitation Medicine (Delisa)). Lippincott Williams & Wilkins, 2010.
- Genêt F, Schnitzler A, Mathieu S, Autret K, Théfenne L, Dizien O, Maldjian A. Orthotic devices and gait in polio patients. *Ann. Phys. Rehabil. Med*. 2010;53(1):51-59. doi: 10.1016/j.rehab.2009.11.005.
- Gok H, Kucukdeveci A, Altinkaynak H, Yavuzer G, Ergin S. Effects of ankle-foot orthoses on hemiparetic gait. *Clin Rehabil* 2003;17(2):137-139. doi:10.1191/0269215503cr605oa.
- Hogue RE, McCandless S. Genu recurvatum: auditory biofeedback treatment for adult patients with stroke or head injuries. *Arch Phys Med Rehabil* 1983;64(8):368-370.
- Jagadamma KC, Owen E, Coutts FJ, Herman J, Yirrell J, Mercer TH, Van Der Linden ML. The effects of tuning an ankle-foot orthosis footwear combination on kinematics and kinetics of the knee joint of an adult with hemiplegia. *Prosthet Orthot Int*. 2010;34(3):270-276. doi: 10.3109/03093646.2010.503225.
- Klotz MC, Wolf SI, Heitzmann D, Maier MW, Braatz F, Dreher T. The Influence of Botulinum Toxin A Injections into the Calf Muscles on Genu Recurvatum in Children With Cerebral Palsy. *Clin Orthop Relat Res*. 2013;471(7):2327-2332 doi: 10.1007/s11999-013-2897-7.
- Kobayashi, Orendurf MS, Singer ML, Gao F, Daly WK, Foreman KB. Reduction of genu recurvatum through adjustment of plantar flexion resistance of an articulated ankle-foot orthosis in individuals post-stroke. *Clin Biomech (Bristol, Avon)*. 2016; 35:81-85. doi: 10.1016/j.clinbiomech.2016.04.011.
- Morinaka Y, Matsuo Y, Nojima M, Inami Y, Nojima K. Biomechanical study of a knee ankle-foot-orthosis for hemiplegic patients. *Prosthet Orthot Int*. 1984;8(2):97-99. DOI:10.3109/03093648409145356.
- Morinaka Y, Matsuo Y, Nojima M, Morinaka S. Clinical evaluation of a knee-ankle-foot-orthosis for hemiplegic patients. *Prosthet Orthot Int*. 1982;6(2):111-115. DOI:10.3109/03093648209166778.
- Ota S, Ueda M, Aimoto K, Suzuki Y, Sigward SM. Acute influence of restricted ankle dorsiflexion angle on knee joint mechanics during gait. *Knee* 2014;21(3):669-675. doi: 10.1016/j.knee.2014.01.006.
- Portnoy S, Frechtel A, Raveh E, Schwartz I. Prevention of Genu Recurvatum in Poststroke Patients Using a Hinged Soft Knee Orthosis. *PM & R*. 2015; 7(10):1042-1051. doi: 10.1016/j.pmrj.2015.04.007.
- Requier B, Bensoussan L, Mancini J, Delarque A, Viton JM, Kerzouf M. Knee-ankle-foot orthoses for treating posterior knee pain resulting from genu recurvatum: Efficiency, patients' tolerance and satisfaction. *J Rehabil Med*. 2018;50(5):451-456. doi: 10.2340/16501977-2333.
- Simon SR, Deutsch SD, Nuzzo RM, Mansour MJ, Jackson JL, Koskinen M, Rosenthal RK. Genu recurvatum in spastic cerebral palsy: report on findings by gait analysis. *J Bone Joint Surg Am*. 1978;60(7):882-894.
- Stanic U, Acimovic-Janezic R, Gros N, Trnkoczy A, Bajd T, Kljajic M. Multichannel electrical stimulation for correction of hemiplegic gait. Methodology and preliminary results. *Scand J Rehabil Med* 1978;10(2):75-92.
- Svehlik M, Zwick EB, Steinwender G, Saraph V, Linhart WE. Genu recurvatum in cerebral palsy-part A: influence of dynamic and fixed equinus deformity on the timing of knee recurvatum in children with cerebral palsy. *J Pediatr Orthop B*. 2010;19(4):366-372. doi: 10.1097/BPB.0b013e32833a5f72.
- Woolley SM. Characteristics of gait in hemiplegia. *Top Stroke Rehabil* 2001;7(4):1-18. doi:10.1310/JB16-V04F-JAL5-H1UV.

REVIEWS

Cryotherapy in athletes

Valeria Laza

*Hygiene Discipline, Department of Community Medicine, “Iuliu-Haieganu” University of Medicine and Pharmacy Cluj-Napoca, Romania***Abstract**

Topical cryotherapy procedures such as ice packs, cold-water immersion or cold-water ingestion have been used since ancient times to cure malaise or pain and to improve health and recovery. Since the 1970s the Japanese have invented whole-body cryotherapy, using special closed rooms where the temperature is gradually decreased by using liquid nitrogen.

In the world of sport, cryotherapy is now used in most clubs as a highly effective procedure for preparing and fostering pre-competitive athletes, for recovery after race and sport injuries, and to extend the competitive life of athletes.

Despite the numerous studies demonstrating the positive influence of cryotherapy on muscle recovery and damage, the optimal protocol remains insufficiently studied and established, and investigations are still not unanimous on the results.

More studies are required to determine the method security and to track the effects on athletic performance.

Key words: cryotherapy, athletes, recovery.

Introduction

Like other warm-blooded animals, humans can maintain their core temperature constant (at about 37°C) irrespective of the temperature variations in the air, due to a dynamic equilibrium between the two opposite mechanisms of thermoregulation: thermogenesis (heat production by cell metabolism) and thermolysis (heat loss, especially in the skin).

When exposed to an excessively hot or excessively cold microclimate, the body will try to increase thermolysis (to avoid hyperthermia) or accelerate thermogenesis (to avoid hypothermia).

Exposure to a cold microclimate stimulates peripheral thermoreceptors and puts into action mechanisms of thermoregulation: the sympathetic nervous system causes increased secretion of adrenaline with peripheral vasoconstriction (to reduce heat losses), increased heart rate and blood pressure, increased muscle contraction (about 10 contractions per second) – shivering (Liu et al., 2015). Peripheral vasoconstriction is accompanied by muscle vasodilation and blood flow is directed to the core of the body in order to preserve normal body temperature (37°C) and to sustain vital functions. Increased circulation in organs and tissues means better oxygenation, promotes a better disposal of waste (including accumulated lactate in muscle) and improves healing of muscle microlesions (Kenny & Flouris, 2014).

Reducing the skin temperature below 13°C stimulates

liver metabolism and muscle reactions allowing calories burning, improves blood circulation, relieves pain, and reduces inflammation (Caldwell et al., 2018; White & Wells, 2013; Mawhinney et al., 2013).

As early as 2500 BCE, cold was used by Egyptians to treat injuries and inflammation (Freiman & Bouganim, 2005).

Frostbite and hypothermia, which can lead to death in the poorest and most fragile (homeless) individuals, are the effects of extreme exposure to cold air. Cold has been used medically since ancient times, especially in Egypt and Greece, where cold immersion was used to cure malaise or pain (Ziemann et al., 2014).

Since the 1700s, cold therapy (from the Greek ‘cryo’ = cold) has been used to improve health and recovery, to slow cell aging, to promote weight loss, and alleviate muscle spasms - subjects soaked in ice baths or in cold tubs (Méline et al., 2017).

Over time, cryotherapy (CT) procedures used rather topically have applied external cold, such as: ice packs (Tseng et al., 2013), ice cuffs (Pointon & Dufeld, 2012), extreme cold air (Guilhem et al., 2013), ice sprays (Leicht et al., 2009), CO₂ torch, alternation of cold-hot water, cooling vests (Minnet et al., 2012), cold-water immersion (4°C-15°C) of the lower part of the body (CWI) (Ingram et al., 2009; Diong & Kamper, 2013; Diong & Kamper, 2014; Stephens et al., 2017; White et al., 2014), or other combinations of these methods, such as cold-water

Received: 2019, March 18; Accepted for publication: 2019, March 25

Address for correspondence: “Iuliu Haieganu” University of Medicine and Pharmacy Cluj-Napoca, Romania, 400349, Louis Pasteur Str. No. 6

E-mail: v_laza@yahoo.com

Corresponding author: Valeria Laza, v_laza@yahoo.com

<https://doi.org/10.26659/pm3.2019.20.2.85>

ingestion (Fröhlich et al., 2014; Hue et al., 2013; Stanley et al., 2010; Tran et al., 2015); the latter procedure has led to conflicting results (Hue et al., 2013). Although local cryotherapy and immersion in cold water seem to be effective ways to fight muscle inflammation, these methods do not realize unanimity (Hausswirth et al., 2011; Hausswirth et al., 2013; Wilson et al., 2019).

