International Conference on Digital Health Technologies

(ICDHT 2022)
Magdeburg, Germany
September 14-16, 2022

	Wednesday, Sep.14 Lecture Room N 6		Thursday, Sep.15 Lecture Room N 6		Friday, Sep. 16 Lukas Klause
08:30	Registration	**09 :00**	Prof. Dr. Rado Pišot	**09:00-11:30**	Oral Session 4
10.00	Opening Ceremony	**10 :00**	Dr. Boštjan ŠIMUNIČ	**11:30-12:00**	Coffee break
10:15	Dr. Roman Fomin	**11 :00**	Dr. Uroš Marušič	**12:00-12:30**	Closing Ceremony
11:15	Dr. Soléakhéna Ken	**12 :00**	Lunch Break		
12:15	Lunch Break	**13 :00-13 :45**	Prof. Dr. Cornelia Herbert		
13:00	Prof. Dr. Olaf Ueberschär	**13 :45-14 :30**	Prof. Dr. Rudy José Nadori-Junior		
14:00-16:00	Exhibition (Festung Mark)	**14 :30-15 :00**	Coffee Break		
16 :00-16 :15	Coffee Break	**15:00-16:30**	Oral Session 1/2 **Rooms:** 231/238		
16 :15-17:45	Medical smart home for mental health monitoring Workshop + Poster Sessions	**16:30-16:45**	Coffee Break		
17:45-18:15	The foundation of the platform of innovation for digital health technologies	**16:45-18:15**	Oral Session 3 **Rooms:** 231		
18 :30	BBQ Party: OvGU	**19:00**	Social evening: Lukas Klause		

ICDHT Program

Keynote Speaker 1: Dr. Roman Fomin
Chair: Prof. Dr. Anita Hökelmann

UFC Performance Institute: Cutting Edge of Sport Science, Analytics, and Innovations

Keynote Speaker 2: Prof. Dr. Soléakhéna Ken
Chair: Prof. Dr. Hadj Batatia

Multi-parametric Magnetic Resonance Imaging and MR Spectroscopy for brain lesions and injuries

Keynote Speaker 3: Prof. Dr. Olaf Ueberschär
Chair: Prof. Dr. Walid Mahdi

Wearables in rehabilitation, fitness and elite sports – solution to everything or big business?

Keynote Speaker 4: Prof. Dr. Rado Pišot
Chair: Prof. Dr. Jürgen Edelmann-Nusser

Digital Technology – from an Obstacle to an Incentive for a Healthy and Active Lifestyle

Keynote Speaker 5: Dr. Boštjan ŠIMUNIČ
Chair: Dr. Bassem Bouaziz

The decomposition of Tensiomyography using advanced mathematics

Keynote Speaker 6: Dr. UROŠ MARUŠIČ
Chair: Dr. Tarek Zlitni

The decomposition of Tensiomyography using advanced mathematics

Keynote Speaker 7: Prof. Dr. Cornelia Herbert
Chair: Prof. Dr. Kerstin Witte

'Exercise4Health' Promoting mental health and physical activity of emerging adults by means of physical activity and digital exercise interventions

Keynote Speaker 8: Prof. Dr. Rudy José Nadori-Junior
Chair: Prof. Dr. Anita Hökelmann

Biological Individuality: Fingerprints in the guidance of sports talents and exercise prescription

Oral Sessions (10-minutes presentation + 5-minutes discussion for each paper)

Oral Session 1: Sport Science

Chair 1: Prof. Dr. Anita Hökelmann

Chair 2: Prof. Dr. Olaf Ueberschär

Paper 9302: Lower risk of injury due to virtual reality training?
Dan Bürger, Stefan Pastel and Kerstin Witte

Paper 2844: Effects of a randomized six-month dance intervention in selected cognitive and motoric functions in elderly MCI patients
Corinna Langhans and Anita Hökelmann

Paper 4675: Dance against dementia (DiADEM): effects of a sportive dance training on cardiorespiratory fitness (and cognition) in seniors with mild cognitive impairment (MCI)
Marvin Stiebler

Paper 0225: Effects of a randomized six-month dance intervention in neuromuscular functions of MCI patients - muscle performance measured with Tensiomyography
Nicole Halfpaap and Anita Hökelmann

Paper 2375: Effects of isometric exercise and fatigue on cognition: neurophysiological correlates
Tariq Ali Gujar and Cornelia Herbert

Paper 1631: Neuromotor and Functional Adaptations in Schoolchildren Practicing Exergames
Estelio Henrique Martin Dantas, Karollyni Bastos Andrade, Madson Rodrigo Silva Bezerra, Renato Ramos Coelho, Estevão Scudese, Eric Marcos Nunes Calvacante, João Wolney Teles Soares, Thiago Rubens da Rocha Esch, Thigna Carvalho Batista and Roberto Jerônimo Santos Silva

Oral Session 2: Computer Science

Chair 1: Prof. Dr. Lotfi Chaari

Chair 2: Prof. Dr. Hadj Batatia

Paper 4967: MCI identification based on EEG signals during cognitive test
Amal Boudaya, Siwar Chaabene, Bassem Bouaziz, Anita Hökelmann and Lotfi Chaari

Paper 9426: Development of a machine learning model to assess the risk factors and postoperative day for superficial VS deep/organ space surgical site infections
Hafiza Sundus Fatima, Wardah Rafaqat, Muhammad Khurram and Sadaf Khan

Paper 9495: Sensor data preprocessing for generation of behavioral metrics in ECOCAPTURE@HOME
Mathilde Boucly, Idil Sezer and Benedicte Batrancourt

Paper 9447: Explainability of Artificial Neural Networks, performing a Motor-Imagery Task
David Kreuzer and Cornelia Herbert

Paper 5078: A deep learning-based approach for the classification of mild cognitive impairment from scalp EEG recordings
Abdelaziz Triki, Anita Hökelmann, Bassem Bouaziz and Walid Mahdi

Paper 5256: Depthwise Separable Convolution ResNet with attention mechanism for Alzheimer's detection
Rahma Kadri, Bassem Bouaziz, Mohamed Tmar and Faiez Gargouri

Oral Session 3: Technologies in Rehabilitation and Prevention

Chair 1: Prof. Dr. Walid Mahdi

Chair 2: Dr. Tarek Zlitni

Paper 3726: Remote Physiotherapy to Protect Physcial Health in Duchenne Muscular Dystrophy: Telerehabilitation
Arzu Erden, Demet Öztürk, Mustafa Sarı, Halil İbrahim Çelik, Azize Reda Tunç, Banu Ünver, Hasan Erkan Kılınç, Nurhayat Korkmaz, Mehtap Turanoğlu, Selda Gürsoy and Aynur Ayşe Karaduman

Paper 5796: Exergames and Autism Spectrum Disorder: an Integrative Review
Karollyni Bastos Andrade Dantas, Estevão Scudese, Renato Ramos Coelho Ramos Coelho, Jocélia Pinho Mendonça Pinho Mendonça, Maria Eduarda Fonseca, Maria Fernanda Franco, Maria Fernanda Targino, Maria Luísa Barreto Paiva, Maria Paula Aragão Andrade and Estélio Estélio Henrique Matin Dantas

Paper 3363: Wearables and wireless technology for training and telerehabilitation services
Uroš Marušič and Luka Šlosar

Paper 8549: Digital Health Application for Personalized Rehabilitation after Ankle Inversion Trauma
Rosemary Dubbeldam, Jonathan Neugebauer, Yu Yuan Lee, My Linh Pham, Lokman Beser, Luka Gerlach and Herbert Kuchen

Paper 7022: Inertial Sensor Based Assessment of Transversal Upper Body Rotation in Junior Elite Long Distance Runners
Charlotte Lang, Fides Berkel, Axel Schleichardt, Frank Warschun, Nico Walter, Daniel Fleckenstein and Olaf Ueberschär

Paper 8014: Use, perceptions, and attitudes of Slovenian ″digitalized seniors″ towards information-communication technology
Saša Pišot, Katarina Puš, Kaja Teraž, and Blaž Lenarčič

Oral Session 4: Technologies & Sport Science (Hybrid)

Chair 1: Prof. Jürgen Edelmann-Nusser

Chair 2: Prof. Dr. Rado Pišot

Paper 1398: Impact of wearing FFP2 masks on biomechanical asymmetries in running gait
Corinne Rinck, Jonas Tim Helmholz, Franziska Schneider and Olaf Ueberschär

Paper 8290: The multifunctional sensor-based diagnostic device and its application in orthopedic diseases of the lower extremities
Stefanie John and Kerstin Witte

Paper 0700: Musculoskeletal effectiveness of using exoskeletons in various lifting tasks in the logistics sector
Birte Scholz, Niklas Stanko, Johanna Rath, Elena Trümper, Luca Wilkat, Franziska Schneider and Olaf Ueberschär

Paper 0705: Cognitive control during walking: preliminary results of an ERP study
Manca Peskar, Klaus Gramann, and Uros Marusic

Paper 6555: Interoperability Challenges and Critical Success Factors in the Deployment of Cross-border Digital Medical Prescriptions in Finland and Estonia
Flor Nino Palma

Paper 6076: Mobile Applications for Performance Assessment and Prescription for Elderly
Karollyni Bastos Andrade Dantas, Estélio Henrique Martin, César Augusto Souza Santos, Lúcio Flávio Gomes Ribeiro da Costa, Rafaela Cristina Araújo Gomes and Fabiana Rodrigues Scartoni

Paper 4897: Technology and Sample Characteristics of Home-Based Technology-Assisted Exercise/Physical Activity (PA) Interventions in Older Adults: A Scoping Review
Niharika Bandaru and Anita Hökelmann

