

Kognitivno-motorička (dual-tasking) rehabilitacija i prevencija u kliničkim istraživanjima:

- Moždani udar
- ADHD
- Cerebralna paraliza
- Parkinsonova bolest
- Multipla skleroza

MOŽDANI UDAR

👉 **PEMOCS: effects of a concept-guided, PErsonalized, MOrtor-Cognitive exergame training on cognitive functions and gait in chronic Stroke—a randomized, controlled trial.** Huber et al.; 2025

<https://pubmed.ncbi.nlm.nih.gov/40182756/>

Among secondary outcomes, the mobility domain of the HRQoL questionnaire, intrinsic visual alertness, cognitive flexibility, working memory, and outdoor walking speed as well as swing width (unaffected side) showed significant interaction effects in favour of the exergame group.

Additional exergaming helped maintaining global cognitive functioning and showed encouraging effects in mobility and cognitive outcomes. Responders and non-responders did not differ in adherence, baseline values or age. Enhancing the frequency and intensity of sessions could unlock more substantial benefits. Adopting a blended therapy approach may be key to maximizing positive effects.

👉 **Effect of dual task-based training on motor and cognitive function in stroke patients:** a systematic review and meta-analysis of randomized controlled trials. Mou, Jiang; 2025

<https://pubmed.ncbi.nlm.nih.gov/40660174/>

Results: 30 RCTs involving 1,588 people were included in the analysis. The study found that compared with the control group, dual-task cognitive motor training can improve the walking performance of stroke patients (WMD = 3.19, 95%CI: 2.26, 4.12), the recovery of lower limb motor function (WMD = 2.78, 95% CI: 1.38, 4.18), cognitive function (WMD = 2.93, 95% CI: 0.95, 4.91) and mental state (WMD = 3.39, 95% CI: 0.06, 6.72), and the functional state of activities of daily living (WMD = 7.47, 95% CI: 3.97, 10.96). Subgroup analyses showed that cognitive-motor dual-task training was more likely to have a clinical effect after at least 3 weeks of intervention.

Conclusions: Dual-task training significantly improves walking ability, lower limb motor function, cognitive function, mental status, and activities of daily living in stroke patients. No significant effects were found for basic mobility and gait speed. These findings support its clinical application, with personalized programs recommended based on patient needs.

Dual-Task Exercise Reduces Cognitive-Motor Interference in Walking and Falls After Stroke; Pang et al., 2018

<https://pubmed.ncbi.nlm.nih.gov/30571419/>

Results: Only the dual-task group exhibited reduced dual-task interference in walking time posttraining (forward walking combined with verbal fluency [9.5%, P=0.014], forward walking with serial-3-subtractions [9.6%, P=0.035], and the timed-up-and-go with verbal fluency [16.8%, P=0.001]). The improvements in dual-task walking were largely maintained at the 8-week follow-up. The dual-task cognitive performance showed no significant changes. The dual-task program reduced the risk of falls and injurious falls by 25.0% (95% CI, 3.1%–46.9%; P=0.037) and 22.2% (95% CI, 4.0%–38.4%; P=0.023), respectively, during the 6-month follow-up period compared with controls. There was no significant effect on other secondary outcomes (P>0.05).

Conclusions: The dual-task program was effective in improving dual-task mobility, reducing falls and fall-related injuries in ambulatory chronic stroke patients with intact cognition. It had no significant effect on activity participation or quality of life.

👉 The Contribution of Paresis, Age, and the Effect of Short Training on Cognitive–Motor Dual-Task Interference After Stroke: A Pilot Study.
Judith Mally et al., 2025; Life MDPI

<https://www.mdpi.com/2075-1729/15/12/1881>

(Doprinos pareze, dobi i utjecaj kratkog treninga na kognitivno-motoričku interferenciju dvostrukih zadataka nakon moždanog udara: Pilot studija.)