Modern CT techniques consist of placing the subject in a closed room where the temperature is gradually decreased by using liquid nitrogen, allowing cryotherapy of the whole body (WBC). The Japanese invented this type of therapy in the 1970s, and cryotherapy was introduced into clinical practice (Yamauchi et al., 1981; Lombardi et al., 2017). Initially, this therapeutic method was used in the treatment of patients with multiple sclerosis or rheumatoid arthritis.

In the world of sport, the application of ice (salt batteries, cold gel, freon, dichloroethane, or other) to trauma or injury areas is a very common habit used since ancient times for pain relief and anti-inflammatory and anti-bleeding effects (Versey et al., 2013).

Limiting vascular permeability (via vasoconstriction and by slowing nerve conduction of the nociceptive message) and therefore the inflammatory process is the main beneficial effect of cold during recovery, thereby reducing muscle pain and bleeding in case of injury (Hausswirth et al., 2011; White & Wells, 2013; Mawhinney et al., 2013). The use of cryotherapy as post-exercise recovery has been increasing in popularity (Hohenauer et al., 2015; Costello et al., 2015), being an alternative to conventional therapies with ice packing (Ferreira-Junior et al., 2014).

The method consists of placing the subject in a chamber (cryoair chamber, closed rooms for one or more people) or a cabin, in which the temperature is gradually decreased to values less than minus 110°C (between -120°C and -180°C), either by using an electric cooling system or by means of liquid nitrogen, which volatilizes in contact with the skin and causes controlled cooling of the body (Hohenauer et al., 2015; Ferreira-Junior, 2014). WBC is a medical practice that must be performed in specialized facilities under the supervision of well-trained personnel (Bieuzen et al., 2015).

Precautions before sessions:

- avoiding sports 30 minutes before the procedure;
- avoiding shower or hot bath 30 minutes before the procedure;
- maintaining a minimum period of 60 minutes after the last meal;
- removal of metal jewelry and piercings;
- protection of keloid scars and areas sensitive to cold.

Cryotherapy (cryosauna) can be applied to the entire body (Whole Body Cryotherapy, WBC) or on certain parts of the body, localized application (Part Body Cryotherapy, PBC). Hausswirth sustains that WBC induces a greater stimulation of the autonomic nervous system compared to PBC (Hausswirth et al., 2013). Cryosauna is used today in therapy centers, hospitals, rehabilitation and training centers, or at the users' home.

In the case of WBC, the subject is minimally dressed (e.g., bathing suit), with adequate protection of the most vulnerable parts of the body: hands, feet, nose and ears

(socks, clogs, headband, and surgical mask to avoid bronchial spasm). He/she enters the vestibule chamber (at minus 60°C for about 30 seconds of body adaptation) and then passes to a special chamber, with strictly controlled temperature and humidity (-110°C to -140°C). During the entire session, the chamber door is closed. Cryogenic gas is delivered in the chamber and allows slowly lowering of the temperature up to -140°C (in 30 seconds), then the temperature remains constant. During exposure, the subject is continuously walking with slow speed (to avoid muscle thermogenesis and so, body heating), and the breath is calm.

The duration of each procedure depends on the patient (possible illness), being generally between 1 and 3 minutes (no more than 3 minutes). The optimal number of sessions is not well established, but there is a strong correlation between the number of procedures and effects. Regarding frequency, 1 or 2 exposures daily could be enough (separated by 3 or 6 hours). The maximum effect of CT is obtained by cooling the skin to a temperature of 8-12°C (1); (2); (3).

It is important to consider some other precautions:

- It is mandatory to remove any sweat before entry to avoid the risk of skin burning and necrosis;
- Access to the chamber is allowed only in the presence of skilled personnel, supervising the procedures (visual and audio contact between patient and skilled personnel during the entire procedure is permanent);
- The entire system can be stopped at any time;
- The subject is free to leave the chamber at any time.

In France, a preliminary physical exam is demanded (skin inspection, symptoms, heart rate, blood pressure, oxygen saturation); in Switzerland, the medical certificate confirming lack of contraindications is not mandatory (Costello et al., 2015; Lombardi et al., 2017).

After CT, the subject is dressed and placed on a bed for 30 minutes, and then he/she can resume sport activities (3); (4).

When the subject leaves the cryosauna, blood vessels dilate, nutrient-rich blood flow increases, favoring in the outlying areas the healing of tissue damage and removal of toxins, and giving a pleasant and comfortable feeling. Heat shock stimulates body hardening (increases the body defenses), reduces pain, enhances joint mobility and triggers a series of reactions that lead to the release of well-being hormones such as endorphins (Rose et al., 2017).

The main accepted and unanimously validated indications of WBC are: inflammatory rheumatism (ankylosing spondylarthritis, rheumatoid arthritis), pain and sports medicine (Peake et al., 2017).

CT in athletes

WBC is now used in most clubs of the world as a highly effective way to develop and maintain a fit body; for immediately preparing and fostering pre-competitive athletes; for recovery after the race and after acute or chronic sports injuries; and to extend the competitive life of athletes (Bertrand & Mesure, 2014).

a) *During the athletes' preparation* (pre-cooling) at the beginning of the season, CT is effective in much faster recovery and avoids the risk of injury due to muscle fatigue

(Wozniak et al., 2007).

b) During intensive training and preparation for competitions (the 3 pre-competitive hours), WBC proved its positive influence on muscle performance (Ziemann et al., 2012). WBC positive effects on performance are due to sympathetic and parasympathetic stimulation systems, and action on the cardiovascular system, oxidative stress and the hormonal system.

- *On the cardiovascular system*, cold produces reflex tachycardia, peripheral vasoconstriction, slight elevation of blood pressure, increased systolic (but not diastolic) ejection volume, increasing muscle blood flow and oxygenation (Fonda et al., 2014).

- *Oxidative stress* is a natural response of the body when exposed to a significant effort (match, race, and workout). It reflects an imbalance between oxidants and antioxidants (overtraining syndrome). A session of WBC determines oxidative stress that is not dangerous to healthy adults. By repeating the sessions, WBC induces an adaptation of the body, increasing antioxidant defense (Lubkowska et al., 2012; Mila-Kierzenkowska et al., 2013). Studies in football, rugby and basketball players, athletes, kayakers, handball, badminton, squash and table tennis players evidenced a significant impact of WBC on reducing the recovery time (Abaidia & Dupont, 2018; Banf et al., 2009; Chan et al., 2016; Lombardi et al., 2013).

- *Hormonal system*. WBC sessions significantly stimulate norepinephrine, a neurotransmitter synthesized by the sympathetic nervous system, increasing arousal, selective attention, vigilance and emergency reactions which are important in sports requiring prompt reflex reactions (fencing, tennis, squash) (Korzonek-Szlacheta et al., 2007).

c) In the post-competition season (Selfe et al., 2014), WBC supports recovery processes after intense physical effort. Like training, athletes' recovery is a key factor of performance and should be planned and organized. Without thorough programming, maintaining the performance level is endangered. Suboptimal recovery of elite athletes often leads to fatigue, impairing the quality of future training sessions and/or competitive performance. A plethora of research studies the impact of cold-water immersion (CWI) and its benefits by reducing intramuscular temperature and metabolism and limiting hypoxic stress and the generation of reactive oxygen species (ROS) (Santos et al., 2012; Smolander et al., 2006).

During exercise, muscles are strained over their limit of elasticity, and induce microscopic injuries accompanied by an increase in muscle enzymes. Microlesions may go unnoticed, but over time they can lead to more serious injuries (rupture, elongation) resulting in immobilization, impossibility of training and participation in the next competition. WBC decreases blood levels of testosterone and estradiol (Korzonek-Szlacheta et al., 2007). Pournot has demonstrated a reduction of inflammatory response after strenuous long-term exercise: increased plasma concentrations of anti-inflammatory cytokines and decreased pro-inflammatory cytokines (Pournot et al., 2011). Broatch maintains that post-exercise cold-water immersion benefits are not greater than the placebo effect (Broatch et al., 2014).

Intense exercise is a stress to the body and can cause delayed onset muscle soreness (DOMS) and alter the markers of muscle damage (increasing the blood levels of several muscle proteins such as creatinine kinase and myoglobin), especially during running or cross-country skiing. Exercise-induced muscle damage negatively impacts performance, so many scenarios of recovery techniques have been imagined: physiological and nutritional approaches, massage, active recovery (ACT) and cryotherapy.