Paper 6814: Exergames and Elderly Cognition: An Integrative Review
Karollyni Bastos Andrade Dantas, Renato Ramos Coelho, Elizabeth Carvalho Lugão, Estevão Scudese, Gabrielly Gomes Lima de Sá, Rhayana Oliveira Falcão, Laís Oliveira Melo, Lara Letycia Araujo Costa, Álvaro Carson Alves Vieira and Estélio Henrique Martin Dantas

Paper 0550: Steps to organisational change towards digital health for elders - A case of success.
João Teixeira-Sousa, António Bandeira, Fabiana Lima, Daniel Beirão and Filipe Freitas-Pinto

Abstracts

Oral Session 1: Sport Science

Chair 1: Prof. Dr. Anita Hökelmann

Chair 2: Prof. Dr. Olaf Ueberschär

Paper 9302: Lower risk of injury due to virtual reality training?
Dan Bürger, Stefan Pastel and Kerstin Witte

Abstract: Training in virtual reality (VR) has been examined extensively in recent years. Most studies showed a positive effect of VR training on real world (RW) performance. Although it is not entirely ensured to what extent the results are transferable into RW, some advantages of VR are already usable, for example, the lower risk of injury. Due to missing body contact in combat sports or the simulation of dangerous situations, it is possible to prevent many injuries. Furthermore, VR training can be used in addition to RW training to improve, for example, the orientation ability of seniors to prevent injuries in everyday life. Nevertheless, new injury sources appear in VR, like walking into real objects, which are not visible in the head-mounted display VR. These pros and cons need to be evaluated and can be used to provide guidance on setting up VR training to reduce the risk of injury while still having effective training.

Keywords: virtual reality, sports, training, injury prevention

Paper 2844: Effects of a randomized six-month dance intervention in selected cognitive and motoric functions in elderly MCI patients
Corinna Langhans and Anita Hökelmann

Introduction: The senior population is getting increased day by day in the European Union. In 2017 19.5% of the population will be over 65 years, and till 2080 it will be increased to 29.1 %. In the ageing society dementia is the biggest challenge and in 2050 131.5 million people will face dementia around the world. In relation to dementia the decline of motor and cognitive abilities reduces the ability to perform activities of daily living (ADL) (Feldman, Van Baelen, Kavanagh, & Torfs, 2005; Sauvaget, Yamada, Fujiwara, Sasaki, & Mimori, 2002). The dementia transit from the normal aging decline and mild cognitive impairment (MCI) (Hampel & Lista, 2016). There is no consensus about pharmacological treatment for MCI, so it is important to structure nonpharmacological interventions

for increasing their cognitive reserve and physical activity is considered most effect to reverse MCI - so senior not followed to dementia. (Teixeira, Gobbi, Corazza, Stella, Costra, Gobbi, 2012) The objective of the current study is to find out the effect of systematic sportive dance training on the cognitive function, cortical modulation and physiological state of MCI- patients.

Method: A randomized, controlled intervention study will investigate the extent to which a 6 monthly sportive dance program (2 x weekly, 90 minutes each). The study is in a standard design (pretest, six-month intervention, posttest). The active intervention group completes a sportive dance training. The control group does not undergo through intervention and receives normal health care. CERAD + test battery and Functional (Resting MRI) Balance tests (equilibrium test rehab (GGT), gait examinations (by means of Initial sensors under single and dual task), cardiovascular fitness and motor tests will be used to evaluate the efficiency on the sportive dance intervention plan.

Results and Discussion: The primary outcome of the intervention is results from neurodegenerative disease progression, quantified by using the CERAD + test battery. Secondary outcomes are results of neuropsychological examinations, structural and functional neuroplasticity tests, blood parameters, quality of life questionnaires and structured observations during intervention. We assume that a special movement program with selected means/ methods of dance could be a cost-effective preventive offer for MCI- patients.

Paper 4675: Dance against dementia (DiADEM): effects of a sportive dance training on cardiorespiratory fitness (and cognition) in seniors with mild cognitive impairment (MCI)

Marvin Stiebler

Introduction: Current research indicates that lifestyle factors, especially physical activity, could play a key role in healthy ageing and prevention of neurodegenerative diseases. Dance training in healthy older adults has been shown to be superior to repetitive physical exercise in inducing brain plasticity as it poses demands on both physical and cognitive functions. However, studies on the effects of motor-cognitive training in older adults with MCI are still lacking. Methods: A total of 51 older adults with MCI were recruited and randomly assigned to either inactive control (N=20; age = 67 ± 6.6; female = 10) or intervention group (N=25; age = 70 ± 5.5; female = 16). The dance intervention consisted of a six-month long program with two dance interventions per week lasting up to 90 minutes and increasingly difficult choreographies. An extensive pre/post-assessment was performed at baseline and post-intervention including cognition, MRI, blood analysis, and spiroergometry. Here we focus on our preliminary results for cardiopulmonary exercise testing (CPET). Spiroergometry was done pre- and post-intervention on a cycle ergometer with gas exchange analysis (ramp protocol, beginning 25 W, increase 25 W all 3 minutes) in accordance with current safety recommendations. Furthermore, lactate levels and rate of perceived exertion (BORG-Scale) were assessed. Results: Average training load (% of of maximal heart rate (HRmax = 220 – age) during dance training was 65% of maximum heart rate. Pre/post analysis of spiroergometry demonstrated a (statistically not significant) increase of cardiorespiratory fitness (VO2max) in the dance group (pre= 25.2±6.3; post= 25.7±7.1; p=.708) while the inactive control group showed a statistically significant decrease (pre= 27.3±7.4; post= 25.0±6.8; p=.007). Analysis of other parameters (e.g. heart rate, lactate levels, perceived exertion using BORG-Scale) revealed no significant changes. Discussion: Our results demonstrate that sportive dancing training can improve and/or stabilize cardiorespiratory fitness in older patients with MCI. Because cardiorespiratory fitness is a predictor of quality of life, these results could impact autonomy and independence of patients with MCI.

Keywords: Spiroergometry, MCI, Dementia, Sports medicine

Paper 0000: Effects of a randomized six-month dance intervention in neuromuscular functions of MCI patients - muscle performance measured with Tensiomyography

Nicole Halfpaap and Anita Hökelmann

Introduction: The musculature is an important organ system for locomotion of humans in sporting as well as everyday life. With advancing age, people lose muscle mass and performance (Rodriguez-Ruiz, D. 2013). In bed rest studies by Simunic et al. (2019), early atrophic processes could be determined by means of tensiomyography (TMG), especially in the muscle belly displacement (Dm), even before a change in the muscle composition becomes visible (Simunic, B. 2019). In this randomized study, TMG was used to identify changes after a special six-month dance intervention in seniors with mild cognitive impairment (MCI) in muscle performance.
Method: During the study, the focus was on the TMG parameters contraction time (tc), muscle belly displacement (Dm) and reaction time (td) of certain muscles. In this long-term study, the conditions of seniors in intervention group (IG) (n=25) aged 72,3 ± 4,9 years and seniors in control group (CG) (n=20) aged 68,95 ± 6,52 years were compared.
Results: Between groups, a trend could be found in the percentage changes in the m. semitendinosus (ST) left Dm (p= .075). Significant differences could be found in m. semitendinosus (ST) left within both groups in Dm (IG – p= .0001; CG – p= .014).
Conclusion
TMG appears to be a well-functioning method for determining differences in contractile properties to detect changes after an intervention in seniors with MCI. In particular, Dm could be an important parameter, because of its correlation to muscle force. It describes muscle volume and tone/stiffness and could be a mark for intervention effects.
Keywords: Tensiomyography, muscle performance, mild cognitive impairment, MCI

References

Rodriguez-Ruiz, D. (2013): Effects of age and physical acivity on response speed in knee flexor and extensor muscles, Eur Rev Aging Phys Act (2013) 10:127-132.
Simunic, B. (2019): Tensiomyography detects early hallmarks of bed-rest-induced atrophy before changes in muscle architecture. J Appl Physiol 126: 815–822, 2019; doi:10.1152/japplphysiol.00880.2018.,
Simunic, B., Rozman, S., Pisot, R. (2018): Detecting the velocity of the muscle contraction. www.tensiomyography.de.

Paper 2375: Effects of isometric exercise and fatigue on cognition: neurophysiological correlates

Tariq Ali Gujar and Cornelia Herbert

Introduction: Resistance training (RT), as an important part of physical activity, is considered a moderator of neuroplasticity and improvement of gross motor skills (Hortobágyi et al., 2021). However, RT, depending on its intensity is also eliciting fatigue in the body when repetitive, which in turn reduces overall performance and impacts cognitive control thereby increasing the risk of injuries (Faigenbaum and Myer, 2010). Physical activity interventions and their effects on physiology have been explored in the past, as has the impact of PA on cognition. Many evidence shows the positive relationship between muscle strength and cognitive abilities (Sui et al., 2021). However, the neurophysiological mechanism of the sensory-motor system during resistance training (RT) and its relation to fatigue is still an open issue of investigation. The objective of the current study is to understand the neurophysiological effects elicited during isometric resistance activity and its fatigue on the sensory-motor system. **Method:** 20 young participants aged between 20 to 30 years are participating in the current study. The participants undergo a working memory task (modified

Sternberg task) before (T1) and after (T2) handgrip exercise performed with a hand dynamometer (capable of measuring force). The handgrip exercise was performed in two blocks, comprising 90 trials while participants engaged in a visual memory task. Electroencephalography (EEG) was recorded with a 32 channel high-density stationary EEG system (BrainProducts GmbH) with a 10-20 head montage; Electromyography (EMG) and electrocardiac (ECG) activity were also recorded using BRAINAMP MR plus amplifier (BrainProducts GmbH) along with active electrodes. **Results and Discussion**: The impact of the isometric tasks and its fatigue on ERPs elicited by the cognitive task are analyzed to determine at which intensity and across repetitions isometric exercise influences the time course of cognitive processing. Neural connectivity, heart rate variability and ECG, EMG and EEG coherence will complement the analysis of this interaction and unravel the mechanism that link the sensory-motor system during the isometric task and its fatigue and cognition. Further, we expect a standard marker between EEG, EMG, and ECG to predict isometric fatigue and its impact on the sensory-motor system. The study results will support the advice of specific physical activity for the people facing a decline in motor and cognitive abilities.