Niz kognitivno-motoričkih testova (dual tasking - DT) provedeno je na 63 pacijenta nakon moždanog udara (PS) i 49 zdravih kontrolnih ispitanika odgovarajuće dobi. Pacijenti s parezom (P) i bez pareze (NP) uspoređeni su s kontrolnom skupinom prije i nakon intervencijskog treninga. Razlike između NP pacijenata i kontrolne skupine potvrdile su kognitivnu razliku, dok je usporedba između NP i P pacijenata potvrdila veće motoričko oštećenje kod P pacijenata. Stariji pacijenti postigli su lošije rezultate. Prema analizi, dob je bila važnija od pareze kod DT treninga. Kratkotrajni trening (nekoliko dana uzastopce kroz više tjedana) poboljšao je rezultate testa, posebno kod P pacijenata (povećana brzina reakcije i smanjuje grešaka).

After Dual-Task Training Comparison of Dual-Task Tests on Days 1 and 5					
>65 Years					
Tests	Control	Day One Non-Paretic	Paretic	Control	Day Five Non-Paret
Bird	1.5 ± 0.4	2.7 ± 1.2	3.1 ± 1.0	1.2 ± 0.1 ***	1.3 ± 0.3
Simple	0.9 ± 0.2	1.6 ± 0.4	2.3 ± 1.0	0.9 ± 0.1	1.0 ± 0.2 '
Divided	1.0 ± 0.1	1.5 ± 0.2	1.7 ± 0.4	0.9 ± 0.1 **	1.1 ± 0.2 '
Habitat	1.7 ± 0.2	2.0 ± 0.2	2.0 ± 0.4	1.6 ± 0.2 *	1.6 ± 0.2
Hits	74.3 ± 11.4	39.7 ± 17.0	28.5 ± 19.4	108.0 ± 12.7 ***	89.8 ± 19.2
Misses	13.5 ± 4.2	35.7 ± 14.1	44.4 ± 19.0	11.0 ± 5.3	14.5 ± 7.4

Zaključno:

