

# Vpliv različnih programov telesne dejavnosti gibanja specialne olimpijade na komponente telesne pripravljenosti in kakovost življenja odraslih športnikov z intelektualno motnjo

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**Uvod:** Sodobna družba se spoprijema z izzivom, kako ranljivi skupini prebivalstva odraslih športnikov z intelektualno motnjo (IM) v procesu staranja zagotoviti ustrezno podporo pri izboljšanju telesne pripravljenosti, dejavnega življenjskega sloga in kakovosti življenja (1–3). Namen študije je raziskati kratkoročen vpliv treh različnih programov telesne dejavnosti v okviru specialne olimpijade Slovenije (SO) na posamezne komponente telesne pripravljenosti in kakovost življenja starajočih se športnikov z IM ter preučiti povezanost posameznih komponent telesne pripravljenosti s kakovostjo življenja. **Metode:** Uporabljen je bil protokol dvojno slepe stratificirane randomizirane klinične študije, v katero je bilo vključenih 150 telesno nedejavnih odraslih oseb z IM. Razvrščene so bile v dve študijski skupini, in sicer v skupino fun fitness plus v kombinaciji z rednimi treningi SO (N = 50) ter v skupino wellness v kombinaciji z rednimi treningi SO (N = 50) in kontrolno skupino (redni treningi SO). Začetne meritve posameznih komponent telesne pripravljenosti (sklop funkcijskih testov Fun fitness) (4) in ocenjevanje kakovosti življenja s skrajšano različico vprašalnika kakovosti življenja za osebe z IM (angl. World Health Organisation Quality of Life; kratica WHOQOL BREF) (5) so bile izvedene ob začetku in ob koncu štirimesečne raziskave. Uporabljeni sta bili multipla regresijska analiza in diskriminantna analiza. Raziskavo je odobrila Komisija Republike Slovenije za medicinsko etiko (št. 0120-598/2017/7). **Rezultati:** Z F-statistiko (20,260) je postavljeni regresijski model, ki je statistično značilen ( $p \leq 0,001$ ). Popravljen determinacijski koeficient multiple regresije ( $R^2_{pop}$ ) pojasnjuje 53,8 odstotka skupnega prostora med dejavniki telesne pripravljenosti in kakovostjo življenja, kar dokazuje dobro pojasnjenost med spremenljivkami. Na podlagi dobljenih rezultatov obstaja linearna kombinacija merjenih odvisnih spremenljivk s komponentami telesne pripravljenosti. Dobljene razsežnosti so tiste, ki kar najbolj pojasnjujejo razlike v telesni pripravljenosti med udeleženci navedenih skupin. Diskriminantna spremenljivka kaže na podlagi 81-odstotne gotovosti dobro telesno pripravljenost starajočih se odraslih športnikov z IM. **Zaključek:** Študija ima visoko notranjo in zunanjo veljavnost zaradi uporabe strogega raziskovalnega protokola, s katerim se je maksimalno zmanjšal vpliv groženj na veljavnost in zanesljivost. Z omenjenim prispevkom k znanosti se prispeva h globljemu in širšemu razumevanju vpliva različnih programov gibalne aktivnosti (v okviru specialne olimpijade) na posamezne komponente telesne pripravljenosti starajočih se oseb z IM ter na njihovo kakovost življenja.

**Ključne besede:** staranje odraslih oseb z intelektualno motnjo, telesna pripravljenost, specialna olimpijada, kakovost življenja

## The influence of various physical activity programs of the Special Olympics movement on the components of physical fitness and the quality of life of adult athletes with intellectual disability

**Introduction:** A modern society faces the challenge of providing vulnerable groups of adult athletes with intellectual disabilities (ID) in the process of aging with appropriate support in improving physical fitness, active lifestyle and quality of life (1-3). The purpose of our study was to investigate the short-term impact of three different programs of physical activity within the Special Olympics of Slovenia (SO) on individual components of physical fitness and the quality of life of aging athletes with ID and to investigate the connection of individual components of physical fitness with the quality of life. **Methods:** A double-blind, randomized clinical trial (RCT) protocol with stratification was used in which 150 physically inactive adults with ID were classified in 2 study groups, namely fun fitness plus in combination with regular training of SO (N = 50) and wellness team in combination with regular SO training (N = 50), and into the control group (regular training of the SO). Initial measurements of individual physical fitness components (battery of Fun Fitness tests) (4) and quality of life assessment using the shortened version of the quality of life questionnaire for people with ID (5) were carried out at the beginning and at the end of the 4-month study. Multiple regression analysis and discriminant analysis were used. The RCT was approved by the Medical Ethics Commission of the Republic of Slovenia (No. 0120-598 / 2017/7). **Results:** With F-statistic (20,260) a regression model was set up, which is statistically significant ( $p \leq 0.001$ ). Corrected deterministic multi-regression coefficient ( $R^2_{pop}$ ), explains 53.8% of the total space between physical fitness factors and quality of life, which is demonstrated by a good explanation of the variables. Based on the obtained results, there is a linear combination of measured dependent variables with physical fitness components. The obtained dimensions are those that best explain the differences in physical fitness among the participants of the groups. The discriminant variable shows the good physical fitness of aging adult athletes with ID on the basis of 81% confidence. **Conclusion:** The existing RCT has high internal and external validity due to the use of a rigorous research protocol to minimize the impact of threats against validity and reliability. With this contribution to science, it contributes to deeper and broader understanding of the impact of various programs of movement activity (within the framework of the Special Olympics) on the individual components of physical fitness of aging people with ID and their quality of life.

**Key words:** aging of adults with intellectual disability, physical fitness, special olympics, quality of life

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## **Spremembe in zanesljivost 6-minutnega testa hoje, merjenja srčne frekvence in 15-stopenjske Borgove lestvice pri pacientih po možganski kapi – predhodni izsledki**