Lindsay Angus (Angus et al., 2017) conducted a research on combative sports athletes (MMA - mixed martial arts, one of the most physically intense forms of exercise), who might benefit from cold-water immersion that reduces DOMS as well as the hypothalamic-pituitary axis and macrophage activation without impairing functional performance.

Adam has demonstrated that WBC applied after intense exercises (one session of WBC at one hour post-exercise is strongly recommended) has a positive influence on muscular recovery and damage (Adam, 2014), improving healing of microlesions, the effect being maintained for another 2 hours after the session. Also, WBC limits the increase in muscle enzymes produced by intense effort (Costello et al., 2012; Costello et al., 2015), but the results are ineffective if WBC is applied 24 hours after strenuous exercise, without any improvement in muscle strength.

In a research on 9 highly trained runners, Hausswirth and coworkers (Hausswirth et al., 2011) found that cryotherapy is a more efficient post-exercise recovery strategy than far infrared (FIR) or passive (PAS) modalities of muscular recovery: maximal muscle strength was recovered 1h after the WBC session, 24h after FIR and was not attained through the PAS technique.

Other researchers have demonstrated that WBC improves sleep quality (Schaal et al., 2013; Bouzigon et al., 2014; Miller et al., 2012; Mila-Kierzenkowska et al., 2009), sleep being important in the recovery process, along with nutrition and hydration.

There are two variants of recovery cryotherapy, always in combination with other therapies (medical, physiotherapy): the first option consists of a single use of the cryogenic cabin after exercise; the second is the use of cryotherapy daily or twice daily, for a period that does not exceed three weeks, leaving a three month break between courses.

Treatment includes 10, 20 or more procedures. Preventive procedures can be carried out daily or every 2-3 days. The frequency of procedures for the treatment of rheumatic diseases or other conditions may increase to 2/ day (with 6 hours between procedures).

Other effects of CT

- WBC causes *some blood effects*: decreases in hemoglobin (Hb), hematocrit (Ht) and red blood cells (RBCs) after 5, 10, and 20 sessions, with recovery of hemoglobinization after 30 sessions; leukocytes either slightly increase or do not change, while platelets are not affected (Hausswirth, 2011; Roberts et al., 2015). Another study (Lombardi et al., 2013) demonstrated changes in the hematological profile of professional rugby players,

after 5 sessions of WBC, five days in a row. However, this study did not have a control group, so it is difficult to discern whether the effects were due to cryotherapy or the cumulative effects of training (Méline et al., 2017).

- *Stimulates the autonomic nervous system* (parasympathetic) and decreases the heart rate (Hausswirth et al., 2013).

- *Increases aerobic capacity* (Schaal et al., 2013). It is well established that, with intensified exposure to cold, oxygen consumption increases. For example, the increase in oxygen consumption under the influence of a cold bath of 25 kcal/m² is 27-30%, and with a cold air bath of 45 kcal/m², it reaches 48-53% (Boujezza et al., 2018).

- *Improves metabolism* by increasing mitochondrial biogenesis (2 sessions of 5 minutes at -8°C are sufficient) (Joo, 2016).

- Local cryotherapy is used for *weight loss* by stimulating fat metabolism (Dulian et al., 2015). It uses temperatures between -2°C and -4°C in sessions of up to 3 minutes. Cryolipolysis destroys up to 80% of the fat cells which can not be removed by other methods.

- Cold therapy causes an *after-effect*, obvious after one treatment cycle. It consists of favorable changes in biochemical indices a long time after exposure to the hardening treatment, in some cases after a few months or even a year. The real situation in the body is characterized by a rhythmic oscillation of vasoconstriction and vasodilation of the skin, thus preventing ischemic damage to tissues (Abaidia & Dupont, 2018; Elias et al., 2012).

Cooling efficiency and, possibly, treatment effectiveness can be influenced by body composition. Due to differences in body composition, cooling efficiency is potentially greater in females than in males (Hammond et al., 2014).

Other uses of cryotherapy

Therapeutic indications of CT are numerous: Rheumatology, Hepatology, Neurology, Cosmetology, Sexology and Urology, Endocrinology, Pulmonology, Cardiology, Dermatology, Orthopedics and Traumatology. Aircryotherapy (ACT) is very effective in recovery from chronic fatigue syndrome, or as a treatment of depressive states. Under the influence of ACT, irritability disappears, the person becomes enthusiastic, and the desire to consume alcohol or sedatives decreases. Objectively, tremor is reduced and autonomic responses (sweating, dystonia) decrease in intensity. Virtually all patients gain health, their performance increases and their sex life improves.

A recent study (Akiko et al., 2017) found that cryotherapy, specifically having chemotherapy patients wear frozen gloves and socks for 90-minute periods, is useful for preventing symptoms of neuropathy (a frequent and disabling side effect of cancer treatment).

Contraindications of CT

Currently accepted contraindications for WBC include: cryoglobulinemia, agammaglobulinemia, cryofibrinogenemia, cold intolerance, Raynaud disease, hypothyroidism, acute respiratory system disorders, cardiovascular system diseases (unstable angina pectoris, cardiac failure stage III and IV), purulent-gangrenous cutaneous lesions, sympathetic nervous

system neuropathies, local blood flow disorders, cachexia, hypothermia, claustrophobia and mental disorders hindering cooperation with the patient during treatment; stroke, fever, active pulmonary tuberculosis, malignant tumors, bleeding diathesis, severe anemia, hypothyroidism, hysterical neurosis, individual intolerance to cold, cold urticaria, pregnancy, open wounds, drugs, as well as subcutaneous devices (Selfe et al., 2014).

Some relative contraindications also exist: age above 65 (WBC is popular among those aged over 65; age is not a serious contraindication if other more important contraindications do not occur), venous thrombosis and a history of peripheral arterial embolism, and excessive emotional lability (Lubowska et al., 2012; Siero et al., 2007).

In children, the precautionary principle is applied (Lubowska et al., 2012) because of thermoregulatory vascular reactions and their effects on cartilage growth, making this method contraindicated in growing patients (under 18 years of age).

When performed under appropriate and controlled conditions, WBC is considered a safe procedure, which was demonstrated to be deleterious neither for lung nor heart function (Banf et al., 2009). Smolander showed the effects of WBC on lung function, causing moderate bronchoconstriction, which raises caution about its use in asthmatics (Smolander et al., 2006).

However, recorded observation of a very slight, clinically irrelevant increase in systolic blood pressure (Lubkowska et al., 2010; Lubkowska & Suska, 2011) justifies precautions indicated for patients affected by cardiovascular conditions.

Side effects of CT

To date, there are insufficient studies to prove CT effectiveness regarding pain reduction or muscle recovery. Too few studies have been conducted on possible adverse effects despite the precautions taken by cryotherapy centers. Some studies have revealed cases of frostbite, while others were not interested in other potential damage to the body.

Hohenauer considers that currently, the effects of cryotherapy on recovery through DOMS, blood plasma markers (including cytokines), performance parameters and the Borg scale (Hohenauer et al., 2015; Krueger et al., 2019) are often unclear in humans.

A group of four specialists in Northern Ireland, France and Australia conducted a series of studies on cryotherapy. According to them, there is little medical evidence that this method really contributes to functional recovery of athletes, and studies have not taken into account the active surveillance of subjects in terms of side effects. The risks can be fatal if exposure takes place without specialized supervision (5).

Conclusions

1. Physical effort is a stress for the body; athletes are prone to injuries and pain. Insufficient recovery after exhausting physical effort can often lead to fatigue, delayed recovery and reduced competitive performance. WBC seems to be a more comfortable, modern and effective

alternative to cold-water immersion, proposed to reduce pain, inflammation, and muscle soreness.

2. Studies on the effects of cryotherapy in athletes are essential both to determine the security of the method and to track its positive or negative effects on athletic performance. It must also be checked whether cryotherapy could mask a doping product or would entail effects that might give the impression that the athlete uses doping products.

3. Cryotherapy proposes many benefits and has become one of the latest trends for athletes and professional teams, clinicians, trainers, as well as for some celebrities. It is considered a helpful approach to muscle recovery, in addition to other recovery techniques: massage, nutritional and physiological approaches, and active recovery. Although the optimal protocol remains insufficiently studied and established, and investigations are still not unanimous on the results, CT could be helpful in healing and relieving pain from muscle or joint inflammation, in improving sleep quality, in recovery after extreme stress and effort. The field of cryotherapy needs to be deepened, many publications showing beautiful perspectives of this method.