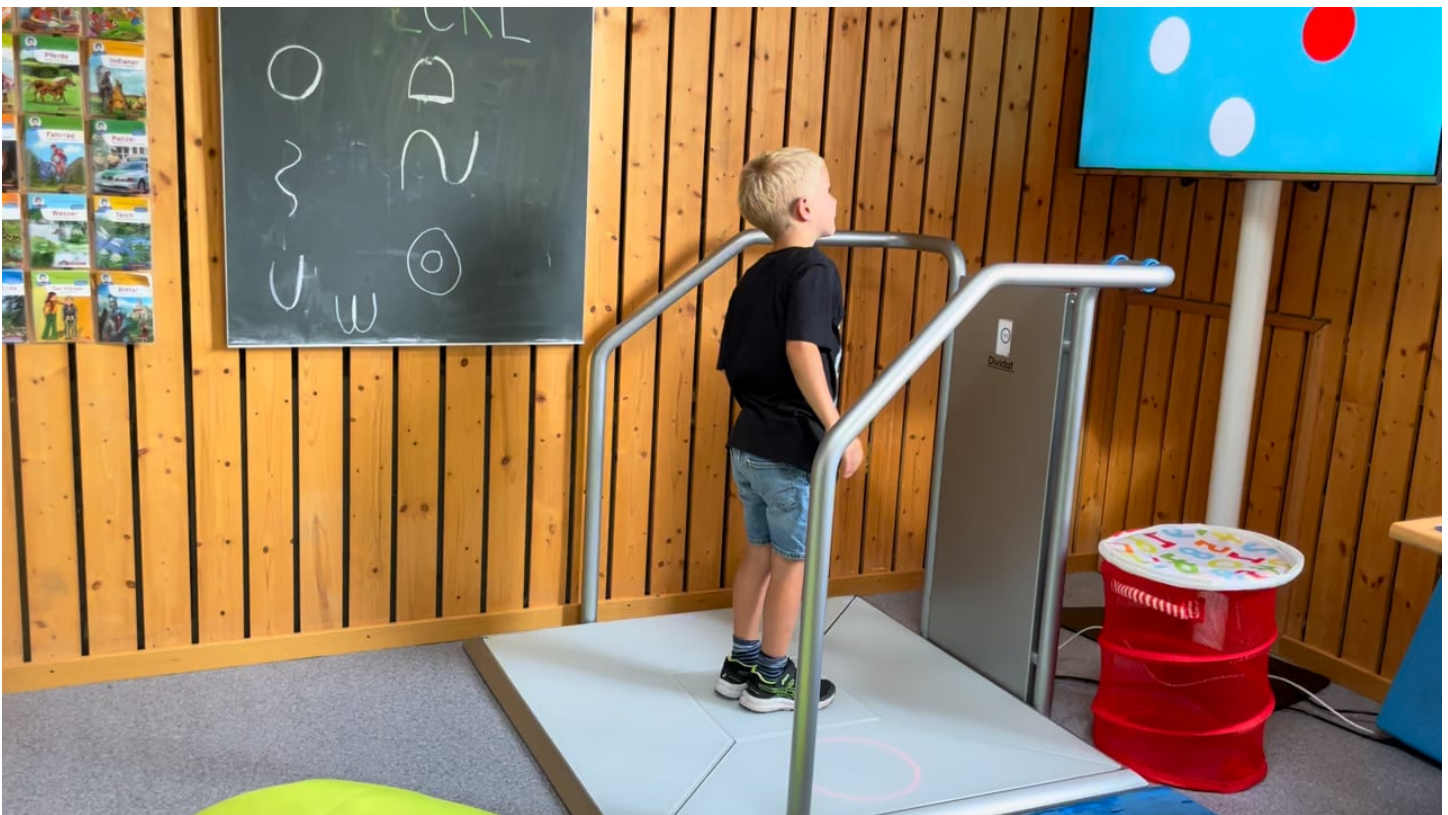
Ovi rezultati sugeriraju prisutnost deficita pažnje i donošenja odluka kod PS pacijenata, dok je DT trening donio poboljšanja kod PS pacijenata, s najvećim učinkom u P skupini (s parezom).

ADHD

👉 **The effect of exergaming on executive functions in children with ADHD:** A randomized clinic trial; Benzig, Schmidt, 2019
<https://pubmed.ncbi.nlm.nih.gov/31050851/>

Methods: In a parallel group randomized trial, 51 children between 8-12 years ($M = 10.63$; $SD = 1.32$) diagnosed with ADHD were assigned either to an 8-week exergame intervention group (three training sessions per week for 30 minutes) or a waiting-list control group. The core executive functions (inhibition, switching, updating), parent ratings of symptoms, and motor abilities were assessed/gathered before and after the intervention.

Conclusions: Findings indicate that exergaming might benefit two domains in which frequent deficits can be observed in children with ADHD, executive functions and motor abilities. Given that these beneficial effects in turn might positively affect psychopathology, exergaming could serve as an individualized home-based intervention in the future. However, in order to maximize benefits and make exergaming a valuable adjunct to treatment for children with ADHD, customized exergames are needed.



CEREBRALNA PARALIZA

👉 **Dual-Task Training Interventions for Cerebral Palsy:** A Systematic Review and Meta-Analysis of Effects on Postural Balance and Walking Speed. Cortes-Perez et al.; 2025
<https://pubmed.ncbi.nlm.nih.gov/40870460/>

Results: Eight RCTs, providing data from 216 children, were included. Meta-analyses suggested that DTT was more effective than conventional therapies for increasing functional (SMD = 0.65; 95% CI 0.18 to 1.13), dynamic (SMD = 0.61; 95% CI 0.15 to 1.1), and static balance (SMD = 0.46; 95% CI 0.02 to 0.9), as well as standing (SMD = 0.75; 95% CI 0.31 to 1.18; $p = 0.001$) and locomotion dimensions (SMD = 0.65; 95% CI 0.22 to 1.08) of the Gross Motor Function Measure (GMFM) and walking speed (SMD = 0.46; 95% CI 0.06 to 0.87). Subgroup analyses revealed that a motor-cognitive dual task is better than a motor single task for functional, dynamic, and static balance and standing and locomotion dimensions for the GMFM.