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**Uvod:** Šestminutni test hoje (angl. six minute walking test – 6MWT) je submaksimalni test aerobne zmogljivosti oziroma splošne telesne vzdržljivosti. Z njim se ocenijo odzivi telesnih sistemov, kot so dihalni, srčno-žilni in živčno-mišični sistem ter mišični metabolizem med hojo (1). Pred in po 6MWT se lahko izmeri tudi srčna frekvenca ter spremlja občuteni napor z Borgovo lestvico (1, 2). Vendar pa obstaja pomanjkanje raziskav o zanesljivosti 6MWT, Borgove lestvice in njune povezanosti s srčno frekvenco pri pacientih po možganski kapi. Namen naše raziskave je ugotoviti izboljšanje prehojene razdalje, zvišanje srčne frekvence in spremembe občutenega napora pri pacientih po možganski kapi. Namen raziskave je tudi ugotoviti zanesljivost med preiskovalci za 6MWT in zanesljivost ponovljenega testiranja za srčno frekvenco ter 15-stopenjsko Borgovo lestvico. **Metode:** V raziskavo je bil do zdaj vključen priložnostni vzorec 15 preiskovancev, starih povprečno 59 (SO 11) let, povprečno 32,3 (razpon 4–126) meseca po možganski kapi, ki so bili na rehabilitaciji. Opravili so 6MWT po standardnih navodilih (1). Pred njim in po njem smo z merilnika (RS800CX, Polar, Finska) odčitali srčno frekvenco. Takoj po testu hoje so preiskovanci ocenili svoj napor na 15-stopenjski Borgovi lestvici (2), prevedeni v slovenščino. Ocenjevanje je izvedel preiskovalec A ob sprejemu na rehabilitacijo. Dva zaporedna dneva ob odpustu pa sta ga izvedla preiskovalca A in B v naključnem vrstnem redu. Razlike v prehojeni razdalji in srčni frekvenci med prvim in drugim ocenjevanjem (preiskovalec A) smo ugotavljali s parnim testom t. Za ugotavljanje zanesljivosti med preiskovalcema smo izračunali intraklasni korelacijski koeficient – ICC (2,1), za zanesljivost ponovnega testiranja pa ICC (3,1). Raziskavo je odobrila komisija za medicinsko etiko URI - Soča (št. 77/2018). **Rezultati:** Med rehabilitacijo se je prehojena razdalja statistično pomembno izboljšala za povprečno 49,33 (SO 54,34) m ( $p = 0,002$ ), med meritvami srčne frekvence pred 6MWT ni bilo statistično pomembne razlike, po njem pa se je povečala za 4,53 (SO 8,95) udarcev/minuto ( $p = 0,035$ ). Mediana ocenjenega napora po Borgovi lestvici je bila pri prvem ocenjevanju 12 (razpon 9–16) točk, ob odpustu pa 13 (razpon 10–15) točk (preiskovanec A) in 13 (razpon 11–17) točk (preiskovanec B). Zanesljivost med preiskovalcema za 6MWT je bila odlična (ICC = 0,97). Zanesljivost ponovnega testiranja za srčno frekvenco pred 6MWT je bila visoka (ICC = 0,81), po njem pa zmerna (ICC = 0,73), za Borgovo lestvico je bila nizka (ICC = 0,46). **Zaključek:** Med rehabilitacijo je prišlo do izboljšanja prehojene razdalje in povečanja srčne frekvence po 6MWT ter ocene napora. 6MWT je zanesljivo merilno orodje pri pacientih po možganski kapi. Dosedanji predhodni izsledki naše raziskave so pokazali, da je zanesljivost ponovnega testiranja za srčno frekvenco visoka oziroma zmerna, za Borgovo lestvico pa nizka. Za ugotavljanje povezanosti in odvisnosti med proučevanimi spremenljivkami je potreben večji vzorec preiskovancev.

**Ključne besede:** 6-minutni test hoje, 15-stopenjska Borgova lestvica, možganska kap, srčna frekvenca, zanesljivost

## Differences and reliability of the 6-minute walk test, heart rate and Borg rating scale of perceived exertion in patients after stroke – preliminary results

**Introduction:** A 6-minute walk test (6MWT) is a submaximal exercise test and overall functional capacity test. It assesses global and integrated responses of body systems, such as respiratory, cardiovascular, nervous and muscular systems and muscular metabolism involved in walking (1). Additionally, before and after 6MWT heart rate can be measured, and effort can be assessed with Borg rating scale of perceived exertion (RPE) (1, 2). However, there is a lack of reliability studies of 6MWT and RPE, and their correlation with physiological measures in patients after stroke. The purpose of this study is to determine the improvement of walking distance, increase of heart rate and change of perceived exertion in patients after stroke. The purpose was also to establish inter-rater reliability for 6MWT, and test-retest reliability for heart rate and RPE (6 to 20 scale). **Methods:** Currently, 15 subjects completed the study. Their mean age was 59 years (SD: 11), and mean time post-stroke was 32.3 months (range 4-126). 6MWT was conducted according to standard guidelines (1). Heart rate was collected before and after 6MWT with the heart rate monitor (RS800CX, Polar, Finland). Immediately after 6MWT, the subjects evaluated their effort on RPE scale of 6 (rest) to 20 (maximum exertion) (2). The evaluation was conducted at admission to rehabilitation (rater A) and two consecutive days at discharge (rater A and B in randomized order). The differences in walking distance and heart rate of the first and second assessment (rater A) were established with the paired t-test. To determine inter-rater reliability, the intraclass correlation coefficient - ICC (2.1), and for test-retest reliabilities ICC (3.1) were calculated. The study was approved by Ethics Committee of URI - Soča (no. 77/2018). **Results:** During rehabilitation, the walking distance statistically significantly increased for an average of 49.33 (SD 54.34) m ( $p = 0.002$ ). There was no difference in heart rate before 6MWT but the heart rate after 6MWT significantly increased, for 4.53 (SD 8.95) beats per minute ( $p = 0.035$ ). The median of RPE at the first assessment was 12 (range 9-16) points, and at discharge it was 13 (range 10-15) points (rater A) and 13 (range 11-17) points (rater B). Inter-rater reliability for 6MWT was excellent (ICC = 0.97). The test-retest reliability of heart rate measurement before 6MWT was good (ICC = 0.81), but moderate after 6MWT (ICC = 0.73), and poor for RPE (ICC = 0.46). **Conclusion:** During rehabilitation, the walking distance improved, and the heart rate after 6MWT and perceived effort increased. 6MWT is a reliable measuring tool in patients after stroke. The preliminary results of our study show good to moderate test-retest reliability of heart rate measurements and poor reliability for RPE. A larger sample of subjects is needed to investigate relationships and dependence of the studied variables.