References: Faigenbaum, A.D. and Myer, G.D. (2010) 'Pediatric resistance training: Benefits, concerns, and program design considerations', Current Sports Medicine Reports, pp. 161–168.
Hortobágyi, T., Granacher, U., Fernandez-del-Olmo, M., Howatson, G., Manca, A., Deriu, F., ... & Colomer-Poveda, D. (2021). Functional relevance of resistance training-induced neuroplasticity in health and disease. Neuroscience & Biobehavioral Reviews, 122, 79-91.
Sui, S. X., Williams, L. J., Holloway-Kew, K. L., Hyde, N. K., & Pasco, J. A. (2020). Skeletal muscle health and cognitive function: a narrative review. International journal of molecular sciences, 22(1), 255.

Paper 1631: Neuromotor and Functional Adaptations in Schoolchildren Practicing Exergames

Estelio Henrique Martin Dantas, Karollyni Bastos Andrade, Madson Rodrigo Silva Bezerra, Renato Ramos Coelho, Estevão Scudese, Eric Marcos Nunes Calvacante, João Wolney Teles Soares, Thiago Rubens da Rocha Esch, Thigna Carvalho Batista and Roberto Jerônimo Santos Silva

Abstract: The most varied motor tasks require articular movements with adequate amplitude, and the execution of the movements involves several capacities, which are somehow developed during physical education classes. The aim was to verify the neuromotor and functional adaptations in schoolchildren practicing exergames. More specifically, the upper and abdominal limbs' flexibility and muscular strength abilities. The experiment was a descriptive, quasiexperimental study with 34 students between 8 and 12 years. The flexibility, upper limb strength, and pre and post abdominal force strength were observed during physical education classes (exergames group) compared to the control group that practiced traditional classes. When analyzing the level of flexibility between the groups, there were significant changes, $F(1, 33) = 7.678$; $p < 0.01$; $r = 0.43$. Presenting significant change in the exergames group $F(1, 33) = 3{,}933$; $p < 0.01$; $r = 0.57$ and showed no significant changes in the Control F group $(1, 33) = 0.558$; $p > 0.01$; $r = 0.43$. The strength of upper limbs did not show significant changes, contrasting to the and in the abdominal strength variable, that presented positive changes only in the exergames group $F(1, 33) = 4{,}968$; $p < 0.01$; $r = 0.36$. The use of exergames in physical education classes promoted significant changes in flexibility and increased abdominal strength but no extra gain in upper limb strength.

Keywords: Range of Motion, Articular; Games, Recreational; Physical Education and Training, Muscle Strength.

Acknowledgments. This study was partly financed by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001

References

1. Galahue DL, Ozmun JC, Goodway JD (2013) Compreendendo o Desenvolvimento Motor. 7th ed. McGraw Hill, Porto Alegre, pp 29-33 p.
2. Medeiros P, Capistrano R, Zequinão MA, Silva SA, Beltrame TS, Cardoso FL (2017) Exergames como ferramenta de aquisição e desenvolvimento de habilidades e capacidades motoras: uma revisão sistemática. Rev Paul Pediatr 35(4):464–71. https://doi.org/10.1590/1984-0462/;2017;35;4;00013
3. World Health Organization. (2010) Global recommendations on physical activity for health. WHO Press, Geneve. https://www.who.int/publications/i/item/9789241599979
4. Huang HC, Wong MK, Lu J, Huang WF, Teng CI (2017) Can using exergames improve physical fitness? A 12-week randomized controlled trial. Comput Human Behav 70:310-6. https://doi.org/10.1016/j.chb.2016.12.086
5. Couto JDO, Gueiros MM, Santos CKA, Santos RJS (2017) Exergames and community intervention: a proposal for its use and intervention. Arch Sport Sci 5(2):28–9.
6. Dantas EHM (2022) A prática da Preparação Física. 7th ed. Manole, Barueri
7. Baranowski T, Blumberg F, Buday R, DeSmet A, Fiellin LE, Green CS, Kato PM, Lu, AS, Maloney AE, Mellecker R, Morril BA, Peng W, Shegog R, Simons M, Staiano AE, Thompson D, Young K (2016) Games for Health for Children – Current Status and Needed Research. Games Health J 5(1):1-12 https://doi.org/10.1089/g4h.2015.0026
8. Martins-Costa HC, Araújo SRS, Lima FV, Menzel H-J, Fernandes AP, Chagas MH (2015) Análise do perfil da flexibilidade de crianças e adolescentes mensurada por meio de dois testes. Rev da Educ Física/UEM 26(2): 257 https://doi.org/10.4025/reveducfis.v26i2.22871
9. Dantas EHM (2018) Alongamento & flexionamento. 6th Ed. Manole, Barueri

Oral Session 2: Computer Science

Chair 1: Prof. Dr. Lotfi Chaari

Chair 2: Prof. Dr. Hadj Batatia

Paper 4967: MCI identification based on EEG signals during cognitive test

Amal Boudaya, Siwar Chaabene, Bassem Bouaziz, Anita Hökelmann and Lotfi Chaari

Abstract. Electroencephalography (EEG) is a valuable method for diagnosing neurological conditions such as Mild Cognitive Impairment (MCI), which is a risk factor for dementia. Based on wearable EEG technologies, recent works have been proposed for the early detection of neurocognitive disorders. Cognitive tests performed during EEG recording have lately emerged as one of the most promising techniques for assisting in the identification of various mental aberrations. In this paper, we suggest a novel method based on ML technology for examining the Consortium to Establish a Registry for Alzheimer's Disease (CERAD) test performance in MCI and healthy patients. This approach is based on EEG data recorded during a CERAD cognitive test. The proposed approach shows promising results in terms of categorization findings for MCI identification during the CERAD cognitive test.

Keywords: MCI detection · EEG · ML · cognitive test · CERAD

Paper 9426: Development of a machine learning model to assess the risk factors and postoperative day for superficial VS deep/organ space surgical site infections

Hafiza Sundus Fatima, Wardah Rafaqat, Muhammad Khurram and Sadaf Khan

Abstract: When compared to superficial Surgical Site Infections (SSI), deep and organ space SSI require rigorous treatment, can result in clinically severe disease, and have different risk factors. Machine Learning (ML) algorithms allow for the analysis of multiple elements in order to predict the type and timing of SSI development. In this study ML models are created to predict the type of SSI and the postoperative week, as well as comparing risk variables for superficial and deep SSIs after a variety of surgical operations. A retrospective study style was adopted in a tertiary care hospital on patients who received general surgery procedures between 2019 and 2020. Six ML algorithms named Logistic Regression, AdaBoost, Gradient Boosting, Stochastic Gradient Boosting, XGBoost and Random Forest Classification were trained as predictors of infection type (superficial vs. deep/organ space) and infection time, and their accuracy was measured using the Area Under the ROC Curve (AUC). There were 113 patients with SSIs whose data was available. Of these, 62 (54.8%) had superficial infections and 51 (45.2%) had deep/organ space infections. Data contained 72 features consisting of post-operative observations, patient and surgery procedure characteristics. Feature selection methods such as basic filtering, correlation and Receiver Operator Characteristic (ROC) curve were used. The XG boost univariate model had the highest 80% accuracy and AUC (0.85) for predicting the type of SSI, and the Stochastic gradient boosting univariate, logistic regression univariate, XG boost univariate, and random forest classification univariate models had the highest AUC (0.74) for predicting the week of infection, when compared to other ML algorithms. The accuracy of ML models in predicting superficial vs. deep SSI and the time it takes for infection to develop is reasonable. ML predictions can help determine the length of follow-up and the allocation of treatment methods.
Keywords: machine learning model, surgical site infection, general surgery

Paper 9495: Sensor data preprocessing for generation of behavioral metrics in ECOCAPTURE@HOME

Mathilde Boucly, Idil Sezer and Benedicte Batrancourt

Abstract: Apathy is a common behavioral syndrome that occurs across a wide range of neurological and psychiatric disorders.1 It is the most common neuropsychiatric syndrome associated with behavioral variant frontotemporal dementia (bvFTD), but it is also highly prevalent in other neurodegenerative conditions.2 Traditionally, apathy has been viewed as a symptom indicating loss of interest or emotions. In 1990, in a highly influential conceptual framework, Marin defined apathy as “diminished motivation not attributable to diminished level of consciousness, cognitive impairment, or emotional distress”.3 In 2006, in another influential theoretical framework, Levy and Dubois refined the definition of apathy to “the quantitative reduction of self-generated voluntary and purposeful behaviors”.4 Consequently, apathy is an observable state that can subsequently be quantified, and a pathology of goal-directed behavior. Apathy is associated with a cognitive decline, and high levels of distress both in patients and their caregivers. Apathy is commonly assessed using validated assessment scales, based on patient and/or informant reports. However, these scales are biased by the subjective evaluation of the patient or his or her relatives. Since, behavior disorders are extremely difficult to capture through questionnaires, the most robust way to assess behaviors might be through ethological approach in natural settings using sensors.

ECOCAPTURE@HOME protocol: We have developed the ECOCAPTURE research program to objectively assess apathy under ecological conditions. Our research aims to bridge the gap between laboratory settings and natural settings. The objective of the ECOCAPTURE@HOME study (clinicaltrials.gov: NCT04865172) are to remotely measure behavioral markers of apathy in

everyday life conditions, and predict the psychological status of the patient-caregiver dyad from the patient's apathetic state. 5 Indeed, ECOCAPTURE@HOME switches from the patient level to the dyad level. We plan to recruit a total of 60 dyads between 40 and 85 years old divided into three groups: bvFTD, Alzheimer Disease (AD); and healthy controls. Data will be collected through a multi-sensor wearable Empatica E4 wristband and questionnaires (on a smartphone application) during a period of 28 consecutive days.