Conclusions: This SRMA, including the major number of RCTs to date, suggests that DTT is effective in increasing balance, walking and gross motor function-related balance in children with CP.

👉 **The effectiveness of dual task exercise training on balance, mobility, physical performance, and quality of life in children with cerebral palsy:** a single-blind randomized controlled trial; Uysal et al., 2023
<https://pubmed.ncbi.nlm.nih.gov/37777679/>

Results: DTG demonstrated significantly improved all KINDL scores ($p < 0.01$). In comparisons between groups adjusted analysis, results showed a better improvement of all KINDL scores in-favor-of DTG ($p < 0.01$). Significant improvements were found in all SLST scores and PBS in DTG ($p < 0.01$). Adjusted analysis results proved there was a significant improvement in all balance scores on behalf of DTG ($p < 0.01$). Significant improvement was observed in DTG for TUG, 3MBWT, and 6MWT scores ($p = 0.001$). An improvement in-favor-of DTG was found for all performance tests in the adjusted analysis ($p < 0.001$).

Conclusion: The results of this randomized controlled trial highlighted the advantage of dual-task training on balance, physical performance, and quality of life in children with CP.

👉 **Dual-task training effect on gait parameters in children with spastic diplegic cerebral palsy:** Preliminary results of a self-controlled study; Okur et al., 2022
<https://pubmed.ncbi.nlm.nih.gov/35247824/>

Results: The difference in step length, step time, stride time, cadence and gait speed of spatiotemporal parameters of gait during dual-task performance were found statistically significant in children with spastic diplegic CP, after dual-task training program ($p < 0,05$). After dual-task training, statistically significant gains were found in 1MWT, movement and balance subtitle of PedsQL-CP module Parent Form ($p < 0,05$).

Significance: Dual-task training program added to a conventional physiotherapy program provides more gains in terms of functionality of children with spastic diplegic CP will contribute to the improvement of the motor functional level.

PARKINSONOVA BOLEST

👉 **Feasibility and effects** of cognitive– motor exergames on fall risk factors in typical and atypical Parkinson's inpatients: a randomized controlled pilot study, Jaggi et al., 2023

<https://dividat.com/en/news/feasibility-and-effects-of-cognitive-motor-exergames-on-fall-risk-factors-in-typical-and-atypical-parkinsons-inpatients>

Results: Thirteen patients [median: 68.0 (IQR: 49.5–73.5) years, median: 34.5 (IQR: 12.25–90.75) months post-stroke] were included, of whom ten completed the study. Rates for inclusion (57%), adherence (95%), compliance (99%), motivation (77%), and satisfaction (74%) were acceptable, however, the attrition rate was high (23%). The perceived motor and cognitive task difficulty predominantly moved below the targeted range. We found a significant change in the TUG ($p = 0.05$, $r = 0.46$) and medium-to-large effect sizes ($p > 0.05$) for swing time of the affected leg, the asymmetry index, time needed for the Trail-making test (TMT) A and accuracy for the TMT B and the Mental Rotation Test (MRT; $0.26 \leq r \leq 0.46$).

Exergaming, as applied in this study, showed to be feasible, safe and likely effective for the improvement of cognitive and motor functions of PD inpatients. Because of this future randomized controlled trials with a main focus on testing the efficacy of this new intervention are warranted.