Conflict of interest

Nothing to declare

References

- Abaidia A, Dupont G. Recovery strategies for football players. *Swiss Sports & Exercise Medicine*. 2018;66(4):28-36.
- Adam J. Impact de la cryothérapie corps entier sur la récupération musculaire chez le sportif. *Kinésithérapie la Revue*. 2014;14:152-153. doi:10.1016/j.kine.2014.06.002
- Akiko H, Ishiguro H, Sozu T, Tsuda M, Yano I, Nakagawa T, Imai S, Hamabe Y, Toi M, Arai H, Tsuboyama T. Effects of Cryotherapy on Objective and Subjective Symptoms of Paclitaxel-Induced Neuropathy: 5 Prospective Self-Controlled Trial. *J Nat Cancer Inst*. 2017;110(2):141-148. doi:10.1093/jnci/djx178.
- Angus Lindsay, Carr S, Cross S, Petersen C, Lewis JG, Gieseg SP. The physiological response to cold-water immersion following a mixed martial arts training session. *Appl Physiol Nutr Metab*. 2017;42(5):529-536. doi:10.1139/apnm-2016-0582.
- Banf G, Melegati G, Barassi A, Dogliotti G, d'Eril GM, et al. Effects of whole-body cryotherapy on serum mediators of inflammation and serum muscle enzymes in athletes. *J Thermal Biol*. 2009;34(2):55-59. doi:10.1016/j.jtherbio.2008.10.003.
- Bertrand D, Mesure S. La cryothérapie corps entier: une nouvelle approche thérapeutique. *Kinésithérapie Rev*. 2014;14(152-153). doi:10.1016/j.kine.2014.06.004.
- Bieuzen F, Louis J, Hausswirth C. Cryothérapie corps entier et exercice. *Body cryostimulation and exercise*. *Science & Sports*. 2015;30(2):113-118. doi:10.1016/j.scispo.2015.02.002.
- Boujezza H, Sghaier A, Ben Rejeb M, Ben Saad H. Effects of cold water immersion on aerobic capacity and muscle strength of young footballers. *La Tunisie médicale* 2018;96(2):107-112. Project: Immersion en eau froide.
- Bouzigon R, Ravier G, Dugue B, Grappe F. The use of whole-body cryostimulation to improve the quality of sleep in athletes during high level standard competitions. Abstracts from the IOC World Conference on Prevention of Injury & Illness in Sport, Monaco 2014. *Br J Sports Med*. 2014;48(7). doi:10.1136/bjsports-2014-093494.33.
- Broatch JR, Petersen A, Bishop DJ. Postexercise cold water immersion benefits are not greater than the placebo effect. *Med. Sci. Sports Exerc*. 2014;46(11):2139-2147. doi:10.1249/MSS.0000000000000348.
- Caldwell JN, van den Heuvel AMJ, Kerry P, Clark MJ, Peoples GE, Taylor NAS. A vascular mechanism to explain thermally mediated variations in deep-body cooling rates during the immersion of profoundly hyperthermic individuals. *Exp Physiol*. 2018;103(3):512-522. doi:10.1113/EP086760.
- Chan YY, Yim YM, Bercades D, Cheng TT, Ngo KL, Lo KK. Comparison of different cryotherapy recovery methods in elite junior cyclists. *Asia Pac. J. Sports Med. Arthrosc.Rehabil. Technol*. 2016;5:17-23. doi:10.1016/j.asmart.2016.06.001.
- Costello JT, Baker PR, Minett GM, Bieuzen F, Stewart IB, and Bleakley C. Whole-body cryotherapy (extreme cold air exposure) for preventing and treating muscle soreness after exercise in adults. *Cochrane Database Syst. Rev*. 2015;18(9):CD010789. doi:10.1002/14651858.CD010789.pub2.
- Diong J, Kamper SJ. Cold-water immersion (cryotherapy) for preventing and treating muscle soreness after exercise. *Br J Sports Med*. published online, 2013; doi:10.1136/bjsports-2013-092433.
- Diong J, Kamper SJ. Cold water immersion (cryotherapy) for preventing muscle soreness after exercise. *Br J Sports Med*. 2014;48(18):1388-1389. doi:10.1136/bjsports-2013-092433.
- Dulian K, Laskowski R, Grzywacz T, Kujach S, Flis DJ, Smaruj M, Ziemann E. The whole body cryostimulation modifies iris concentration and reduces inflammation in middle aged, obese men. *Cryobiology*. 2015;71(3):398-404. doi:10.1016/j.cryobiol.2015.10.143.
- Elias GP, Wyckelsma VL, Varley MC, McKenna MJ, Aughey RJ. 2012. Effectiveness of water immersion on post-match recovery in elite professional footballers. *Int. J. Sports Physiol. Perform*. 2012;8(3): 243-253.
- Ferreira-Junior JB, Bottaro M, Vieira CA, Soares SR, Vieira A, Cleto VA, Cadore EL, Coelho DB, Simoes HG, Brown LE. Effects of partial-body cryotherapy (-110°C) on muscle recovery between high-intensity exercise bouts. *Int J Sports Med*. 2014;35(14):1155-1160. doi:10.1055/s-0034-1382057.
- Fonda B, De Nardi M, Sarabon N. Effects of whole-body cryotherapy duration on thermal and cardio-vascular response. *J Therm Biol*. 2014;42:52-55. doi:10.1016/j.jtherbio.2014.04.001.
- Freiman A, Bouganin N. History of cryotherapy. *Dermatol Online J*. 2005;11(2):9.
- Fröhlich M, Faude O, Klein M, Pieter A, Emrich E, Meyer T. 2014. Strength training adaptations after cold-water immersion. *J Strength Cond Res* 2014;28(9):2628-2633. doi:10.1519/JSC.0000000000000434.
- Guilhem G, Hug F, Couturier A, Regnault S, Bournat L, Filliard JR, Dorel S. Effects of air-pulsed cryotherapy on neuromuscular recovery subsequent to exercise-induced muscle damage. *Am J Sports Med*. 2013;41(8):1942-1951. doi:10.1177/0363546513490648.
- Hammond LE, Cuttall S, Nunley P, Meyler J. Anthropometric Characteristics and Sex Influence Magnitude of Skin Cooling following Exposure to Whole Body Cryotherapy. *Biomed Res Int*. 2014;2014:628724. doi:10.1155/2014/628724.
- Hausswirth C, Louis J, Bieuzen F. Effects of Whole-Body Cryotherapy vs. Far-Infrared vs. Passive Modalities on Recovery from Exercise-Induced Muscle Damage in Highly-Trained Runners. *PLoS ONE* 2011;6(12):e27749. doi:10.1371/journal.pone.0027749.
- Hausswirth C, Schaal K, Le Meur Y, Bieuzen F, Filliard JR, Volondati M, Louis J. Parasympathetic activity and blood catecholamine responses following a single partial-body