**Key words:** 6MWT, RPE, stroke, heart rate, reliability

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## **Fizioterapevtska ocena in obravnava pacientke s sindromom Guillain-Barre**

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**Uvod:** Sindrom Guillain-Barre (GBS) je imunsko pogojena bolezen, do katere pride zaradi vnetja perifernih živcev in živčnih korenin. Incidenca obolenosti je ocenjena na 1 do 2 na 100.000 prebivalcev na leto (1). Kaže se kot pareza tako distalnih kot proksimalnih mišic, prizadene lahko dihalne mišice, obrazni živci, senzibiliteto, požiranje in avtonomno živčevje (2). Faza ozdravitve traja od 4 do 18 mesecev, od 10 do 20 odstotkov pacientov ostane huje prizadetih (1, 2). Fizioterapevtska obravnava temelji na izkušnjah z drugih nevroloških področij, saj jasnih smernic, podprtih z dokazili, še nimamo (3, 4). Za spremljanje stanja pacienta so bistvenega pomena fizioterapevtska merilna orodja. Za oceno sposobnosti premikanja in ravnotežja smo na URI - Soča začeli v prakso uvajati indeks premičnosti de Morton (DEMMI). **Metode:** V študijo primera smo vključili 40-letno pacientko s šibkostjo vseh mišičnih skupin in motnjami požiranja. Na rehabilitacijo je bila sprejeta en mesec po začetku bolezni. Aktivnih gibov z zgornjimi in spodnjimi udi ni zmogla. Opravili smo oceno mišične zmogljivosti, oceno premičnosti in ravnotežja z DEMMI, meritve sklepne gibljivosti, pozneje test hoje na 10 metrov in 6-minutni test hoje, stanje smo spremljali z lestvico funkcijske neodvisnosti (FIM). V 18 mesecih je bila pacientka na rehabilitacijsko obravnavo sprejeta trikrat, prvič za štiri mesece, nato sta sledili dve obnovitveni tritedenski rehabilitaciji. Med rehabilitacijo je fizioterapija potekala petkrat na teden po 1 do 2 uri na dan, vključena je bila tudi v program respiratorne fizioterapije in delovne terapije. Fizioterapevtske metode so bile ob prvi rehabilitaciji usmerjene v postopno vertikalizacijo, ohranjanje pasivne gibljivost sklepov in spodbujanje aktivacije mišic. Ob drugi rehabilitaciji smo nadaljevali z opisanimi metodami, povečali smo intenzivnost vadbe za izboljšanje mišične zmogljivosti in kardiorespiratorne vzdržljivosti. Ob zadnji rehabilitaciji smo se osredotočili na učenje hoje in vadbo ravnotežja. **Rezultati:** Po 18 mesecih se je mišična zmogljivost izboljšala v vseh mišičnih skupinah. Po DEMMI je pacientka napredovala z 0/100 točk na 41/100 točk. Sklepna gibljivost je bila v grobem ohranjena, razen manjših kontraktur v kolenskih sklepih (5°) in plantarne kontrakture v levem skočnem sklepu (7°). Z berglami je prehodila krajšo razdaljo (70 metrov), za hojo na daljše razdalje je uporabljala rolator. Zmogla je hojo po stopnicah ob opori. Prisotna je bila utrudljivost. **Zaključek:** Primer pacientke s težjim potekom GBS potrjuje pomembno vlogo fizioterapije pri okrevanju. Pri pacientih z GBS bi bilo poleg uporabljenih fizioterapevtskih merilnih orodij treba ocenjevati utrudljivost, ki je eden glavnih simptomov te bolezni.

**Ključne besede:** pareza, polinevropatija, DEMMI, manualno testiranje mišic, Guillain-Barre

## Physiotherapeutic assessment and therapy in patient with Guillain-Barre syndrome

**Background:** Guillain-Barre syndrome (GBS) is immune mediated disorder that is caused by inflammation of peripheral nerves and nerve roots. The annual incidence is estimated to be 1-2 per 100 000 worldwide (1). It presents itself as paresis of proximal and distal muscles (2). Recovery occurs 4 to 18 months after the appearance of first symptoms (1, 2). There are currently no evidence-based guidelines for physiotherapy and practice is based on experience from other neurological conditions (3, 4). When monitoring the condition of the patient, physiotherapeutic assessment has important value. In order to assess balance and ability to move, our department at URI - Soča began to introduce the de Morton Movement Index (DEMMI) into practice. **Methods:** A 40-year-old patient with severe muscle weakness and swallowing disorder was admitted to rehabilitation 1 month after the onset of the disease. She could not perform active movements with upper nor with lower limbs. We assessed muscle performance, ability to move (DEMMI), measured joint range of motion and used Functional independence measure (FIM), at later stages we did 10-meter and 6-minute walk test. The patient was admitted to our hospital 3 times in 18 months, the first rehabilitation lasting 4 months, followed by two 3-week rehabilitation treatments. During hospital stay physiotherapy took place 5 times weekly for 1-2 hours a day. The patient was also included in respiratory physiotherapy and occupational therapy. At the beginning, physiotherapeutic methods were aimed at gradual verticalisation, maintaining passive range of motion and stimulating muscle activation. At second rehabilitation we continued with the described methods and increased the intensity of exercise for muscle strengthening and endurance. At last, we focused on walking and balance. **Results:** After 18 months, muscular performance improved in all muscle groups. According to DEMMI, the patient progressed from 0/100 points to 41/100 points. Range of motion was mainly preserved, with the exception of contractures in knee joints (5°) and plantar contracture in the left ankle joint (7°). The patient was able to walk short distances with crutches (70 meters), and the roller walker was used for longer distances. She was able to walk the stairs. Fatigue remained a major problem. **Conclusion:** Our case confirms the important role of physiotherapy in recovery of GBS. Fatigue is one of the main persisting symptoms of GBS. In the future we should consider adding fatigue assessment into our practice.

**Key words:** paresis, polyneuropathy, DEMMI, manual muscle testing, Guillain-Barre

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## **Uporabnost lestvice za oceno funkcionalnosti hoje (FGA) pri bolnikih po operativni odstranitvi vestibularnega tumorja**