👉 **A Review of Recent Advances in Cognitive-Motor Dual-Tasking for Parkinson's Disease Rehabilitation.**

Tan et al., 2024

<https://pubmed.ncbi.nlm.nih.gov/39409390/>

Results: Dual-task training enhances Parkinson's disease (PD) rehabilitation by automating movements and minimizing secondary task interference. The inclusion of a sensor system provides real-time feedback to help patients make immediate adjustments during training. Furthermore, CADT promotes more vigorous participation and commitment to training exercises, especially those that are repetitive and can lead to patient boredom and demotivation. Virtual reality-tailored tasks, closely mirroring everyday challenges, facilitate more efficient patient adaptation post-rehabilitation.

Conclusions: Although the current studies are limited by small sample sizes and low levels, CADT rehabilitation presents as a significant, effective, and potential strategy for PD.

MULTIPLA SKLEROZA

👉 **Effects of dual-task training on balance, gait, dual-task performance, cognitive function, fatigue in individuals with multiple sclerosis:** A randomized controlled trial: Dual-Task Training in MS; EKICI ET AL., 2025
<https://pubmed.ncbi.nlm.nih.gov/40737966/>

Results: Five participants dropped out, leaving 27 for final analysis (DTTG n=13, CG n=14). Significant improvements in the BBS ($p<0.001$), FSS ($p=0.002$), BICAMS ($p<0.001$), and 10MWT ($p=0.019$) favored the DTTG. No significant differences were observed in TUG ($p=0.085$), FI ($p=0.616$), or DTQ ($p=0.402$).

Conclusions: An 8-week motor-motor and motor-cognitive dual-task training program combined with home exercise effectively enhances cognitive function, balance, fatigue, and walking speed in pwMS, supporting its inclusion in rehabilitation program.

👉 **Cognitive-motor dual-task training improves dynamic stability during straight and curved gait in patients with multiple sclerosis:** a randomized controlled trial; Tramontano et al., 2023
<https://pubmed.ncbi.nlm.nih.gov/37997324/>

Results: Thirty-one PwMS completed the trial at T2. Significant improvement within subjects was found in Mini-BESTest scores for DTg from T0 to T1. The IMU-based assessment indicated significant differences in stability ($P<0.01$) and smoothness ($P<0.05$) measures between CTg and DTg during 10mWT and Fo8WT. Substantial improvements ($P<0.017$) were also found in the inter-session comparison, primarily for DTg, particularly for stability, symmetry, and smoothness measures.

Conclusions: This study supports the effectiveness of DT in promoting dynamic motor abilities in PwMS.

Clinical rehabilitation impact: Cognitive-motor DT implemented into the neurorehabilitation conventional program could be a useful strategy for gait and balance rehabilitation.

👉 **Design and Evaluation of User-Centered Exergames for Patients With Multiple Sclerosis:** Multilevel Usability and Feasibility Studies, Schattin et. al., 2021
<https://pubmed.ncbi.nlm.nih.gov/33960956/>

Results: In the first study (N=16), usability was acceptable, with a median SUS score of 71.3 (IQR 58.8-80.0). In the second study (N=25), the median SUS scores were 89.7 (IQR 78.8-95.0; before) and 82.5 (IQR 77.5-90.0; after), and thus, a significant decrease was observed after training ($z=-2.077$; $P=.04$; $r=0.42$). Moreover, high values were observed for the overall FSS (pre: median 5.9, IQR 4.6-6.4; post: median 5.8, IQR 5.4-6.2) and overall Game Flow Questionnaire (pre: median 5.0, IQR 4.7-5.3; post: median 5.1, IQR 4.9-5.3). A significant decrease was observed in the item perceived importance (FSS: $z=-2.118$; $P=.03$; $r=0.42$). Interviews revealed that user-centered exergames were usable, well accepted, and enjoyable. Points of reference were identified for future research and development.

Conclusions: The project revealed that the newly developed, user-centered exergames were usable and feasible for patients with MS. Furthermore, exergame elements should be considered in the development phase of user-centered exergames (for patients with MS). Future studies are needed to provide indications about the efficacy of user-centered exergames for patients with MS.