- cryostimulation and a whole-body cryostimulation. *PLoS One*. 2013;8(8):e72658. doi:10.1371/journal.pone.0072658.
- Hohenauer E, Taeymans J, Baeyens J-P, Clarys P, Clijsen R. The Effect of Post-Exercise Cryotherapy on Recovery Characteristics: A Systematic Review and Meta-Analysis. *Plos One*. 2015;10(9): e0139028. doi: 10.1371/journal.pone.0139028.
- Hue O, Monjo R, Lazzaro M, Baillot M, Hellard P, Marlin L, Jean-Etienne A. The effect of time of day on cold water ingestion by high-level swimmers in a tropical climate. *Int J Sports Physiol Perform*. 2013;8(4):442-451.
- Ingram J, Dawson B, Goodman C, Wallman K, Beilby J. Effect of water immersion methods on post-exercise recovery from simulated team sport exercise. *J Sci Med Sport*. 2009;12(3):417-421. 10.1016/j.jsams.2007.12.011.
- Joo CH. The effects of short-term detraining on exercise performance in soccer players. *J Exerc Rehabil*. 2016;12(1):54-59. doi:10.12965/jer.160280.
- Kenny GP, Flouris A. The human thermoregulatory system and its response to thermal stress. In: *Protective Clothing. Managing Thermal Stress. Project: Understanding and addressing the environmental drivers of poor outcomes in human health, productivity, and performance*. 2014, 319-365. doi:10.1533/9781782420408.3.319.
- Korzonek-Szlacheta I, Wielkoszyński T, Stanek A, Swietochowska E, Karpe J, Siero A. Effect of whole body cryotherapy on the levels of some hormones in professional soccer players. *Endokrynol Pol*. 2007;58(1):27-32.
- Krueger M, Costello JT, Achtzehn S, Dittmar, KH, Mester J. Whole-body cryotherapy (-110 degrees C) following high-intensity intermittent exercise does not alter hormonal, inflammatory or muscle damage biomarkers in trained males. *Cytokine*. 2019; 113:277-284. doi:10.1016/j.cyto.2018.07.018.
- Leicht AS, Sinclair WH, Patterson MJ, Rudzki S, Tulppo MP, Fogarty AL, Winter S. Influence of postexercise cooling techniques on heart rate variability in men. *Exp Physiol*. 2009;94(6):695-703. doi: 10.1113/expphysiol.2009.046714.
- Liu C, Yavar Z, Sun Q. Cardiovascular response to thermoregulatory challenges. *Am J Physiol Heart Circ Physiol*. 2015; 309(11):H1793-H1812. doi:10.1152/ajpheart.00199.2015.
- Lombardi G, Lanteri P, Porcelli S, Mauri C, Colombini A, Grasso D, Zani V, Bonomi FG, Melegati G, Banfi G. Hematological profile and martial status in rugby players during whole body cryostimulation. *PLoS One*. 2013;8(2):e55803. doi: 10.1371/journal.pone.0055803.
- Lombardi G, Ziemann E, Banfi G. Whole-Body Cryotherapy in Athletes: From therapy to stimulation. An updated review of the literature. *Front Physiol*. 2017;8:258. doi:10.3389/fphys.2017.00258.
- Lubkowska A, Szyguła Z, Chudecka M, Fraczek B. Influence of the ten sessions of the whole body cryostimulation on aerobic and anaerobic capacity. *Int J Occup Med Environ Health*. 2010;23(2):181-189. doi:10.2478/v10001-010-0019-2.
- Lubkowska A, Suska M. The increase in systolic and diastolic blood pressure after exposure to cryogenic temperatures in normotensive men as a contraindication for whole-body cryostimulation. *J Thermal Biol*. 2011;36(5):264-268. <https://doi.org/10.1016/j.jtherbio.2011.03.011>.
- Lubkowska A, Dołgowska B, Zbigniew S. Whole-Body Cryostimulation - Potential Beneficial Treatment for Improving Antioxidant Capacity in Healthy Men - Significance of the Number of Sessions. *Plos One*. 2012;7(10):e46352. doi:10.1371/journal.pone.0046352.
- Mawhinney C, Jones H, Joo CH, Low DA, Green DJ, Gregson W. Influence of cold-water immersion on limb and cutaneous blood flow after exercise. *Med Sci Sports Exerc*. 2013;45(12):2277-2285. doi:10.1249/MSS.0b013e31829d8e2e.
- Méline T, Watier T, Sanchez AMJ. Cold water immersion after exercise: recent data and perspectives on "kaumatherapy". *J Physiol*. 2017;595(9):2783-2784. doi:10.1113/JP274169.
- Mila-Kierzenkowska C, Wozniak A, Wozniak B, Drewa G, Rakowski A, Jurecka A, Rajewski R. Whole-body cryostimulation in kayaker women: a study of the effect of cryogenic temperatures on oxidative stress after the exercise. *J Sports Med Phys Fitness* 2009;49(2):201-207.
- Mila-Kierzenkowska C, Jurecka A, Wozniak A, Szpinda M, Augustyńska B, Wozniak B. The effect of submaximal exercise preceded by single whole-body cryotherapy on the markers of oxidative stress and inflammation in blood of volleyball players. *Oxid Med Cell Longev*. 2013;2013:409567. doi: 10.1155/2013/409567.
- Miller E, Markiewicz L, Saluk J, et al. Effect of short-term cryostimulation on antioxidative status and its clinical applications in humans. *Eur J Appl Physiol* 2012;112(5):1645-1652. doi: 10.1007/s00421-011-2122-x.
- Minett GM, Duffield R, Kellett A, Portus M. Effects of mixed-method cooling on recovery of medium-fast bowling performance in hot conditions on consecutive days. *J Sports Sci*. 2012;30(13):1387-1396. doi: 10.1080/02640414.2012.709267.
- Peake JM, Roberts LA, Figueiredo VC, Egner I, Krog S, Aas SN, Suzuki K, Markworth JF, Coombes JS, Cameron-Smith D & Raastad T. The effects of cold water immersion and active recovery on inflammation and cell stress responses in human skeletal muscle after resistance exercise. *J Physiol* 2017;595(3):695-711. doi: 10.1113/JP272881.
- Pointon M, Duffield R. Cold water immersion recovery after simulated collision sport exercise. *Med. Sci. Sports Exerc*. 2012;44(2):206-216. doi:10.1249/MSS.0b013e31822b0977.
- Pournot H, Bieuzen F, Louis J, Filliard JR, Barbiche E, Hausswirth C. Time-Course of Changes in Inflammatory Response after Whole-Body Cryotherapy Multi Exposures following Severe Exercise. *PLoS ONE, Public Library of Science*. 2011;6(7):e22748. doi:10.1371/journal.pone.0022748. hal-01724315.
- Roberts LA, Muthalib M, Stanley J, Lichtwark G, Nosaka K, Coombes JS, Peake JM. Effects of cold water immersion and active recovery on hemodynamics and recovery of muscle strength following resistance exercise. *Am. J. Physiol. Regul. Integr. Comp. Physiol*. 2015;309(4): R389-R398. doi: 10.1152/ajpregu.00151.2015.
- Rose C, Edwards KM, Siegler J, Graham K, and Caillaud C. Whole-body cryotherapy as a recovery technique after exercise: a review of the literature. *Int. J. Sports Med*. 2017;38(14):1049-1060. doi:10.1055/s-0043-114861.
- Santos WOC, Brito CJ, Júnior EAP, Valido CN, Mendes EL, Nunes MAP, Franchini E. 2012. Cryotherapy post-training reduces muscle damage markers in jiu-jitsu fighters. *J. Hum. Sport Exerc*. 2012;7(3):629-638. doi:10.4100/jhse.2012.73.03.
- Schaal K, Le Meur Y, Bieuzen F, Petit O, Hellard P, Toussaint JF, Hausswirth C. Effect of recovery mode on postexercise vagal reactivation in elite synchronized swimmers. *Appl Physiol Nutr Metab*. 2013;38(2):126-33. doi:10.1139/apnm-2012-0155.
- Selle J, Alexander J, Costello JT, May K, Garratt N, Atkins, S, Dillon S, Hurst H, Davison M, Przybyla D, Coley A, Bitcon M, Littler G, Richards J. The effect of three different (-135 degrees C) whole body cryotherapy exposure durations on elite rugby league players. *PLoS One* 2014;9(1):e86420. doi:10.1371/journal.pone.0086420.
- Siero A, Stanek A, Cielar G, Pasek J. Cryorehabilitation - Role of cryotherapy in the contemporary rehabilitation. *Fizjoterapia*. 2007;15(2):3-8.
- Smolander J, Westerlund T, Uusitalo A, Dugué B, Oksa J, Mikkelsen M. Lung function after acute and repeated exposures to extremely cold air (-110 degrees C) during