The Empatica E4 wristband The Empatica E4 wristband (Empatica Inc., Boston, MA, USA) is a wearable, wireless, multi-sensory signal acquisition device with four inbuilt sensors allowing for real-time physiological data collection. It reports Galvanic Skin Response (i.e. electrodermal activity, EDA), Skin Temperature (ST), and Tri-Axial Acceleration (ACC). The PPG (Photoplethysmography) data allows to determine blood volume pulse (BVP) from which heart rate (HR), inter-beat intervals (IBIs) and heart rate variability (HRV) are derived.

Preprocessing of sensor data: Preprocessing of sensor data typically incorporates data cleaning or filtering (e.g., noise reduction), outliers and erroneous measures detection and removal, data transformation (e.g., dataset size reduction), and features extraction (e.g., event detection). Data were collected in twenty pilot subjects. First, these data have been cleaned with several algorithms which allow to detect and remove non-wear periods, and aberrant data (Figure 1A). Second, features have been extracted from preprocessed data. From ACC data, analyses detected sleep periods (Figure 1 B). Fusion data has also been used to combine some features. Then further detections about sleep have been made thanks to the movements during sleep and the storms (Figure 1C). Storms are an augmentation of the EDA during sleep. The storms mostly happen during deep sleep and are a relevant indicator about the sleep quality. To detect them, some features have been extracted from the EDA signal such as a phasis separation or a peaks analysis. The emotional arousal can also be evaluated from the EDA.

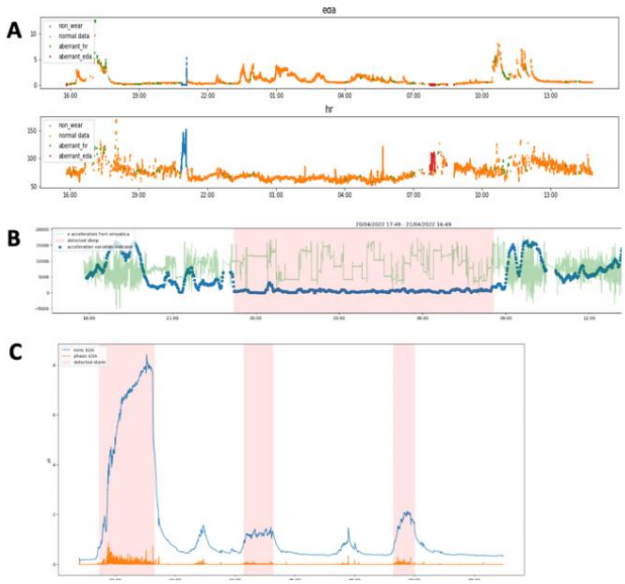

Figure 1. (A) EDA and HR data cleaning. (B) ACC analysis for sleep periods detection. (C) EDA analysis for storms detection.

Conclusion: In order to generate behavioral metrics, the features extracted from sensor data will be aggregated into daily variables. Our aim is to generate behavioral metrics about sleep quality, activity level and emotional activity. These behavioral metrics should provide measures of apathy in the daily life of patients and caregivers.

References:

1. Robert, P. et al. Is it time to revise the diagnostic criteria for apathy in brain disorders? The 2018 international consensus group. Eur. Psychiatry J. Assoc. Eur. Psychiatr. 54, 71–76 (2018).
2. Miller, B. & Llibre Guerra, J. J. Frontotemporal dementia. Handb. Clin. Neurol. 165, 33–45 (2019).
3. Marin, R. S. Differential diagnosis and classification of apathy. Am. J. Psychiatry 147, 22–30 (1990).
4. Levy, R. & Dubois, B. Apathy and the Functional Anatomy of the Prefrontal Cortex–Basal Ganglia Circuits. Cereb. Cortex 16, 916–928 (2006).
5. Godefroy, V. et al. ECOCAPTURE@HOME: Protocol for the Remote Assessment of Apathy and Its Everyday-Life Consequences. Int. J. Environ. Res. Public. Health 18, 7824 (2021).

Paper 9447: Explainability of Artificial Neural Networks, performing a Motor-Imagery Task

David Kreuzer and Cornelia Herbert

Introduction: Electroencephalography (EEG) paradigms perceived as being simple, like the P300 Speller or Motor-Imagery (MI) tasks, are gaining increased popularity. Especially with a growing community in the field of Deep Learning (ML) and Brain-Computer Interfaces (BCI), these experimental stimulus paradigms are often used as showcases on the one hand and for bench-marking the hardware on the other hand. Indeed, the use of these paradigms in combination with automated data analysis methods such as traditional machine learning algorithms and more recently deep learning have grown in popularity to establish automated and flexible usage in a variety of fields of applications ranging from cerebral and motor rehabilitation to the fields of sports and gaming. From a methodological point of view, the unreflected use of these paradigms and algorithms can lead to critical misconceptions, especially when Deep Neural Networks are used, which are often treated as black boxes. Overfitting, unwanted feature promotion like synchronization errors, artifacts or incorrect paradigm execution can lead to mistakenly correct classification results. In this work, methods of the field of Explainable Artificial Intelligence, which is gaining impact, are used to find indicators in the neural networks decision-making process that point to phenomena of the actual problem, to minimize the probability of false statements.
Methods: To allow standardization, the EEG data is recorded non-invasively with a high-density stationary EEG-system (BrainProducts GmbH) using the standardized 10-20 layout for head montage and 32 active electrodes for recording for noise reduction, and a sampling rate of 1000 Hz. Given the importance of motor imagery paradigms in sports and exercise applications, the classical motor imagery task is used as paradigm. The data is preprocessed prior to model fit including bandpass-filter (1-30 Hz) and independent component analysis (ICA) for artifact detection and removal. A Convolutional Neural Network and 2 feed-forward layers are used for feature extraction and classification respectively. Two input representations are used. In addition to the raw data, the frequency domain representation is used for a second training pass. The neural networks activity in different network layers is then analyzed. Correlations between the features generated by the network and the features used in classical machine learning approaches are evaluated.
Results & Discussion: Spatial activity in brain regions that are well known to be important for the task are to be expected to be amplified in the network, as relevant features are likely to be found in these regions. Likewise, it is explored whether electrode channels located above or in the proximity of the motor cortex and activity changes in the EEG frequency domain (alpha and beta bands) are contributing more than other EEG channels and activity changes to the accuracy of the results. The results are discussed with respect to current trends in deep learning-based techniques including

subject-independent classification and real-time employment as well as with respect to usability in sports and exercise research.

Paper 5078: A deep learning-based approach for the classification of mild cognitive impairment from scalp EEG recordings

Abdelaziz Triki, Anita Hökelmann, Bassem Bouaziz and Walid Mahdi

Abstract: As the average lifespan in our society increases, the number of people suffering from neurocognitive diseases such as Alzheimer's is now the most frequent. Advancements in biomedical data and computer capabilities allow for new approaches to detecting and preventing neurocognitive problems. Mild cognitive impairment, which may be a precursor to Alzheimer's disease, is amenable to early identification by using computer-aided Electroencephalography (EEG) analysis. EEG signals were presented as one of the most valuable sources of information by recording the electrical activity of the brain. Furthermore, they provide a reliable and low-cost method to explore different patterns between amnestic mild cognitive impairment (aMCI) and non-aMCI (naMCI). We collected brain wave signals using an EEG system (Nihon Kohden Neurofax EEG-1200) during a 3 level N-Back working memory test, where 32 active electrodes were employed. During the preprocessing step, the EEG signals will be cut into smaller frames and converted to the frequency domain using the Fast Fourier Transform (FFT) transform to extract brainwave sub-bands (theta, alpha, and beta). Then, the extracted brainwave sub-bands will be converted to 2D images, where they will be used as input to train a convolution neural network (CNN) model for patient classification. An accurate classification of subjects into healthy Normal Control (HNC), aMCI, and naMCI in its early stages plays a vital role in intercepting the progression of memory disorders and contributing to ameliorating the quality of life of elderly patients with MCI disorders. In this paper, we propose a new deep learning-based approach, where the baseline is composed of five CNNs and one max-pooling layer to extract discriminative features and perform accurate classification. In addition, we used seven batch-normalization and one fully connected layer as well as a rectified linear unit (ReLU), which is used as an activation function. The proposed method can lead to several benefits for potential MCI individuals and can also lead to an early diagnosis of Alzheimer's. To validate the effectiveness of the proposed method, we performed experiments on our collected dataset and compared them with the state-of-the-art methods. The experimental results showed that the suggested approach for subject classification offered high accuracy for the healthy, aMCI, and naMCI groups. The proposed method has yielded a classification accuracy of 94%, 92% and 93.7% for HNC, aMCI and naMCI, respectively, outperforming the competing methods.

Keywords: MCI; classification; EEG signals; CNN, N-Back Test

Paper 5256: Depthwise Separable Convolution ResNet with attention mechanism for Alzheimer's detection

Rahma Kadri, Bassem Bouaziz, Mohamed Tmar and Faiez Gargouri

Abstract. Convolutional neural networks (CNNs) have been widely applied for brain disease detection based on neuroimaging data. It shows significant and accurate results. Alzheimer's disease is one of the most common neurodegenerative disorders affecting a person's ability and cannot be reversed. The early detection of this disease can slow its progression. Researchers adopt Magnetic Resonance Imaging (MRI) modality as a biomarker for Alzheimer's disease detection based on CNN. Building a CNN model that enhances reliable feature extraction and representation is challenging for Alzheimer's disease detection. The main drawback of CNN is that increasing model size could affect the model's performance. Furthermore, CNN cannot capture long relationships between image features. In this paper, we proposed a Depthwise Separable Convolutional ResNet with an attention mechanism to address these challenges. The proposed network replaces the standard convolution

operation with a depth-wise separable convolution to decrease the network parameters and size, which reduces overfitting. The attention mechanism is employed to boot the network feature representation capability. We evaluated our model using MRI data from the Open Access Series of Imaging Studies (OASIS) dataset. The proposed model outperforms different CNN models.
Keywords: Alzheimer's detection· CNN· MRI · Depthwise Separable Convolution ResNet · attention mechanism.