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**Uvod:** V zgodnjem bolnišničnem obdobju imajo bolniki po operativni odstranitvi vestibularnega tumorja motnje ravnotežja v sedečem in stoječem položaju ter med hojo. Eden izmed najpogosteje uporabljenih kliničnih testov za ocenjevanje bolnikovega ravnotežja in njegove splošne premičnosti je Bergova lestvica za ravnotežje (BLR), ki pa ne opredeljuje bolnikovega dinamičnega nadzora in prilagoditve telesa med hojo (1). Za ta namen je primernejša lestvica za oceno funkcionalnosti hoje (FGA), ki ustreza obsežnim merskim zahtevam in omogoča ocenjevanje bolnikovega dinamičnega ravnotežja (2). Namen raziskave je bil preveriti uporabnost FGA-lestvice kot vadbeno ali merilno orodje v času bolnišnične oskrbe ter ugotoviti stopnjo bolnikove ravnotežne okvare med hojo in ogroženosti za padce. **Metode:** Raziskava je bila zasnovana kot pilotska študija za nadaljnje raziskave z več vključenimi bolniki z enako diagnozo. Raziskavo je odobrila Komisija RS za medicinsko etiko 14. aprila 2015. V raziskavo smo vključili deset hospitaliziranih bolnikov po operaciji vestibularnega tumorja, ki so bili sposobni slediti navodilom in so na kratkem preizkusu spoznavnih sposobnosti dosegli več kot 25 točk izmed 30 možnih. Glede na bolnikovo začetno nesamostojnost pri osnovnih dejavnostih vsakodnevnega življenja smo stopnjo njihove funkcijske neodvisnosti ovrednotili z oceno po indeksu Barthelove, ki je znašala več kot 8 od 20 možnih točk. Ob vključitvi v raziskavo smo vse preiskovance ocenili z BLR, ob odpustu z FGA-lestvico in BLR ter tri mesece po odpustu samo z FGA. V času hospitalizacije so bili vsi bolniki vključeni v specifično usmerjen ravnotežni program fizioterapevtske obravnave. Bolniki so z vajami nadaljevali v domačem okolju, saj so ob odpustu dobili pisna navodila in posnetke vaj na DVD-ju. Zapisovali so tudi število padcev v za to pripravljen obrazec. Dobljene rezultate smo analizirali z metodami deskriptivne statistike. **Rezultati:** Povprečna starost bolnikov (6 žensk, 2 moška, 2 najstnika) je bila 39,5 leta (od 18 do 57 let), hospitalizacija je povprečno trajala 10,5 dneva (od 7 do 14 dni). Klinično pomembna sprememba v izboljšanju statičnega ravnotežja med dvema BLR-meritvama znaša 8 točk (1). V dvotedenski fizioterapevtski obravnavi smo izračunali najmanjšo zaznavno spremembo med dvema meritvama po lestvici BLR, ki je znašala 6 točk, povprečna razlika ocen pa 11,7 točke. Najmanjšo zaznavno spremembo je preseglo 80 odstotkov bolnikov in tako izboljšalo statično ravnotežje, 20 odstotkov bolnikov pa ni doseglo zadostnega napredka. Ob odpustu bolnikov v domače okolje smo z analizo rezultatov FGA ugotovili, da imajo vsi vključeni bolniki hude motnje proprioceptivnega sistema in zmerne motnje vestibularnega sistema ter da so vsi ogroženi za padce. Klinično pomembna sprememba v izboljšanju dinamičnega ravnotežja med dvema FGA ocenama je 5 točk (2). Rezultati naše raziskave kažejo najmanjšo zaznavno spremembo med dvema FGA meritvama 4 točke, povprečno razliko ocen pa 8,6 točke. Minimalno zaznavno spremembo je preseglo 70 odstotkov bolnikov in tako izboljšalo dinamično ravnotežje ter posledično zmanjšalo možnost za padce. **Zaključek:** FGA-lestvica je v zgodnjem pooperativnem obdobju odlično vadbeno orodje za odkrivanje motenj in izboljšanje dinamičnega ravnotežja, saj specifične gibalne spretnosti olajšajo bolnikovo funkcioniranje v domačem okolju. Kot merilno orodje pa FGA-lestvico zaradi popolne nesamostojnosti bolnikov v osnovnih dejavnostih vsakodnevnega življenja v začetku hospitalizacije priporočamo tik pred odpustom bolnikov v domače okolje in za poznejše ambulantno spremljanje bolnikovega napredka.

**Ključne besede:** vestibularni tumor, operativni poseg, ocenjevanje, ravnotežje, hoja

## Usefulness of Functional Gait Assessment Scale (FGA) in patients after vestibular tumor surgery

**Background:** Patients in the acute phase after vestibular tumor surgery frequently experience balance disorders in a sitting and standing position and during gait. One of the most commonly used clinical tests for evaluating the patient's balance and his general mobility is the Berg Balance Scale (BBS), which does not define the patient's dynamic control and adjustment of the body while walking (1). The Functional Gait Assessment (FGA) enables the assessment of the dynamic balance during gait and corresponds to extensive measurement requirements (2). The purpose of the study was to verify the usefulness of the FGA scale as an exercise or measuring tool during hospital care, and to determine the patient's equilibrium malfunction during walking and risk of falls. **Methods:** The research was designed as a pilot study and will serve as a preposition for further research with more included patients with the same diagnosis. The study was approved by Medical Ethics Committee on April 14, 2015. The sample was selected conveniently. The study included 10 hospitalized patients after vestibular tumor surgery, that were able to follow the instructions and reached more than 25 points out of 30 possible on the Mini Mental Test. Given the patient's initial incompatibility in the basic activities of everyday life, we assessed the degree of their functional independence with Barthel Index (BI), which was more than 8 points out of 20 possible. All patients were evaluated at the beginning with BBS, at discharge from the hospital with BBS and FGA and after three months with FGA. During the hospitalization, all patients were included in a specifically directed equilibrium program of physiotherapy treatment. The patients continued their exercises in the home environment, as they received written instructions and DVD recordings on discharge. The number of falls in the prepared form was also recorded by the patients. The results were analyzed using descriptive statistics. **Results:** The mean age of the patients (6 women, 2 men, 2 teenagers) was 39.5 years (from 18 to 57 years), hospitalization lasted for 10.5 days (from 7 to 14 days). A clinically significant change in the improvement of the static equilibrium between two BBS measurements is 8 points (1). The minimum perceptible change for BBS score in a two-week physiotherapeutic treatment was calculated to be 6 points, which was exceeded by 80% of the patients, indicating an improvement in static balance, while 20% of the patients did not achieve sufficient progress. The average difference in two BBS grades was calculated to be 11.7 points. With the release of the patients into the home environment, the analysis of FGA results showed that all the patients involved had severe disorders of the proprioceptive system and moderate disturbance of the vestibular system, and were all at risk of falls. A clinically significant change in improving the dynamic balance between two FGA scores is 5 points (2). The minimum perceptible change for FGA score for the assessment three months after the discharge was calculated to be 4 points and was exceeded by 70% of the patients, indicating an improvement in dynamic balance, and thus lower risk for falls. 30% of the patients did not make enough progress. The average difference of the two FGA ratings was 8.6 points. **Conclusion:** The FGA scale is an excellent training tool for detecting interferences and improving the dynamic balance in the early post-operative period. Specific mobility skills facilitate the patient's functioning in the home environment. As a measuring tool, the FGA scale, due to the complete incapacity of patients in the basic activities of everyday life at the beginning of hospitalization, is recommended just before the release of patients into the home environment and for subsequent outpatient monitoring of the patient's progress.