- whole-body cryotherapy. *Clin Physiol Funct Imaging*. 2006;26:232-234. doi:10.1111/j.1475-097X.2006.00675.x.
- Stanley J, Leveritt M, Peake JM. Thermoregulatory responses to ice-slush beverage ingestion and exercise in the heat. *Eur J Appl Physiol*. 2010;110(6):1163-1173. doi:10.1007/s00421-010-1607-3.
- Stephens JM, Halson S, Miller J, Slater GJ, Askew CD. Cold-water immersion for athletic recovery: one size does not fit all. *Int. J. Sports Physiol. Perform*. 2017;12(1):2-9. doi:10.1123/ijspp.2016-0095.
- Tran Trong T, Riera F, Rinaldi K, Briki W, Hue O. Ingestion of a cold temperature/menthol beverage increases outdoor exercise performance in a hot, humid environment. *PLoS One*. 2015;10(4):e0123815. doi:10.1371/journal.pone.0123815.
- Tseng CY, Lee JP, Tsai YS, Lee SD, Kao CL, Liu TC, Lai C, Harris MB, Kuo CH. Topical cooling (icing) delays recovery from eccentric exercise-induced muscle damage. *J Strength Cond Res*. 2013;27(5):1354-1361. doi:10.1519/JSC.0b013e318267a22c.
- Versey NG, Halson SL, Dawson BT. Water immersion recovery for athletes: effect on exercise performance and practical recommendations. *Sports Med*. 2013;43(11):1101-1130. doi:10.1007/s40279-013-0063-8.
- White GE, Wells GD. Cold-water immersion and other forms of cryotherapy: physiological changes potentially affecting recovery from high-intensity exercise. *Extreme Physiol. Med*. 2013;2(1):26. doi:10.1186/2046-7648-2-26.
- White GE, Rhind SG, Wells GD. The effect of various cold-water immersion protocols on exercise-induced inflammatory response and functional recovery from high-intensity sprint exercise. *Eur J Appl Physiol*. 2014;114(11):2353-2367. doi:10.1007/s00421-014-2954-2.
- Wilson LJ, Dimitriou L, Hills FA, Gondek MB, Cockburn E. Whole body cryotherapy, cold water immersion, or a placebo following resistance exercise: a case of mind over matter? *Eur J Appl Physiol*. 2019;119(1):135-147. doi:10.1007/s00421-018-4008-7.
- Wozniak A, Wozniak B, Drewa G, Mila-Kierzenkowska C. The effect of whole-body cryostimulation on the prooxidant-antioxidant balance in blood of elite kayakers after training. *Eur. J. Appl. Physiol*. 2007;101(5):533-537. doi:10.1007/s00421-007-0524-6
- Yamauchi T, Kim S, Nogami S, Kawano AD. Extreme cold treatment (-150°C) on the whole body in rheumatoid arthritis. *Rev. Rheum* 1981;48(Suppl.):P1054.
- Ziemann E, Olek RA, Kujach S, Grzywacz T, Antosiewicz J, Garszka T, Laskowski R. Five-day whole-body cryostimulation, blood inflammatory markers, and performance in high-ranking professional tennis players. *J. Athl. Train*. 2012;47(6):664-672. doi:10.4085/1062-6050-47.6.13.
- Ziemann E, Olek RA, Grzywacz T, Kaczor JJ, Antosiewicz J, Skrobot W, et al. Whole-body cryostimulation as an effective way of reducing exercise-induced inflammation and blood cholesterol in young men. *Eur. Cytokine Netw*. 2014;25(1):14-23. doi:10.1684/ecn.2014.0349.

Websites

- (1) Available at: http://www.canal-insep.fr/fr_FR/recuperation/la-cryotherapie-corps-entier-en-medecine-du-sport. Accessed online: 28 January 2019.
- (2) Available at: <http://www.cryotherapy.ro/crיותרapia.php>. Accessed online: 12 January 2019.
- (3) Available at: https://www.kinesport.info/cryotherapie-corps-entier-et-recuperation-en-pratique_a2150.html. Erwann Le Corre. Accessed online: 23 January 2019
- (4) Available at: <https://doi.org/10.1371/journal.pone.0139028>. Accessed online: 23 January 2019.
- (5) Available at: <https://doi.org/10.1002/14651858.CD008262.pub2>. Cochrane Database of Systematic Reviews. Cold-water immersion (cryotherapy) for preventing and treating muscle soreness after exercise. Cochrane Systematic Review - Intervention Version published. 2012. Accessed online: 21 December 2018.

RECENT PUBLICATIONS

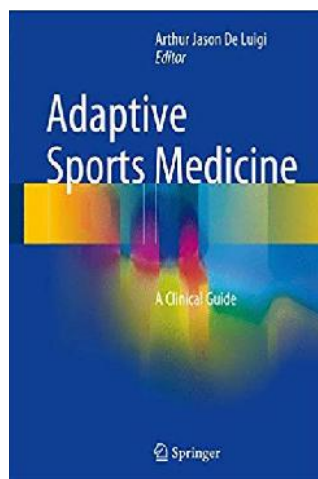
Book reviews

Adaptive Sports Medicine: A Clinical Guide

Editor: Arthur Jason De Luigi

Publishing House: Springer, 2018

402 pages; price: 135.19 €(paper) /107.09 €(eBook)



Together with a really formidable team of 48 collaborators, Prof. Arthur Jason De Luigi from the MedStar National Rehabilitation Hospital/Georgetown University Hospital, internationally recognized as a leader in adaptive sports medicine, provides us with an impressive clinical guide in the field. It is the first-of-its-kind text, comprehensively presenting all the aspects of the domain, which all those professionally interested in this area have been waiting for for a long time, taking into consideration that adaptive athletes – the beneficiaries of such new expertise – are increasingly more involved in sport, both for its positive effects on health and for performance, within local, regional, national or international competitions.

The unique material of the book is distributed in four unequal parts. The first one is dedicated to the conditions and evolutions that have made possible the emergence and development of adaptive sports medicine. Obviously, the most important condition – in fact an absolutely crucial prerequisite – was the implementation and evolution of policies and legislation in the field of disabled persons' rights, which “created the fertile soil to grow adaptive

sports” (Chapter 1). Apart from this essential legislative framework, the continuous concern and progress in wheelchair sports technology and biomechanics (2), as well as in the technology of adaptive sports prostheses (3) are extremely important.

The next part addresses medical aspects in adaptive sports medicine. Here, those interested will find extensive information on the injury epidemiology in paralympic sports (Chapter 4), as well as the state-of-the-art knowledge about emergent care (6), surgical aspects (7) and rehabilitation of adaptive athletes (8). So that even without any prior knowledge and experience in the field, everyone will understand what can happen within adaptive sports competitions, and will not be intimidated in providing medical care for the respective athletes.

Part three is by far the most voluminous of all, as it consists of over 260 pages and no less than 20 of the 31 chapters of the book. This part starts with three chapters that teach us about adaptive running, cycling, and golf, respectively, and then continues with the 8 adaptive sports practiced by wheelchair athletes: basketball (12), rugby (13), power soccer (14), softball (15), dance (16), fencing (17), curling (18) and tennis and table tennis (19). The aspects related to adaptive volleyball described in Chapter 20 are followed by three sports requiring special conditions, namely water sports (21), ice sled hockey (22) and alpine skiing and para-snowboarding (23), the other sports of this family - extreme sports - being presented in the last chapter (28) of this part, after adaptive throwing (24), shooting (25), weight lifting (26) and combative sports (27).

The next two chapters - 29 and 30 - belonging to part four, address the problems of event planning and of how to promote the benefits of sports participation for individuals with disabilities. The last chapter, entitled *Controversies in adaptive sports*, aims to clarify how the governing bodies – as well as participants in adaptive sports competitions – can make the difference between a fair accommodation and an adaptation (and generally speaking “a solution”) which may provide an unfair competitive advantage.

Gheorghe Dumitru

gdumitru@seanet.ro

EVENTS



INSPECTORATUL ȘCOLAR
JUDEȚEAN CLUJ



The educational health prevention project in rural areas in progress

The educational health prevention project in rural areas, *Sport – an alternative for a healthy life* progresses, taking the form of a *Great educational health prevention project*, by involving an increasing number of rural localities.

The sports competitions in Aghire u-Fabrici (1)

On 16 May 2019, the first edition of the *Valea Nadului*

Cup school sports competition was held in Aghire u-Fabrici. This year, 5 localities in the Nad river valley participated: Aghire u Fabrici, Sânpaul, Mera, Gârbiș, Băciu. The program comprised the following events: 50 m sprint, oina ball throw from standing position, and a mini-football championship separately for boys and girls. The results were as follows:

Place	50 m sprint		Oina ball throw	
	Girls	Boys	Girls	Boys
1	Popa Anca - Aghire u-Fabrici	Cetera Leon - Băciu	Szabo Adrien - Mera	Mocan Ionut - Gârbiș
2	Robotin Anca - Sânpaul	Pop Sergiu - Mera	Smical Mădălina - Gârbiș	Lingurar Andrei - Sânpaul
3	Nagy Celia-Băciu	Pintea Alin - Sânpaul	Rosta Rafaela - Băciu	Cetera Leon - Băciu

Place	Football		General ranking
	Girls	Boys	
1	Ion Alexandru Middle School - Sânpaul	Middle School Aghire u-Fabrici	Constantin Brâncoveanu Middle School - Băciu
2	Constantin Brâncoveanu Middle School - Băciu	Ion Alexandru Middle School - Sânpaul	Ion Alexandru Middle School - Sânpaul
3	Middle School Gârbiș	Constantin Brâncoveanu Middle School - Băciu	Middle School Aghire u-Fabrici

Physical education teachers: Mari Maximiliana-Theona - Ion Alexandru Middle School - Sânpaul; Barto Paula Karina - Constantin Brâncoveanu Middle School - Băciu; Tamăsi Edmond Rolland - Tamăsi Gyula Middle School - Mera; Marian Sergiu - Middle School Aghire u-Fabrici; Alua Tudor Alexandru - Middle School Gârbiș; Director: Mureșan Ancușă Simona; Mayor: Lehen Sorinel-Gelu.