Oral Session 3: Technologies in Rehabilitation and Prevention

Chair 1: Prof. Dr. Walid Mahdi

Chair 2: Dr. Tarek Zlitni

Paper 3726: Remote Physiotherapy to Protect Physcial Health in Duchenne Muscular Dystrophy: Telerehabilitation

Arzu Erden, Demet Öztürk, Mustafa Sarı, Halil İbrahim Çelik, Azize Reda Tunç, Banu Ünver, Hasan Erkan Kılınç, Nurhayat Korkmaz, Mehtap Turanoğlu, Selda Gürsoy and Aynur Ayşe Karaduman

Aim: The aim of the study was to investigate the effects of the telerehabilitation program on performance level, endurance, fall frequency, respiratory functions, and satisfaction of individuals with DMD. Method: Fourty two patients with DMD were included in the study. Thirty of them were ambulant in group 1, and 12 were non-ambulant in group 2. The tele-rehabilitation program applied the for 24 sessions (3 days/week). Ten-meter walking test, stand up from the supine position, and modified upper extremity performance test were used. Their endurance were assessed by the knee and elbow flexion/extension tests. Single breath count (SBC) test were used for pulmonary function. The fall frequency and satisfaction level were also recorded.
Results: Significant improvement was found between before and after telerehabilitation in elbow and knee flexion/extension test, upper extremity performance, pick up coin, fall frequency and pulmonary function results in group 1 ($p<0.001$, $p<0.001$, $p=0.002$, $p=0.017$, $p=0.026$, $p=0.035$). Also, there was an improvement in pulmonary function in the group 2 ($p=0.013$). Satisfaction with the service was 88%.
Conclusion: The 8-weeks telerehabilitation program which applied remotely was effective in improving endurance, upper extremity performance, fall frequency, pulmonary function and satisfaction levels in patients with DMD. Keywords: Duchenne Muscular Dystrophy, telerehabilitation, satisfaction, pulmonary function, falling, performance test.

Paper 5796: Exergames and Autism Spectrum Disorder: an Integrative Review

Karollyni Bastos Andrade Dantas, Estevão Scudese, Renato Ramos Coelho Ramos Coelho, Jocélia Pinho Mendonça Pinho Mendonça, Maria Eduarda Fonseca, Maria Fernanda Franco, Maria Fernanda Targino, Maria Luísa Barreto Paiva, Maria Paula Aragão Andrade and Estélio Estélio Henrique Matin Dantas

Abstract: Exergames are games characterized by the physical interaction of participants with active video games, which capture and virtualize the actual movements of users. Parallel to this, the population with Autism Spectrum Disorder (ASD) prefers more sedentary and indoor activities, which encompass visuospatial skills, such as screen-based ones. Therefore, exergames are safe and have several advantages in ASD intervention. They work as a potential tool to treat children and adolescents, specifically physical activities, cognitive functions, and repetitive behavior. Exergames can influence treatment adherence because they are more pleasant and motivational than everyday

physical activities. Exergame interventions result in significant improvements in physical fitness, executive function, and self-perception, which results in positive active behavior. For instance, physical exercises may be promising for reducing repetitive behaviors in children with ASD and improving their cognitive functioning. However, the neurophysiological mechanisms are still not well understood. It is known that the immediate and long-term effects would be the improvement in cerebral blood flow, which leads to a better supply of oxygen and nutrients, and the removal of brain by-products. Furthermore, the time devoted to exergames might be essential for acquiring new skills in controlling objects associated with limb movements, such as catching or kicking a ball. The most used consoles are Xbox Kinect, Nintendo Switch, and PlayStation, and the most common games are: "Kinect Sports," "Just Dance," and "Kinect Adventure." Regarding Kinect, this tool provides three-dimensional activities. It identifies the execution of movements, being an excellent platform since it does not require the user to use or hold something and challenging the execution of mutual and shared behaviors. For example, a previous study showed that the effects of a single 20-minute session of exergames were able to generate a significant decrease in repetitive behavior and improve the cognitive performance of students with ASD compared to the control group that only watched television. Corroborating data shows that Xbox Kinect participants spent 76% to 94% of their time playing at moderate to vigorous intensity within the American College of Sports Medicine (ACSM) guidelines, which recommend at least 150 minutes of moderate-intensity aerobic exercise per week. Thus, a protocol of exergames of three to four sessions of one hour per week will lead the patient to be within the recommended physical activity levels. Despite the positive results associated with exergames, little has been observed regarding the development of motor skills and emotional regulation in the literature. Therefore, clinicians should be careful about the expectation of benefiting emotional and motor regulation of skill development when prescribing exergames to children and adolescents with ASD. Future research should provide evidence on the treatment and longitudinal effects of exergames.

Keywords: Autism Spectrum Disorder; Cognition; Games, Recreational.

References

1. Lima JL, Axt G, Teixeira DS, Monteiro D, Cid L, Yamamoto, T, Murillo-Rodriguez, E, Machado S (2020) Exergames for Children and Adolescents with Autism Spectrum Disorder: An Overview. Clinical Practice and Epidemiology in Mental Health 16:1-6. https://doi.org/10.2174/1745017902016010001
2. Ruggeri A, Dancel A, Johnson R, Sargent B (2020) The effect of motor and physical activity intervention on motor outcomes of children with autism spectrum disorder: A systematic review. Autism: The International Journal of Research and Practice 24(3):544-68. https://doi.org/10.1177/1362361319885215
3. Rafiei HM, Sheikh M, Najafabadi MG, Saghaei B, Naghdi N, Dewey D (2021) The effects of physical activity and exergaming on motor skills and executive functions in children with autism spectrum disorder. Games for Health Journal, 10(1):33-42. https://doi.org/10.1089/g4h.2019.0180
4. Anderson-Hanley C, Tureck K, Schneiderman RL (2011) Autism and exergaming: effects on repetitive behaviors and cognition. Psychology Research and Behavior Management 2011(4):129-37. http://dx.doi.org/10.2147/PRBM.S24016
5. Edwards J, Jeffrey S, May T, Rinehart NJ, Barnett LM (2017) Does playing a sports active video game improve object control skills of children with autism spectrum disorder? Journal of Sport and Health Science, 6(1):17-24. https://doi.org/10.1016/j.jshs.2016.09.004

Paper 3363: Wearables and wireless technology for training and telerehabilitation services

Uroš Marušič and Luka Šlosar

INTRODUCTION: Recent advances in wearables and wireless technology offer a number of opportunities to better understand human behavior and open new avenues for training and rehabilitation. The goal of this study is to introduce the recently developed Mobile Brain/Body Imaging (MoBI) approach and to develop a classification system for technologies used in movement-related research, with particular attention to technologies associated with extended reality (XR). Finally, we will highlight critical challenges for future solutions in this area.

METHODS: PubMed, Embase, Web of Science, and MEDLINE (NLM) databases were searched (preferably with publication dates < 5 years). Manuscripts on "wearable technology," "remote technology," and "wireless technology" in combination with "training" and "extended reality" (with specific variations in keyword combinations) were searched. We also searched for telerehabilitation requirements that could potentially support home health care services.

RESULTS: The classification of wearables is generally related its placement on the user's body. The main groups can be classified as follows: Head-worn wearables - software capable of combining real and virtual environments (referred to as extended reality - XR); Body-worn devices - such as electroencephalography (EEG) or inertial measurement units (IMUs) - based motion tracking systems. A recently developed MoBI approach (Greeley et al., 2021) adapts wireless sensors capable of simultaneously capturing whole-body motion and brain activity. Although complex analysis is still required for EEG monitoring, most wearables can share data with apps installed on smartphones and get quick responses (Djapic et al., 2018).

CONCLUSION: Under more natural conditions, the emerging field of MoBI facilitates understanding of brain and body dynamics. Combined with XR environments, this technology can potentially enhance user sensory stimulation and create possible future conditions for remote physical and cognitive assessment and rehabilitation. To guide discussion on the emerging topic of technology integration in movement interventions and provide recommendations for the necessary original research, we propose a classification system with appropriate definitions for future movement-related interventions based on the digital device used, location on human body, and the user-related experience (including all forms of XR environments).

REFERENCES:

Djapic, R., Vivier, G., Zhen, B., Wang, J., Lee, J., & Haiming, W. (2018). Wearables white paper. Retrieved from Den Haag: http://resolver.tudelft.nl/uuid:9065648e-8b2e-4a40-b2e1-0aaed6512464
Greeley, B., Hanada, G., Boyd, L. A., and Peters, S. (2021). The time for translation of mobile brain and body imaging to people with stroke is now. Phys. Ther. 101:pzab058. doi: 10.1093/ptj/pzab058

Paper 8549: Digital Health Application for Personalized Rehabilitation after Ankle Inversion Trauma

Rosemary Dubbeldam, Jonathan Neugebauer, Yu Yuan Lee, My Linh Pham, Lokman Beser, Luka Gerlach and Herbert Kuchen

INTRO Ankle injuries after inversion trauma are common and they can have serious consequences1. Physiotherapy is rarely prescribed, although studies report a 60% reduced risk of re-injury after balance training2,3. Patients demonstrate a broad variety of impairments in function and activity after ankle inversion trauma1,4. E-health solutions such as InjuryMap© and SWORD HEALTH offer more or less independent rehabilitation after ankle inversion trauma. Their first user experiences are positive, though adherence is low without health professional interaction, and personalisation is limited. The digital system in this study aims to provide personalized rehabilitation, which could help

patients return to work or sport in an effective and efficient manner and reduce the risk of chronic disability.