**Key words:** vestibular tumor, surgery, assessment, balance, gait

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## **Hipoterapija pri mladostnikih s cerebralno paralizo**

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**Uvod:** Hipoterapija je terapevtska obravnava, pri kateri se uporablja konj (1). V prispevku je predstavljen vpliv hipoterapije na senzomotorične mehanizme (nadzor in upravljanje drže, gibanje telesnega težišča, ravnotežja in grobe motorične funkcije) (2, 3, 4) in na psihosocialne učinke (zdravje, zadovoljstvo, anksioznost in negotovost pri gibanju), povezane s kakovostjo življenja mladostnikov s cerebralno paralizo (CP) (5). Gibanju konja sledi gibanje jahačevega telesa, ki izvabi nadzor drže ter gibanje medenice in celega telesa. Jahanje omogoča priložnost za integracijo kinestetičnega, vidnega in vestibularnega priliva. Ponavljajoče se izvabljanje ravnotežnih in vzravnalnih odzivov prispeva k boljšemu nadzoru in upravljanju drže. **Metode:** V randomizirani 12-tedenski klinični raziskavi je sodelovalo 20 mladostnikov, starih od 16 do 22 let. Predhodno so bili izbrani glede na vključitvena in izključitvena merila ter naključno razvrščeni v dve skupini po deset mladostnikov. V raziskovalni skupini je bilo pet deklet in pet fantov, ki so imeli poleg rednih terapevtskih obravnav (fizioterapija in delovna terapija) še hipoterapijo dvakrat na teden po 30 minut. V kontrolni skupini je bilo šest deklet in štirje fantje, ki so imeli poleg rednih terapevtskih obravnav (fizioterapija in delovna terapija) še polurno hojo dvakrat na teden. Opravili smo osnovne meritve, in sicer ocenjevanje senzomotoričnih in psihosocialnih učinkov v povezavi s kakovostjo življenja mladostnikov, izvedene pred raziskavo in po končani raziskavi. Raziskavo je odobrila Komisija RS za medicinsko etiko s številko 97/09/11. **Rezultati:** Pri testih, ki vplivajo na senzomotorične mehanizme, so bile ugotovljene statistično značilne razlike, in sicer pri modificiranem testu senzorične organizacije na stabilometrični plošči ( $p < 0,03$ ), testu stoje na eni nogi ( $p < 0,00$ ) in testu Gross Motor Function Measure ( $p < 0,00$ ). Statistično značilne razlike so bile ugotovljene tudi pri vprašalnikih, ki vplivajo na kakovost življenja mladostnikov s CP, in sicer pri vprašalniku za ugotavljanje negotovosti pri gibanju ( $p < 0,00$ ), pri splošnem vprašalniku o zdravju ( $p < 0,00$ ), pri lestvici zadovoljstva z življenjem ( $p < 0,00$ ) in pri testu anksioznosti kot stanja ( $p < 0,00$ ). Zanesljivost in pristranskost vprašalnikov je bila preverjena s testom zanesljivosti,  $\alpha$ -koeficient po Cronbachu (od ,73 do ,92), korelacija med posameznimi testi pa s Pearsonovim koeficientom korelacije. **Zaključek:** Hipoterapija vpliva na izboljšanje senzorično-motoričnih gibalnih mehanizmov, ki se kažejo prav tako v izboljšanju zdravja, zadovoljstva in kakovosti življenja mladostnikov s CP, kar potrjujejo izsledki raziskave. Na podlagi teh lahko ugotavljamo, da hipoterapija dobro prispeva k vseživljenjski rehabilitaciji mladostnikov s CP.

**Ključne besede:** cerebralna paraliza, drža, ravnotežje, hipoterapija, kakovost življenja

## Hippotherapy in adolescents with cerebral palsy

**Background:** Hippotherapy is a therapeutic treatment using a horse (1). The paper presents the influence of hippotherapy on sensory-motor mechanisms (control and control of body posture, movement of the body's centre of gravity, balance and gross motor function) (2, 3, 4), as well as on the psycho-social effects (health, satisfaction, anxiety and dizziness handicap inventory) associated with the quality of life of adolescents with cerebral palsy (CP) (5). The movement of the horse is followed by the movement of the rider's body, which demands the control of the body posture, movement of the pelvis and the whole body. Riding provides an opportunity for the integration of a kinesthetic, visual and vestibular inflow. The repetitive causing of equilibrium and righting reactions contributes to better control and control of the body posture. **Methods:** In a randomized twelve-week clinical trial, 20 adolescents, aged 16 to 22 years, were involved. They had been previously selected according to inclusion and exclusion criteria and randomly assigned into two groups of 10 adolescents. In the research group there were 5 girls and 5 boys who had, in addition to regular therapeutic treatment, hippotherapy twice a week for 30 minutes. In the control group, there were 6 girls and 4 boys, who, in addition to regular therapeutic treatments, had a half-hour walk twice a week. Basic measurements were done: the assessment of senso-motor and psycho-social effects in relation to the quality of life of adolescents, carried out before and after the completion of the study. The research was approved by the Medical Ethics Commission of the Republic of Slovenia, number 97/09/11. **Results:** In the tests affecting sensory-motor mechanisms, statistically significant differences were found, namely in a modified sensory organization test on the stabilometric platform ( $p < 0.03$ ), in a single leg stance test ( $p < 0.00$ ) and the test of gross motor functions ( $p < 0.00$ ). Statistically significant differences were also found in the questionnaires affecting the quality of life of adolescents with CP, namely in the questionnaire dizziness handicap inventory ( $p < 0.00$ ), the general health questionnaire ( $p < 0.00$ ), in the satisfaction with life scale ( $p < 0.00$ ) and the anxiety inventory test ( $p < 0.00$ ). The reliability and bias of the questionnaires were verified by the reliability test, Cronbach's alpha (from, .73 to .92), and the correlation between individual tests with Pearson correlation coefficient. **Conclusion:** Hippotherapy influences the improvement of sensory-motor movement mechanisms, which are also shown in the improvement of health, satisfaction and quality of life of adolescents with CP, as confirmed by the results of the research. On the basis of these, hippotherapy contributes to lifelong habilitation of adolescents with CP.