The Annual County School Cup in Athletics (6)

Held on 5 June 2019, this county sports competition introduced at the beginning of this year's program a category for children with special needs, who practiced events specific to this category. Next, the middle schools in Cluj competed by age and sex categories, by teams, in oina ball throw and dribbling with basketball throw.

On 5 June 2019, the *County School Cup in Athletics - 2019, 6th edition*, took place on Cluj Arena Stadium. This year, the mentioned competition was intended for children from rural areas. All the 190 pupils of the 18 rural schools

were awarded medals.

Concomitantly with this sports competition, on the same Cluj Arena stadium, the Transylvania Special Middle School Băciu, in collaboration with the County School Inspectorate, organized the *County Bocce Championship of special schools*, 9th edition, a sports event dedicated to children with motor disabilities. This competition was designed as a modality for the integration of pupils with SEN (special educational needs), and was attended by 33 children from special schools in Cluj county and 12 children from mass education schools.



Prof. Maria Baias surrounded by the pupils of the Transylvania Special Middle School in Băciu commune, Cluj county, participating in the *County Bocce Championship of special schools*, 9th edition, a sports competition dedicated to children with motor disabilities.



Preparation of competitors for the long jump from standing



The competition staff: School Inspector Prof. Cristian Potora, School Inspector Prof. Laura Ionescu, director of Cluj Arena Stadium, Radu Răduț, director of Sports High School - Florin Covaci, Prof. Marcela Gabor and Prof. Mircea Boncu.

<https://doi.org/10.26659/pm3.2019.20.2.93>

Copyright © 2010 by "Iuliu Haieganu" University of Medicine and Pharmacy Publishing



Award ceremony: tefan Pascu Middle School in Apahida and teacher Pojar-Pa cu Florin



Award ceremony: Middle School in C eiu and teacher Anca Cosma

“Gheorghe Moceanu” Symposium (9)

The 9th edition of “Gheorghe Moceanu” Symposium took place on the beautiful stadium in Iclod on 10 June 2019, and brought two novelties this year: an oina game demonstration, theoretically presented by teachers Gal Daniel from the *Constantin Brancu i* Technological High School in Dej and Mihaela Hango from the Middle School in Câ c u. Refereeing was conducted by teacher Cosma Anca in C eiu. The demonstrative activity was performed by the team of the Chiuie ti school. The second novelty

was a competition of traditional folk dances added to the program of the symposium, which was entitled Gheorghe Moceanu 1st edition – 2019. The dances were performed by the teams of the participating schools. The folk dance team of the Special Technological High School for Hearing Impaired in Cluj-Napoca was invited and attended the event. Gheorghe Moceanu is considered to be the f rst physical trainer in Romania who was concerned during his career with acrobatic gymnastics introduced in schools, as well as with the promotion of Romanian folk dances throughout the world.



The symposium was opened by the speeches of the mayor of Iclod commune, Emil Pâr oc, School Inspector Prof. Cristian Potor , the representative of the Teaching Staf Resource Center, Dina Pripon, the director of the Middle School in Iclod, Liana Dobocan



The presentation given by teacher Mihaela Hango as a representative of the Romanian Oina Federation



Presentation of the rules of the oina game by teacher Daniel Gal from the *Constantin Brancu i* Technological High School in Dej.



The practical demonstration was conducted and refereed by teacher Anca Cosma



The f rst place was won by the Dansatorii de pe Some ensemble in Iclod

Cristian Potor , Laura Ionescu
cristipotora@gmail.com
lauraionescu2005@yahoo.com

EVENTS



The annual meeting of veteran athletes of the „U” Club-100 (25)

The Cluj veteran athletes celebrated slightly in advance the centenary of the U Club. This meeting should have been held on the first Saturday of September, but considering that the *Centenary Anniversary of all U Club - 100 sections* will take place on 28th September 2019, the annual meeting of veteran athletes of the U Club was brought forward. This

anniversary of veteran athletes took place on 14 June 2019, in the conference room of Cluj Arena, on the occasion of the International Romanian Athletics Championships. The veteran athletes and coaches of the U Club-100 who attended the event were awarded prizes.



Three of the veteran athletes: Tuka Laszlo, Mircea Pop and Ilarie M gda .



Some “younger” veteran athletes of the U Club: Ioana Ciupei-Dobr u, Draga Com a-Cri an, Vasile Selever. In the second row, Eva Zörgö-Raduly.



The President of the U Club, Ovidiu Vasu, the President of the Romanian Athletics Federation, Florin Florea, and the veteran decathlete Vasile Bogdan.



One of the veteran coaches with the most titles, Prof. Dr. Mircea Alexei



One of the less well-known veteran coaches, Ion M celaru and his wife, Melintia M celaru



Group picture at the end of the reunion of veteran athletes of the U Club-100

Traian Bocu
traian_bocu@yahoo.com

FOR THE ATTENTION OF CONTRIBUTORS

The subject of the journal

The journal has a multidisciplinary nature oriented toward biomedical, health, exercise, social sciences fields, applicable in activities of physical training and sport, so that the dealt subjects and the authors belong to several disciplines in these fields. The main sections are: "Original studies" and "Reviews".

Regarding "Reviews", the main subjects that are presented are: oxidative stress in physical effort; mental training; psychoneuroendocrinology of sport effort; physical culture in the practice of family doctors; extreme sports and risks; emotional determinants of performance; recovery of patients with spinal column disorders; stress syndromes and psychosomatics; Olympic education, legal aspects of sport; physical effort in the elderly; psychomotricity disorders; high altitude sports training; fitness; biomechanics of movements; EUROFIT tests and other evaluation methods of physical effort; adverse reactions of physical effort; sport endocrinology; depression in sportsmen/women; classical and genetic drug usage; Olympic Games, etc.

Among articles devoted to original studies and research, we are particularly interested in the following: methodology in physical education and sport; influence of some ions on effort capacity; psychological profiles of students regarding physical education; methodology in sport gymnastics; selection of performance sportsmen.

Other articles approach particular subjects regarding different sports: swimming, rhythmic and artistic gymnastics, handball, volleyball, basketball, athletics, ski, football, field and table tennis, wrestling, sumo.

The authors of the two sections are doctors, professors and educators from university and pre-university education, trainers, scientific researchers etc.

Other sections of the journal are: the editorial, editorial news, reviews of the latest books in the field and others that are rarely presented (inventions and innovations, university and pre-university programs, forum, memories, competition calendar, portraits, scientific events).

We highlight the section "The memory of the photographic eye", where photos, some of which extremely rare, of sportsmen in the past and present are presented.

Articles signed by authors from the Republic of Moldova regarding the organization of sport education, the variability of cardiac rhythm, the stages of effort adaptability, and articles by some authors from France, Portugal, Canada must also be mentioned.

The main objective of the journal is highlighting the results of research activities, as well as the permanent and actual dissemination of information for specialists in the field. The journal assumes an important role in the achievement of necessary scores by the teaching staff in university and pre-university education, as well as by doctors in the medical network (through recognition of the journal by the Romanian College of Physicians), regarding didactic and professional promotion.

Another merit of the journal is the obligatory publication of the table of contents and a summary in English for all articles. Frequently, articles are published in extenso in a language of international circulation (English, French).

The journal is published quarterly and papers are accepted for publication in Romanian and English. The journal is sent by e-mail or on a floppy disk (or CD-ROM) and printed, by mail to the address of the editorial staff. The works of contributors that are resident abroad and of Romanian authors must be mailed to the editorial staff to the following address:

Health, Sports & Rehabilitation Medicine

Chief Editor: Prof. Dr. Traian Bocu

E-mail address: hesrehab@gmail.com; traian_bocu@yahoo.com

Postal address: Clinicilor street no. 1, postal code 400006, Cluj-Napoca, Romania

Phone: +400264-598575

Website: www.jhsrm.org

Objectives

Our intention is that the journal continues to be a route to highlight the research results of its contributors, especially by stimulating their participation in project competitions. Articles that are published in this journal are considered as part of the process of promotion in one's university career (accreditation that is obtained after consultation with the National Council for Attestation of University Titles and Diplomas).

We also intend to encourage the publication of studies and research that include relevant original elements, especially by young people. All articles must bring a minimum of personal contribution (theoretical or practical), that will be highlighted in the article.

In the future, we propose to fulfill criteria that would allow the promotion of the journal to superior levels according international recognition.