CONTENTS Deviations from normal recovery of balance, gait, and the ability to jump or land predict chronic ankle injury4. Several impairments can be addressed by patients themselves. For example, static stretching has a positive effect on ankle range of motion; Balance training and muscle strengthening improve balance and reduce the risk of recurrent injury2. Validated questionnaires related to the rehabilitation process include e.g., the Foot and Ankle Ability Measure and the Cumberland Ankle Instability Tool. Therefore, such questionnaires and simple assessments of structural function and activities are used to determine the user's baseline level, design a personalized training program and monitor the user's progress.

SYSTEM The developed digital system consists of several phases, such as educating the users about their injuries, assing their impairments, and providing a customized training program. Notifications are built in to help users stick to their rehabilitation program and feedback on impairments serves extrinsic motivation. On the one hand, the system involves a mobile app providing different activities and information to the user. It can be used on both iOS and Android devices. On the other hand, there is a corresponding server component with which the mobile app synchronizes. Here, data collected based on the activities within the app is saved in a database to be used for statistical analysis. Additionally, the medical knowledge involved in determining new exercises based on the user's progress is expressed through adaptable rules which are evaluated by a so-called rules engine. This mechanism makes it easy for health experts to change the app's behaviour. By employing different software engineering techniques, we designed the system to be adaptable to other fields of medical research with comparably low effort. Namely, we follow a model-driven software development approach and use a domain-specific language to specify questionnaires to be offered in the mobile app; artefacts necessary for the system are generated automatically based on such specifications.

CONCLUSION This system can be used independently by users or accompanied by a health professional. The system does not need additional technology and can be easily adapted by health professionals if needed. The system provides users with information about their injuries and personalized training, as well as health professionals with therapy support and progress monitoring. Since the system can store health-related data such as the user's function and activities as well as answers to questionnaires, it will also be a useful tool for research.

REFERENCES

1. Hertel, 2019. An updated model of chronic ankle instability. J Athl Tr
2. Eils, 2001, A multi-station proprioceptive exercise program in patients with ankle instability. Med Sci Spo Exc
3. Bleakley, 2019. Rehabilitation Exercises Reduce Reinjury Post Ankle Sprain, But the Content and Parameters of an Optimal Exercise Program Have Yet to Be Established: a systemaic review. Arch Phy Med Rehab
4. Doherty, 2016. Recovery From a First-Time Lateral Ankle Sprain and the Predictors of Chronic Ankle Instability. Am J Spo Med

Paper 7022: Inertial Sensor Based Assessment of Transversal Upper Body Rotation in Junior Elite Long Distance Runners

Charlotte Lang, Fides Berkel, Axel Schleichardt, Frank Warschun, Nico Walter, Daniel Fleckenstein and Olaf Ueberschär

Introduction Running enjoys widespread popularity in recreational and competitive sports. Despite its various physiological benefits, the prevalence of lower body overuse injuries is still high, partly due to high impact forces. While the majority of studies has been focusing on leg dynamics and kinematics, only a few address the dynamics of the upper body so far. The aim of this study is to close this gap by assessing upper body transversal rotation in junior elite athletes by means of

magneto-inertial sensors. From a biomechanical point of view, this additional perspective is mandatory to avoid excessive torsional stress in the legs and to optimise running efficiency.
Methods Eighty-six healthy junior elite runners (49 females, 37 males) from the German national team completed an incremental treadmill test of four stages of either 2000 m (middle distance) or 3000 m (long distance). For each participant, triaxial magneto-inertial measurement units (Xsens MTw Awinda) were fixed non-invasively at the shoulders and the sacrum in order to measure scapula and pelvis rotation angles.
Results Running speed significantly affects transversal rotation of the scapulae over the four stages ($p < 0.001$), with mean amplitudes increasing by 6.0° and 4.1° from stage 1 to 4 for female and male runners, respectively. Gender exhibits a further highly significant effect for every stage ($p < 0.001$), where the females show higher scapular rotation angles than the males for all stages. Post-hoc tests showed significant increases in rotational range from stage to stage for both genders ($p < 0.025$; $0.11 \square d \square 0.49$), as they do for the pelvis rotation, but without any significant gender effect.
Conclusions Upper body rotation significantly intensifies with increasing running speed. The extent of transversal trunk rotation seems to be influenced by gender-specific mass ratios between upper and lower extremities. The collected data may serve as a reference for healthy junior elite runners.

Paper 8014: Use, perceptions, and attitudes of Slovenian ″digitalized seniors″ towards information-communication technology

Saša Pišot, Katarina Puš, Kaja Teraž, and Blaž Lenarčič

Introduction: The rapid technological development and the increasing ageing population are among the most evident changes that permeate society. According to Adler (2005) , we are now at the intersection of megatrends - the technology and ageing. Nevertheless, the enthusiasm for all opportunities presented by technological development in the field of ICTs often makes us forget the other megatrend, namelythat the information society is also an ageing society. It can be said that the ICT designers, developers and policymakers focus on the needs and requirements of main users, i.e., younger people, while the ageing factor is underestimated. Just as the use of ICT can improve the quality of life of younger generation, it can also contribute to a higher quality of life for the third generation. This was especially evident in the last two years of pandemic, when physical isolation took place and maintaining social life was possible mainly through ICT. The aim is to present the current state of technology field of the elderly and access to ICT, which devices are used most, the purpose and frequency of ICT, use and their attitudes toward ICT.

Methods: The data derive from the project ActivAge – Supporting ageing adults to stay active funded by the EU Erasmus+ Programme. The random sample of Slovenian respondents was provided by University of Maribor and Science and research centre Koper, during the summer of 2021. Respondents completed the questionnaire which consisted of 78 questions split into 7 sections among which we focus on access to ICT and perception of digital technology.

Total sample consisted of 153 respondents (63.4% women) with mean age 72.0 ± 6.2 years. The statistical analysis was conducted in IBM SPSS (SPSS Inc., Armonk, NY, USA). Primary analysis was done with descriptive statistics, additionnaly we have used Peason's coefficient to evaluate correlatation between different variables. Statistical significance was set at $p < 0.05$.

Results: Of the total sample, the majority (96.9% of women and 94.6% of men) have access to a computer, laptop, or tablet. We found a positive correlation between the use of technology at least twice a week and finding ICTs fun ($r=.335$, $p <.001$) and the use of technology at least twice a week and agreeing that it makes their lives easier ($r=.546$, $p <.001$). On the other hand, we found a negative correlation between participants who use technology at least twice a week and find it difficult to keep up with the pace of progress ($r= -.294$, $p = .001$) and participants who use technology at least twice a

week and those who are afraid that they will not be able to use digital technologies (r= -.277, p = .001). We also found a positive correlation between the age and those who fear they will not be able to use digital technologies (r = .307, p = .002). Participants who engage in regular physical activity at least three times per week also use technology at least twice a week (r = .333, p <.001).

Discussion: It has been shown that regular use of this technology reduces stress and fear of the unknown and new things while being fun or entertaining. However, it is evident that the age of the user limits both the inclination and the ability to use ICT, mainly due to the lack of experience and the related fear of novelty. It has also been shown that active elderly people use ICT more frequently. Conclusions: When introducing the use of ICT, it is important to be aware of the barriers such as fear bias and insecurity faced by the older adults and to adapt the equipment as well as the ICT training accordingly.

Oral Session 4: Technologies & Sport Science (Hybrid)

Chair 1: Prof. Jürgen Edelmann-Nusser

Chair 2: Prof. Dr. Rado Pišot

Paper 1398: Impact of wearing FFP2 masks on biomechanical asymmetries in running gait

Corinne Rinck, Jonas Tim Helmholz, Franziska Schneider and Olaf Ueberschär

Purpose Running enjoys worldwide popularity as a recreational sport. Irrespective of training setting (i.e., road, track, cross-country, treadmill), imbalances in lateral load distribution in the lower limbs are considered a risk factor for overuse injuries. With the onset of the Covid 19 pandemic in spring 2020, recreational runners were widely obliged to wear FFP2 masks during their indoor treadmill sessions, and sometimes even during their outdoor runs. While it has meanwhile been shown that FFP2 masks substantially affect cardiopulmonary functions, their implicit biomechanical effect on running gait is still unknown. In this study, this research deficit is addressed by measuring the effect of FFP2 masks on biomechanical loads and asymmetries in recreational runners.
Methods Thirteen recreational runners (9 males, 4 females, 28,7±7,0 years of age, BMI of 21,8±2,5 kg m-2) participated in this study. All subjects completed three bouts of 5 min each in randomised order on a motorised treadmill at their individual typical aerobic running speed. The three bouts comprised the conditions shoed without mask, shoed with FFP2 mask and barefoot without mask. For all bouts, mean peak accelerations in tibiae, scapulae and sacrum were measured using 5 wireless IMUs.
Results While running with shoes vs. barefoot substantially affected lateral asymmetries on the individual level, overall statistics did not show a significant common trend. However, wearing a FFP2 mask did lead to a small, but significant increase in mean lateral load asymmetry in the sacrum, growing from 5.2% to 6.2% ($p<0,05$, Cohen's d of 0.11). Conclusion Wearing a FFP2 mask not only affects cardiopulmonary function, but also impacts biomechanics of running gait towards higher load asymmetries, intriguingly more strongly than running with shoes vs. barefoot. Given the small sample size, further research is indicated to verify those results for a larger cohort.