**Key words:** cerebral palsy, posture, balance, hippotherapy, quality of life

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## **Uporaba ortoz in funkcionalne električne stimulacije v domačem okolju pri pacientih z okvaro hrbtenjače**

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**Uvod:** Pokončni položaj pri pacientih z okvaro hrbtenjače izboljša psihološki status, ledvično funkcijo in kostno gostoto ter ugodno vpliva na spastičnost, ortostatsko hipotenzijo in gibljivost sklepov (1). Za hojo lahko uporabimo različne pripomočke, kot so ortoze za koleno, gleženj in stopalo, ki stabilizirajo koleno v smeri ekstenzije in skočni sklep v smeri dorzalne fleksije (1). Druga možnost je hoja s funkcionalno električno stimulacijo (FES), pri kateri stimulacija peronealnega živca simulira fazo zamaha, stimulacija mišice kvadriceps femoris pa fazo opore (2). Pacienti poročajo o boljšem počutju po uporabi FES, ne glede na to, ali jo uporabljajo za stoji, hojo ali krepitev mišic (3). Namen raziskave je bil ugotoviti uporabo ortoz in FES v domačem okolju pri osebah z okvaro hrbtenjače, njihov vpliv na funkcijske zmožnosti, kakovost življenja ter pozitivne učinke in neželene lastnosti pripomočka. **Metode:** Anketa je bila poslana 139 pacientom z okvaro hrbtenjače, ki so končali rehabilitacijo na Univerzitetnem rehabilitacijskem inštitutu Republike Slovenije - Soča (URI - Soča) od leta 2013 do leta 2017 ter so ob odpustu prejeli ortoze ali FES za spodnja uda. Anketi sta obsegali osem vprašanj in se razlikovali glede na uporabo ortoz ali FES. Povprečna starost pacientov, ki so jim bile predpisane ortoze, je bila 53,8 leta (SO 16,7). Povprečna starost pacientov, ki so prejeli FES, pa 49 let (SO 13,8). Raziskavo je odobrila komisija za medicinsko etiko URI - Soča (št. 61/2018). **Rezultati:** Od 98 poslanih anket pacientom, ki so prejeli ortoze, smo prejeli 45 izpolnjenih. 39 jih ortoze še vedno uporablja, večinoma za hojo zunaj (37,7 %), od eno do dve uri (33,3 %) do več kot štiri (26,7 %) ure na dan. Od pozitivnih učinkov so najpogosteje navajali boljše počutje (68,9 %), od neželenih lastnosti pa težko in dolgotrajno nameščanje ortoz (37,8 %). Od 41 poslanih anket pacientom, ki so prejeli FES, smo prejeli 18 izpolnjenih. 15 pacientov FES še vedno uporablja, večinoma za hojo zunaj (50 %) in krepitev mišic (22,2 %), od manj kot eno uro (33,3 %) do eno do dve uri (44,4 %) na dan. Od pozitivnih učinkov so najpogosteje navajali izboljšano kakovost življenja (44,4 %), od neželenih pa strah pred padci (50 %). **Zaključki:** Večina pacientov, ki so odgovorili, še vedno uporablja predpisani pripomoček zaradi pozitivnih učinkov na počutje ter kakovost življenja. Ortoze uporabljajo večinoma za hojo zunaj, FES pa za hojo zunaj in krepitev mišic.

**Ključne besede:** okvara hrbtenjače, pripomočki za hojo, anketa, fizioterapija, rehabilitacija

## Use of orthoses and functional electrical stimulation in home environment in patients with spinal cord injury

**Background:** The upright position in patients with spinal cord injury improves their psychological status, renal function, and bone density, positively affects spasticity, orthostatic hypotension and joint range of motion (1). Various assistive devices can be used for walking, such as knee ankle foot orthoses, which stabilizes the knee in extension and ankle in dorsal flexion (1). Another option is walking with functional electrical stimulation (FES), where stimulation of the peroneal nerve simulates the swing phase and the stimulation of the quadriceps femoris muscle simulates the stand phase (2). Patients report to feel better after using FES, regardless of whether they use it for standing, walking or muscle strengthening (3). The aim of this research was to find out the use of orthoses and FES in home environment in patients with spinal cord injury, their impact on patients' functional abilities, quality of life, positive effects and adverse features of usage. **Methods:** The survey was sent to 139 patients with spinal cord injury, who completed rehabilitation at the University Rehabilitation Institute of the Republic of Slovenia - Soča (URI - Soča) from 2013 to 2017, and received orthoses or FES for their lower limb at the time of dismissal. Two surveys contained eight questions and were differed according to the use of either orthoses or FES. The mean age of the patients, who received orthoses, was 53.8 years (SD 16.7). The mean age of the patients, who received FES, was 49 years (SD 13.8). Research was approved by the Medical Ethics Committee of URI - Soča (No. 61/2018). **Results:** Out of 98 surveys sent to the patients, who received orthoses, 45 of them were returned completed. 39 patients continue to use prescribed orthoses, mostly for walking outside (37.7 %), from one to two hours (33.3 %) to more than four hours (26.7 %) daily. Of various positive effects, the most commonly reported was »feeling better« (68.9 %), while the most common adverse feature was difficult and long lasting application (37.8 %). Out of 41 surveys sent to the patients who received FES, 18 of them were returned completed. 15 patients still use FES, mostly with the aim of walking outside (50 %) and muscle strengthening (22.2 %), for less than one hour (33.3 %) to one to two hours (44.4 %) daily. Of various positive effects, the most often reported was the higher quality of life (44.4 %), while fear of falling (50 %) was the most common adverse effect. **Conclusions:** Most patients still use the prescribed device because of various positive effects on their well-being and quality of life. They use orthoses mostly for walking outside, while they use FES for walking outside and muscle strengthening.

**Key words:** spinal cord injury, gait assistive devices, survey, physiotherapy, rehabilitation

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## **Primerjava učinkov različnih serijskih ortoz za gleženj in stopalo pri pacientih po možganski kapi: vpliv na funkcijsko mobilnost in mnenje pacientov – predhodni izsledki**