THE STRUCTURE AND SUBMISSION OF ARTICLES

The manuscript must be prepared according to the stipulations of the International Committee of Medical Journal Editors (<http://www.icmjee.org>).

The number of words for the electronic format:

– 4000 words for original articles;

- 2000 words for case studies;
- 5000-6000 words for review articles.

Format of the page: edited in WORD format, A4. Printed pages of the article will be numbered successively from 1 to the final page.

Font: Times New Roman, size 11 pt.; it should be edited on a full page, with diacritical marks, double spaced, with equal margins of 2 cm.

Illustrations:

The images (graphics, photos, etc.) should be numbered consecutively in the text, with Arabic numerals. They should be edited with EXCEL or SPSS programs, and sent as distinct files: “figure 1.tif”, “figure 2. jpg”, to the editors. Every graphic should have a legend, written under the image.

The tables should be numbered consecutively in the text, with Roman numerals, and sent as distinct files, accompanied by a legend that will be placed above the table.

PREPARATION OF THE ARTICLES

1. Title page: Includes the title of the article (maximum 45 characters), the first name of the authors followed by their surname, workplace, postal address of the institute and postal address and e-mail of the first author. It will follow the name of the article in English.

2. Abstract: Original articles require a summary structured in: (Background, Aims, Methods, Results, Conclusions), of maximum 250 words, followed by 3-8 key words (if possible from the list of established terms). All articles will have a summary in English. Within the summary (abstract), abbreviations, footnotes or bibliographic references should not be used.

Background. Description of the importance of the study and explanation of premises and research objectives.

Methods. Include the following aspects of the study:

Description of the basic category of the study: of orientation and applicative.

Localization and the period of study. Description and size of groups, sex (gender), age and other socio-demographic variables should be given.

Methods and instruments of investigation that are used.

Results. Descriptive and inferential statistical data (with specification of the statistical tests used): the differences between the initial and the final measurement for the investigated parameters, the significance of correlation coefficients are necessary. The level of significance (the value *p* or the dimension of effect *d*) and the type of the statistical test used, etc. should be mentioned.

Conclusions. Conclusions that have a direct link with the presented study should be provided.

Orientation articles and case studies should have an unstructured summary (without respecting the structure of experimental articles) up to a limit of 150 words.

3. Text

Original articles should include the following chapters which will not be identical with the summary titles: Introduction (General considerations), Hypothesis, Materials and methods (including ethical and statistical information), Results, Discussing results, Conclusions and suggestions. Other types of articles, such as orientation articles, case studies, editorials, do not have an obligatory format. Excessive abbreviations are not recommended. The first time an abbreviation is used in the text, it should follow the term *in extenso*, being placed in parentheses, and thereafter the short form should be used.

Authors must take responsibility for the correctness of the published materials.

4. References

The bibliography should include the following data:

For articles from journals or other periodical publications, the international Vancouver Reference Style should be used: the first name of all authors as initials and their surname, the year of publication, the title of the article in its original language, the title of the journal in its international abbreviated form (italic characters), number of volume, pages.

Articles: Carlos S, de Irala J, Hanley M, Martínez-González MÁ. The use of expensive technologies instead of simple, sound and effective lifestyle interventions: a perpetual delusion. See comment in PubMed Commons below 2014;68(9):897-904. doi:10.1136/jech-2014-203884.

Books: Fox SI. Human Physiology. Twelfth Ed. Publ MCGraw Hill. New York, 2011,403-470.

Chapters from books: Sternfeld B, Lee IM. Physical activity and cancer: the evidence, the issues and the challenges. In: Lee IM, Eds. Physical Activity and Health Epidemiologic Methods and Studies. New York: Oxford University Press, 2009.

Starting with issue 4/2010, every article should include a minimum of 15 and a maximum of 100 bibliographic references, mostly journal articles published in the last 10 years. Only a limited number of references (1-3) older than 10 years will be allowed. At least 20% of the cited resources should be from the recent international literature (not older than 10 years).

Conflict of interest

The authors must mention all possible conflicts of interest including financial and other types. If you are sure that there is no conflict of interest, we ask you to mention this. The financing sources should also be mentioned in your work.

Acknowledgements

The specifications must concern only people outside the study who have had a substantial contribution, such as statistical processing or review of the text in English. The authors have the responsibility to obtain the written permission from

the persons mentioned within the respective chapter, in case readers refer to the interpretation of results and conclusions of these persons. Also it should be mentioned if the article uses partial results from certain projects or if these are based on master or doctoral theses defended by the author.

Peer-review process

In the final stage, all materials will be closely reviewed by at least two competent referees in the field (professors and docent doctors) so as to correspond in content and form to the requirements of an international journal. After this stage, the materials will be sent to the journal's referees, according to their profiles. After receiving the observations from the referees, the editorial staff shall inform the authors of the necessary corrections and publishing requirements of the journal. This process (from receiving the article to transmitting the observations) should last about 4 weeks. The author will be informed if the article has been accepted for publication or not. If it is accepted, a period of correction by the author will follow, in order to meet the publishing requirements.

Ethical criteria

The Editors will notify the authors in due time whether their article is accepted or not or if there is a need for modifying the text. Also, the Editors reserve the right to edit articles accordingly. Papers that have been printed or sent for publication to other journals will not be accepted. All authors should send a separate letter containing a written statement proposing the article for submission, pledging to observe the ethics of citation of the sources used (bibliographic references, figures, tables, questionnaires).

For original papers, according to the requirements of the Helsinki Declaration, the Amsterdam Protocol, Directive 86/609/EEC, and the regulations of the Bioethical Committees from the locations where the studies were performed, the authors must provide the following:

- the informed consent of the family, for studies in children and juniors;
- the informed consent of adult subjects, patients and athletes, for their participation;
- malpractice insurance certificate for doctors, for studies in human subjects;
- certificate from the Bioethical Committees, for human study protocols;
- certificate from the Bioethical Committees, for animal study protocols.

This information will be mentioned in the paper, in the section Materials and Methods. The documents will be obtained before the beginning of the study. The registration number of the certificate from the Bioethical Committees will also be mentioned.

Editorial submissions will not be returned to the authors, whether published or not.

FOR THE ATTENTION OF SPONSORS

Requests for advertising space should be sent to the Editors of the *Health, Sports & Rehabilitation Medicine* journal, 1, Clinicilor St., 400006, Cluj-Napoca, Romania. The price of an A4 full color page of advertising, will be EUR 250 and EUR 800 for an advert in all 4 issues. The costs of publication of a logo on the cover will be determined according to its size. Payment should be made to the Romanian Medical Society of Physical Education and Sports, CIF 26198743. Banca Transilvania, Cluj branch, IBAN: RO32 BTRL 0130 1205 S623 12XX (RON).

SUBSCRIPTION COSTS

The *Health, Sports & Rehabilitation Medicine* journal is printed quarterly. The subscription price is 100 EUR for institutions abroad and 50 EUR for individual subscribers outside Romania. For Romanian institutions, the subscription price is 150 RON, and for individual subscribers the price is 120 RON. Note that distribution fees are included in postal costs.

Payment of subscriptions should be made by bank transfer to the Romanian Medical Society of Physical Education and Sports, CIF 26198743. Banca Transilvania, Cluj branch, IBAN: RO32 BTRL 0130 1205 S623 12XX (RON), RO07 BTRL 01,304,205 S623 12XX (EUR), RO56 BTRL 01,302,205 S623 12XX (USD). SWIFT: BTRLRO 22

INDEXING

Title of the journal: *Health, Sports & Rehabilitation Medicine*

pISSN 2668-2303, ISSN-L 2668-2303

Profile: a Journal of Study and interdisciplinary research

Editor: "Iuliu Haieganu" University of Medicine and Pharmacy of Cluj-Napoca and The Romanian Medical Society of Physical Education and Sports in collaboration with the Cluj County School Inspectorate

The level and attestation of the journal: a journal rated B+ by CNCS (Romanian National Research Council) since 2007, certified by CMR (Romanian College of Physicians) since 2003, CFR (Romanian College of Pharmacists) since 2015 and CMDR since 2018

Journal indexed in International Databases (IDB): EBSCO, Academic Search Complete, USA and Index Copernicus, Journals Master List, Poland; DOAJ (Directory of Open Access Journals), Sweden, CiteFactor, Canada/USA, CrossRef, Lynnfeld, MA (US)/Oxford (UK)

Year of first publication: 2000

Issue: quarterly

The table of contents, the summaries and the instructions for authors can be found on the internet page: <http://www.jhsrm.org>. Access to the table of contents and full text articles (in pdf format) is free.