Keywords: IMUs, running gait, symmetry analysis, biomechanical analysis, FFP2 mask

Paper 8290: The multifunctional sensor-based diagnostic device and its application in orthopedic diseases of the lower extremities

Stefanie John and Kerstin Witte

Abstract: Examinations of function after lower limb injuries or surgeries are important to improve and document rehabilitation progress. To provide a standardized measuring system for objective and reliable data, a sensor-based multifunctional diagnostic device was developed for the analysis of hip strength, hip range of motion and static and dynamic balance abilities. The data obtained in the different testing scenarios are processed and visualized in an in-house software serving as feedback for patients and therapists. Due to its special features (pelvic support, rotatable base plate, swivelling seat for resting), the device is specially tailored to the needs of patients with a lower limb amputation as it enables a comfortable and safe measuring environment. Measurements have been performed with transfemoral and transtibial amputees. The parameters derived from the diagnostic device provided therapists with information about potential deficits of the amputees, which can be very important for the reduction of muscular imbalances, postural defects and associated pain. Furthermore, these parameters can help to objectify the classification of lower-limb amputees into the different mobility levels (so-called K-level), which are important for the allocation of the prosthetic components. Measurements have also been conducted with patients that had undergone a total hip replacement. Persisting inter-limb differences between the operated and the nonoperated side as well as general deficits compared to a control group could be revealed even 4 to 5 years after the surgery. The diagnostic device can be extended to many clinical areas of the lower extremities to help quantify individual changes or progress in the rehabilitation process.

Paper 0700: Musculoskeletal effectiveness of using exoskeletons in various lifting tasks in the logistics sector

Birte Scholz, Niklas Stanko, Johanna Rath, Elena Trümper, Luca Wilkat, Franziska Schneider and Olaf Ueberschär

Purpose Around the world, passive exoskeletons are increasingly gaining usage at workplaces in the logistics sector. Previous research suggests that they significantly alter the load onto the musculoskeletal system. To elucidate their effectiveness, we examine the musculoskeletal unloading of the human body when wearing passive exoskeletons during typical lifting in package warehousing and shipping. **Methods** Muscular load during self-controlled lifting task execution is compared via EMG among exoskeletons of two leading manufacturers (Hunic, Laevo) and to the unassisted case. Lifting tasks comprise a lower-limb driven movement pattern (“proper lifting”) and a back-driven pattern (“incorrect lifting”), each for zero and 10 kg extra weight. Each of the healthy subjects (5 m, 5 f) performs 12 bouts for every lifting task. Myoelectrical activity is assessed during lifting in 7 relevant muscles (trapezius (ascending part), latissimus dorsi, gluteus maximus, biceps femoris, rectus femoris, vastus medialis and gastrocnemius lateralis). **Results** Preliminary results for one subject confirm that an increase in weight from 0 to 10 kg leads to an elevated mean muscle activity in all muscles studied. For proper, unassisted lifting of 10 kg, overall muscle activation amounts to 98%, as opposed to 76% for Hunic-assisted and to 69% for Laevo-assisted lifting (where for each muscle highest measured activation among all three cases is defined as 100 %). Altogether, Hunic and Laevo exoskeletons reduce mean upper-body muscle activity in 10 kg proper lifting by 22% and 28%, respectively. **Conclusion** Passive exoskeletons may substantially reduce muscular load in various muscle groups of the lower and upper body for common lifting tasks. However, the amount of unloading seems to decisively depend on lifting movement pattern and the weight to be lifted, and may even turn into an unintended increase of muscular load. Ongoing research will have to verify those preliminary results.

Paper 0705: Cognitive control during walking: preliminary results of an ERP study

Manca Peskar, Klaus Gramann, and Uros Marusic

INTRODUCTION: There exists an ongoing debate with respect to how the maintenance of posture during standing and walking affects cognitive control. Walking is an attentionally demanding task, and some argue that if introduced in a cognitive-motor dual-task paradigm, the execution of walking contributes to cognitive-motor interference by occupying a portion of available attentional resources (Al-Yahya et al., 2011). Conversely, others claim that in healthy subjects with ample cognitive reserve, such walking-related recruitment of attentional resources in fact leads to enhanced attentional selectivity, resulting in cognitive-motor facilitation (Rosenbaum et al., 2017). In this study, we systematically manipulated the load on the cognitive and motor systems using a dual-task paradigm examining the electroencephalographic event-related P3 marker associated with stimulus categorization processes and attentional reserve.

METHODS: While sitting, standing, and walking at self-selected speed, 16 healthy participants aged 34.5 (± 8.63) years performed the Stroop task at three difficulty levels requiring increasing interference control, namely (a) the color word-reading, (b) ignoring the word but responding to the ink color, (c) and switching of the two tasks on trial-by-trial basis. Concurrently, EEG was recorded using a mobile 72-channel system. The P3 mean amplitude was computed over the 270-400 ms window post stimulus at the Pz site, and all post-hoc comparisons were Bonferroni corrected.

RESULTS: Reaction times and error rates were negatively affected by increasing difficulty of a Stroop task ($p < .05$) while no significant effect was observed with respect to the motor conditions. ANOVA for the P3 amplitude revealed a significant main effect of the Stroop task, indicating greater amplitude in the ink-naming task ($M = 3.92$, $SD = 2.63$) compared to the Word-reading task ($M = 3.06$, $SD = 2.15$, $p = .009$), whereas the mean amplitude was not significantly different in the Switching task. ($M = 3.35$, $SD = 1.96$). Also, for the P3 amplitude, a main effect of motor condition was observed, however, failing to survive Bonferroni correction, only a non-significant trend of greater amplitude while sitting ($M = 3.72$, $SD = 2.11$) compared to standing ($M = 3.39$, $SD = 2.15$, $p = .087$) and walking ($M = 3.22$, $SD = 2.29$, $p = .069$) was observed.

CONCLUSION: Our results indicate the following three things. First, in healthy individuals, behavioural performance deteriorates with increasing difficulty of a cognitive task, irrespective of motor condition. Secondly, it points that greater difficulty of a cognitive task is reflected in greater P3 amplitude for Stroop tasks, but this does not extend to even more challenging switching between the Stroop tasks. Thirdly, at supra-threshold level, our results suggest that motor conditions which require greater postural control diminish the cognitive-task-related P3 amplitude if performed concurrently. This is often interpreted as a motor-related decline in available attentional resources.

REFERENCES:

Al-Yahya, E., Dawes, H., Smith, L., Dennis, A., Howells, K., & Cockburn, J. (2011). Cognitive motor interference while walking: A systematic review and meta-analysis. Neuroscience and Biobehavioral Reviews, 35(3), 715–728.

Rosenbaum, D., Mama, Y., & Algom, D. (2017). Stand by Your Stroop: Standing Up Enhances Selective Attention and Cognitive Control.

Paper 6555: Interoperability Challenges and Critical Success Factors in the Deployment of Cross-border Digital Medical Prescriptions in Finland and Estonia

Flor Nino Palma

Abstract—This case study explores the challenges in the interoperability of cross-border digital medical prescriptions between Finland and Estonia as pioneer countries in cross-border ePrescription which means Finnish patients' prescriptions can be dispensed with medicines in Estonian pharmacies and vice versa. This delves into the critical factors that contributed to the success of this government e-service as well as the different deployment constraints that happened at every stage of the six levels of the refined eHealth European Interoperability Framework. Using the proposed integrative public value framework, the reported challenges and implemented solutions are further mapped out at which environments they typically occur whether in micro, meso, and macro levels. The data collection was done in multi-method by which semi-structured interviews were conducted to eight (8) key government experts from Finland and Estonia. Results revealed that common interoperability challenges typically happened at the collaborative environment or Meso level during the integration of ePrescription systems of these two countries. Challenges include different healthcare systems and processes, different national legislations on the policy of consent, limitations in financial and intellectual resources, constraints in the semantic level as new drugs and new prescriptions emerge in the pharmaceutical markets and the need for assessment to measure actual benefits and impact. On one side, the drivers of successful implementation consist of organizational and country resources, long-standing cross-border cooperation, trust, and political commitment, panEuropean support, and the qualities of their national ePrescription systems.

Keywords—interoperability challenges, critical success factors, cross-border ePrescription

Paper 6076: Mobile Applications for Performance Assessment and Prescription for Elderly

Karollyni Bastos Andrade Dantas, Estélio Henrique Martin, César Augusto Souza Santos, Lúcio Flávio Gomes Ribeiro da Costa, Rafaela Cristina Araújo Gomes and Fabiana Rodrigues Scartoni

ABSTRACT Diagnostic evaluation methods using technologies through integrated equipment are increasingly present in a scenario where the world population is aging rapidly. In this context, the increase in life expectancy increases the risk of falls and Chronic Non-Communicable Diseases (CNCDs). Diagnosing the risk of falls, functional autonomy, and physical conditioning are essential for prescribing efficient training for the elderly. The objective of this study is to present the computerized technologies developed by the Laboratory of Biosciences of Human Motricity (LABIMH) with potential for employability and applicability in the prevention, protection, and promotion of health, with low cost, namely: Applicative for Functional Autonomy Assessment (GDLAM AF); Applicative for Risk Assessment of Falls (BARQ); Kit for Risk Assessment of Falls (Kit BARQ); and Applicative for Assessment of the Physical Conditioning Index (ICFI). The applicatives (Apps) aim to optimize, through technological innovations, the manual procedures for collecting data from the respective evaluation protocols, improving the use and even increasing the security of the data collected through automatic archiving in a database in the cell phone itself. The BARQ Kit enables the correct application of the methodology for identifying the risk of falls in the elderly, facilitating the application by professionals. It is recommended to use the technologies proposed by LABIMH through the developed Apps to reduce costs and increase precision through more reliable and faster results, accelerating health intervention. Keywords (DeCS/MeSH): Innovation, Mobile Applications, Exercise, Elderly Health, Elderly.