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**Uvod:** Ortoze za gleženj in stopalo (OGS) ali ortoze za gleženj (OG) pogosto uporabljamo za izboljšanje gibljivosti v stopalu in preprečevanje padajočega stopala ter z njimi kompenziramo biomehanski primanjkljaj (1, 2). Namen raziskave je bil ugotoviti, kako določene serijske ortoze vplivajo na izvedbo različnih funkcijskih dejavnosti. **Metode:** 13 pacientov po prvi možganski kapi, vključenih v rehabilitacijsko obravnavo, ocenjenih z lestvico za razvrstitev funkcijske premičnosti med 4 in 6, je sodelovalo v dvojno slepem randomiziranem kliničnem poskusu. V drugem tednu rehabilitacije so v treh zaporednih dneh s serijsko OGS, z eno izmed serijskih elastičnih OG (fizioterapevt je izbral najprimernejšo med štirimi različnimi) in brez ortoze v naključnem vrstnem redu opravili test hoje na 10 metrov, 6-minutni test hoje, test hoje po stopnicah navzgor in navzdol ter test petih vstajanj s stola. Ob odpustu je preiskovanec izvedel teste le z izbrano ortozo in brez nje. Med izvedbo testov smo ortozo zakrili z gamašo, da je preiskovalec ne bi prepoznal. Drug preiskovalec je ob koncu ocenjevanja preiskovanca izprašal o njegovih subjektivnih občutkih in zadovoljstvu s posamezno ortozo. Raziskavo je odobrila komisija za medicinsko etiko URI - Soča (18/2017). **Rezultati:** V vseh primerih so bile ob koncu rehabilitacije izbrane OG. Pri obeh ocenjevanjih so bili najboljši povprečni izidi večine testov z OG. Statistično značilne razlike so se pokazale pri testu hoje na 10 metrov in pri 6-minutnem testu hoje. Brez ortoze so pri končnem ocenjevanju hodili 0,16 (SO 0,09) m/s hitreje kot pri prvem ( $p = 0,04$ ). Pri končnem ocenjevanju so z OG prehodili 18,2 (SO 2,2) m daljšo razdaljo kot brez ortoze ( $p = 0,01$ ) ter 38 (SO 46,3) m več kot pri prvem ocenjevanju z OG ( $p = 0,04$ ). Pri testu petih vstajanj s stola in testu hoje po stopnicah navzgor in navzdol parni t-test s Holenovim popravkom ni pokazal statistično značilnih razlik med testnimi pogoji. Preiskovanci so se pri hoji z OG počutili varnejše. Hoja je bila pravilnejša in stopalo se jim je manjkrat zataknilo. Več bi jih tudi raje čez cel dan nosilo OG (85 %) kot serijsko OGS (8 %). **Zaključki:** OG ima pozitiven učinek na hitrost hoje in prehojeno razdaljo. Pri hoji s serijsko OGS je hoja počasnejša in prehojena razdalja krajša kot z OG. Z izbrano OG so bili pacienti zadovoljnejši kot s serijsko OGS. Za jasnejše ugotovitve glede vpliva različnih ortoz ali hoje brez ortoze na premičnost je potreben večji vzorec preiskovancev.

**Ključne besede:** možganska kap, ortoze, primerjava

## Comparison of different serial ankle-foot orthoses in patients after a stroke: effects on the functional mobility and patients' opinion – preliminary results

**Background:** Ankle-foot orthoses (AFO) or ankle orthoses (AO) are frequently prescribed to improve mobility, to restore the *ankle foot* function, and to compensate for biomechanical deficits (1, 2). The aim of this study was to establish how a certain serial made orthosis affects a performance of various functional activities. **Methods:** Thirteen patients after a first hemorrhagic or ischemic stroke, included in rehabilitation, scored with Functional Ambulation Categories (FAC) 4-6, participated in the double blind randomised clinical trial. In the second week of rehabilitation, the 10-meter walk test (10MWT), the 6-minute walk test (6MWT), the Timed up and down stairs (TUDS) and the Five times sit to stand test (FTSTS) were performed randomly in 3 consecutive days with a serial AFO, one of the serial elastic AO (PT has chosen the most appropriate from 4 AO) and without orthosis. At discharge, patients performed tests only with the selected AO and without it. During the tests, type of orthosis was covered to the tester with a protection above the footwear (Fig 3.). Another investigator interviewed the patients about subjective feelings and satisfaction with each orthosis. This study was approved by the Ethics Committee of the University rehabilitation institute, Slovenia (18/2017). **Results:** At the end of rehabilitation in all the cases AO was chosen. In both evaluations the best results are measured with AO. Statistically significant differences were shown in 10MWT and 6MWT. Without orthosis in the last evaluation the patient walked 0.16 (SO 0.09) m/s faster than in the first evaluation ( $p = 0.01$ ). At the second evaluation they walked with AO 18.2 (SO 2.2) m longer distance compared to walking without an orthosis ( $p = 0.01$ ) and 38 (SO 46.3) m more compared to the first testing with AO ( $p = 0.04$ ). For the 5TSTS and TUDS paired t-test with a Holm's correction did not show statistically significant differences between testing conditions. Most of the patients while wearing AO felt more secure, their walking was better and their leg stick less often. More of the patients would wear it throughout the day (85%) compared with a serial AFO (8%). **Conclusions:** The AO has a positive effect on the walking speed and distance. A serial AFO reduced walking speed and distance. Patients were more satisfied with the AO compared with a serial AFO. Future studies with larger sample size are needed for statistical analysis of the tests performance with different types of orthoses and without it.

**Key words:** stroke, orthoses, comparison

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## **Primerjava učinkovitosti vadbe hoje na tekočem traku s hkratno uporabo navideznega okolja in hoje na tekočem traku brez dodanih nalog pri pacientih po možganski kapi**