References:

de Araújo Alencar, N., Bezerra, J. C. P. & Dantas, E. H. M. (2009). Avaliação dos níveis de atividade física, autonomia funcional e qualidade de vida de idosas integrantes do programa de saúde da família. Fitness & Performance Journal, 8(5), 315–321.

Figueiredo, C. M. S. & Nakamura, E. (2003). Computação móvel: Novas oportunidades e novos desafios. T&C Amazônia, 1(2), 21.
Gamito, P., Oliveira, J., Lopes, P., Morais, D., Brito, R., Saraiva, T., Bastos, M., Cristóvão, S., Caçôete, C. & Picareli, F. (2013). Assessment of frontal brain functions in alcoholics following a health mobile cognitive stimulation approach. Annual Review of Cybertherapy and Telemedicine, 191, 110–114.
Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I.-M., Nieman, D. C. & Swain, D. P. (2011). Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory, Musculoskeletal, and Neuromotor Fitness in Apparently Healthy Adults. Medicine & Science in Sports & Exercise, 43(7), 1334–1359. https://doi.org/10.1249/MSS.0b013e318213fefb
Lavie, C. J., Ozemek, C., Carbone, S., Katzmarzyk, P. T. & Blair, S. N. (2019). Sedentary Behavior, Exercise, and Cardiovascular Health. In Circulation Research (Vol. 124, Issue 5, pp. 799–815). Lippincott Williams and Wilkins. https://doi.org/10.1161/CIRCRESAHA.118.312669
Malta, D. C., Morais Neto, O. L. de & Silva Junior, J. B. da. (2011). Apresentação do plano de ações estratégicas para o enfrentamento das doenças crônicas não transmissíveis no Brasil, 2011 a 2022.
Mosa, A. S. M., Yoo, I. & Sheets, L. (2012). A systematic review of healthcare applications for smartphones. BMC Medical Informatics and Decision Making, 12(1), 1–31.
Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., Macera, C. A. & Castaneda-Sceppa, C. (2007). Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. Circulation, 116(9), 1094.
OMS. (2005). Envelhecimento ativo: uma política de saúde. Organização Pan-Americana da Saúde-OPAS.
Pimentel, W. R. T., Pagotto, V., Stopa, S. R., Hoffmann, M. C. C. L., Andrade, F. B. de, Souza, P. R. B. de, Lima-Costa, M. F. & Menezes, R. L. de. (2018). Quedas entre idosos brasileiros residentes em áreas urbanas: ELSI-Brasil. Revista de Saúde Pública, 52.

Paper 4897: Technology and Sample Characteristics of Home-Based Technology-Assisted Exercise/Physical Activity (PA) Interventions in Older Adults: A Scoping Review

Niharika Bandaru and Anita Hökelmann

Introduction: Evidence exists for literature reviews on physical activity interventions in older adults primarily focused on fall prevention, acute care rehabilitation, and specific health conditions. However, no reviews have been conducted on physical activity interventions using technology in home settings for the elderly. Hence, our current scoping review focuses on finding technologies available for the senior population for home-based exercise intervention and their sample characteristics.
Methods: The PRISMA Extension for Scoping Reviews (PRISMA SCR) was used to conduct this scoping review. The articles are searched in the following six databases: PubMed, Research Gate, Epistemonikos, Embase, Science Direct, and the Cochrane Database of Systematic Reviews from 1 January 2000 to 1 May 2022 based on eligibility criteria. The following data were extracted from each study: author; publication year; type of technology used; duration and type of Intervention; sample characteristics (total participants, average age, education level, experience with technology, economic level, and male/female ratio); technology characteristics (Acquisition of frequency of usage, the usability of the technology, and psychological input). Data coding, aggregation and charting were performed in Microsoft Excel using extracted data and framework coding.
Results: Twelve articles considered in the study were published in the last 22 years (2000-2022), indicating that the use of technologies for physical activity interventions at homes for the elderly has moderate development. Also, the distribution of sample sizes for all the studies included in the current scoping review exhibits the right skewness.

Discussion: All the studies have focused on the physical activity interventional outcomes, but only a few have focused on participants' economic background, educational level, and experience with technology. Regarding technology characteristics, fewer studies focus on techniques to improve Implicit motivation and decrease initial usage assistance. However, the right-skewness highlights the scarcity of large-scale, population-based health-based study designs with long-term follow-up.

Paper 6814: Exergames and Elderly Cognition: An Integrative Review

Karollyni Bastos Andrade Dantas, Renato Ramos Coelho, Elizabeth Carvalho Lugão, Estevão Scudese, Gabrielly Gomes Lima de Sá, Rhayana Oliveira Falcão, Laís Oliveira Melo, Lara Letycia Araujo Costa, Álvaro Carson Alves Vieira and Estélio Henrique Martin Dantas

Abstract: Aging is associated with the individual's executive functional loss, hence the importance of finding ways to minimize this decline. In this sense, exergames emerges as a possibility to stimulate the elderly through immersion and a virtual environment. Thus, through a systematic review, the aim was to verify the effect of activities mediated by an exergame on the elderly. The searches were carried out in the following databases: Web of Science, Scopus, PubMed, SciELO and Google Scholar, articulating different Boolean terms and operators. The articles considered were published from 2018 to 2022, and with subjects of exergame interventions on physical outcomes such as balance, gait, limb movements, muscle strength, cognition, and memory in healthy and unhealthy older adults. Positive results were observed in different domains such as cognition, abstract reasoning, memory, and greater engagement in physical activities. Even groups of vulnerable older adults, such as asylum members and those with Parkinson's, obtained significant gains from the practice of exergames. Thus, it was found that an exergame is a valuable tool for improving cognition, reasoning, and memory and as an incentive to practice physical activity in the elderly, even in the most fragile groups.

Keywords: Aged; Cognition; Games, Recreational; Mental Health; Video Games.

References

1. Chen C-K, Tsai T-H, Lin Y-C, Lin C-C, Hsu S-C, Chung C-Y, Pei Y-C, Wong, AMK. (2018) Acceptance of different design exergames in elders. PLoS ONE 13(7):e0200185. https://doi.org/10.1371/journal. pone.0200185
2. Garcia-Agundez A. Folkerts A-K, Konrad R, Caserman P, Tregel T, Goosses M, Göbel S, Kalbe E (2019) Recent advances in rehabilitation for Parkinson's Disease with Exergames: A Systematic Review. Journal of NeuroEngineering and Rehabilitation 16:17 https://doi.org/10.1186/s12984-019-0492-1
3. Meneghini V, Barbosa AR, Mello ALSF, Bonetti A, Guimarães AV (2016) Perception of the elderly regarding participation in exergaming-based exercise: a qualitative study. Ciênc. saúde colet. 21(4):1033-41. https://doi.org/10.1590/1413-81232015214.11812015
4. Chu CH, Quan AML, Souter A, Krisnagopal A, Biss RK (2022) Effects of Exergaming on Physical and Cognitive Outcomes of Older Adults Living in Long-Term Care Homes: A Systematic Review. Gerontology 1-17. https://doi.org/10.1159/000521832
5. Wollesen B, Wildbredt A, Van Schooten, KS, Lim ML, Delbaere K (2020) The effects of cognitive-motor training interventions on executive functions in older people: a systematic review and meta-analysis. European Review of Aging and Physical Activity 17(9):01-22. https://doi.org/10.1186/s11556-020-00240-y

Paper 0550: Steps to organisational change towards digital health for elders - A case of success.

João Teixeira-Sousa, António Bandeira, Fabiana Lima, Daniel Beirão and Filipe Freitas-Pinto

With population ageing and increasing healthcare services usage, health institutions are forced to reinvent themselves across time. Transitioning to digital health has been identified as a way to promote sustainability of healthcare systems. Knok is a private digital-healthcare service provider that is conducting a pilot intervention in elders' nursing homes, aiming to change how the institutionalised elder population receives their primary medical care.
This project followed the eight steps of change implementation according to John P. Kotter's: 1- "Establishing a Sense of Urgency"; 2- "Forming a powerful guiding coalition"; 3- "Creating a vision"; 4- "Communicating the vision"; 5- "Empowering others to act on the vision / overcoming obstacles"; 6- "Planning for and creating short-term wins"; 7- "Consolidating improvements and producing more change"; 8- "Institutionalising new approaches".
Knok successfully implemented digital transformation in nursing homes, having covered all Kotter's steps: (1) The adoption of digital solutions by the nursing homes was perceived as "urgent" in the context of lack of access to traditional healthcare services. (2) A powerful coalition was formed between project leaders and clinical teams of both parties (knok and nursing homes), which promoted change in the day-to-day care of the nursing homes. (3) Through the last 5 years, Knok built a vision of digital health that is shared by several partner organisations (e.g. private hospitals and clinics, telecommunication and insurance companies), which was ready to be shared with the nursing homes. (4) On the field, both clinical and operational teams were embedded in the vision and became pivotal agents in the spread the digital transformation. (5) Healthcare professionals were equipped with training, software, hardware, clinical and operational support, leading to increasing levels of autonomy in the use of digital tools. (6) The operation was structured so results could be seen from day one (e.g. permanent medical availability) and shortterm clinical and operational objectives were defined weekly, monthly and biannually. (7) Data is collected daily to assure continuous improvement. Also, new digital tools (e.g. photoplethysmography and AI emotional recognition) and new digital-health services have been planned for the near future. (8) All tools are being provided to the nursing homes, promoting their autonomy in the design and implementation of new digital health solutions.

References

P. Kotter J (1995) Leading Change: Why Transformation Efforts Fail. In: Harvard Business Review. Harvard Business School Publishing Corporation, pp 59-67
Groom L, McCarthy M, Stimpfel A, Brody A (2021) Telemedicine and Telehealth in Nursing Homes: An Integrative Review. Journal of the American Medical Directors Association 22:1784- 1801.e7