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**Uvod:** Ponovna vzpostavitev hoje je eden najpomembnejših ciljev pacientov po možganski kapi. Izsledki raziskav kažejo, da ponavljajoča se, v funkcijo usmerjena, visokointenzivna vadba pomembno vpliva na izboljšanje funkcionalnega stanja (1). Ena izmed možnosti tovrstne vadbe je hoja na tekočem traku, pri čemer se vse bolj uveljavlja vadba s hkratno uporabo navidezne resničnosti, saj omogoča večje število ponovitev in spodbuja motorično učenje prek neposredne povratne informacije o izvedeni aktivnosti (2). Namen predstavljenе študije je bil ugotoviti, ali vadba hoje na tekočem traku s hkratno uporabo navideznega okolja pomembneje vpliva na izboljšanje ravnotežja in sposobnosti hoje pacientov po možganski kapi kot običajna vadba hoje na tekočem traku. **Metode:** V randomizirano kontrolirano raziskavo je bil vključen priložnostni vzorec 22 pacientov po možganski kapi, sprejetih na obravnavo v URI - Soča, ki so izpolnjevali vključitvena merila. Ocenjeni so bili z lestvico za oceno funkcionalne neodvisnosti (FIM), časovno merjenim testom vstani in pojdi, 6-minutnim testom hoje, testom hoje na 10 m, oceno funkcionalnosti hoje (FGA) in testom korakanja v štirih kvadratih, analiza hoje pa je bila izvedena s pomočjo sistema Zebris. Sledila je vadba hoje na tekočem traku, 20 minut na dan, petkrat na teden, pri čemer je eksperimentalna skupina izvajala hojo s pomočjo nalog v navideznem okolju sistema Zebris, kontrolna pa na tekočem traku Enraf Nonius brez navideznega okolja. Po končanem programu dvajsetih obravnav je bilo izvedeno primerjalno ocenjevanje z enakimi metodami kot ob začetku vadbe. Dobljeni podatki so bili statistično obdelani s paketom IBM SPSS Statistics, različica 22. Porazdelitev podatkov smo preverili s Kolmogorov-Smirnovim z-testom, za ugotavljanje razlik med merjenimi parametri pa smo uporabili Wilcoxonov test predznačenih rangov. **Rezultati:** Skupini se glede na starost ( $z = -1,384$ ,  $p = 0,166$ ) in čas od začetka nastanka kapi ( $z = -0,397$ ,  $p = 0,691$ ) med seboj nista statistično pomembno razlikovali. Po štirih tednih vadbe hoje na tekočem traku so vsi preiskovanci dosegli pomembno izboljšanje vseh merjenih parametrov, kar kaže na izboljšanje funkcionalnih sposobnosti, potrjeno s točkovanjem s pomočjo lestvice FIM. Obenem se je izkazalo, da med skupinama ni prihajalo do statistično značilnih razlik, razen glede zadovoljstva z vadbo, pri kateri je eksperimentalna skupina vadbo ocenila z 8,7 točke (SD 0,7), kontrolna pa s 7,2 točke (SD 0,7);  $p < 0,005$ . **Zaključki:** Na podlagi analize rezultatov ugotavljamo, da je vadba hoje na tekočem traku s hkratno uporabo navidezne resničnosti sicer primerljivo učinkovita kot klasična vadba na tekočem traku, a preiskovanci navajajo večje zadovoljstvo z vadbo v navideznem okolju. Izsledki raziskave so omejeni na vzorec pacientov po možganski kapi v pretežno subakutnem obdobju, smiselno bi jih bilo preveriti na večjem vzorcu oseb po možganski kapi in spremljati tudi dolgoročne učinke vadbe.

**Ključne besede:** vadba hoje, navidezna resničnost, ravnotežje, rehabilitacija, možganska kap

## Effectiveness of virtual reality-based treadmill training in comparison with treadmill training without additional tasks in stroke patients

**Background:** The recovery of walking ability has been recognized as a major goal of stroke rehabilitation. There is an increasing evidence that high-intensity, repetitive, task-specific training might result in better outcome of gait rehabilitation (1). One example of such training is treadmill training, which has been successfully augmented with virtual reality (VR). The use of VR encourages a higher number of exercise repetitions and promotes motor learning through immediate feedback about the performed tasks (2). The purpose of the presented study was to examine whether VR based treadmill training could improve walking and mobility in greater extent than the same duration of treadmill training without using VR. **Methods:** Twenty-two stroke patients, who met the including criteria, participated in the randomized controlled study, conducted at the stroke department of the University Rehabilitation Institute. The participants were evaluated with Functional Independence Measure (FIM), Timed Up and Go Test (TUG), Six-minute Walking Test (6 mWT), 10-meter Walking Test (10 mWT), Functional gait assessment and the Four square step test (FSST). Gait analysis was performed on the treadmill system Zebris. The subjects in the experimental group received VR based treadmill training provided by Zebris, 20 minutes a day, five times a week, for four weeks. The subjects in the control group received treadmill training (Enraf Nonius) of the same frequency, duration, intensity, structure and progressive increase of task demands. At the end of the training all the participants were evaluated with the same assessment tools as at the first assessment. Data analysis was performed with the Statistical Package for the Social Sciences, version 22.0. The testing for normality of the data distribution was performed with Kolmogorov-Smirnov test. Differences for the measured parameters for the experimental and control group were compared by using the Wilcoxon Rank-Sum Test. **Results:** No significant differences in age ( $z = -1.384$ ,  $p = 0.166$ ) and post stroke duration ( $z = -0.397$ ,  $p = 0.691$ ) were observed between groups. Both groups showed statistically significant improvements in all measured variables after four weeks of training, which suggests functional improvement in both groups, confirmed with FIM. But there were no significant changes between the experimental and control group, except higher satisfaction in the experimental group (8.7, SD 0.7) compared to the rate of satisfaction in the control group (7.2, SD 0.7);  $p < 0.005$ . **Conclusions:** Findings of the study support the benefits of treadmill training programs in stroke patients, virtual reality-based training is as effective as treadmill training without additional tasks, but the experimental group reported higher satisfaction with the training. The findings of this study are limited to the sample of mainly subacute patients after stroke. It would be recommendable to investigate long-term effects of training also.

**Key words:** gait training, virtual reality, balance, rehabilitation, stroke

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## **Sposobnost hoje pacientov z nepopolno okvaro hrbtenjače po vadbi hoje na lokomatu: retrospektivna raziskava**

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**Uvod:** Z vadbo hoje na lokomatu se pri pacientih do šest mesecev po nepopolni okvari hrbtenjače v kombinaciji z drugimi fizioterapevtskimi postopki zmanjša potreba po uporabi pripomočkov za hojo in izboljšajo se mišična zmogljivost spodnjih udov, neodvisnost med hojo in prehojena razdalja (1, 2, 3). Vadba na lokomatu ne vpliva na izboljšanje hitrosti hoje do šest mesecev po okvari, prav tako ne vpliva na izboljšanje sposobnosti hoje pri pacientih več kot leto dni po okvari (3). Namen raziskave je bil ugotoviti izid vadbe hoje na lokomatu v kombinaciji z drugimi fizioterapevtskimi postopki pri vseh pacientih, ki smo jih v izbranem obdobju vključili v vadbo na lokomatu. **Metode:** V retrospektivno raziskavo smo vključili vseh 83 pacientov z nepopolno okvaro hrbtenjače, starih povprečno 57,2 leta (SO 17,6), ki so bili med letoma 2014 in 2018 poleg običajne fizioterapevtske obravnave vključeni v vadbo hoje na lokomatu na Univerzitetnem rehabilitacijskem inštitutu Republike Slovenije - Soča (URI - Soča). Sposobnost hoje na začetku in koncu rehabilitacijske obravnave smo ocenjevali s testom sproščene hoje na 10 metrov in s 6-minutnim testom hoje. Mediana števila obravnav na lokomatu je bila 19 (razpon od 1 do 47), povprečna hitrost hoje na lokomatu 0,44 m/s (SO 0,35), povprečna razbremenitev telesne teže 38,5-odstotna (SO 23,6) in povprečno trajanje vadbe 29,3 minute (SO 13). Pri pacientih, ki pred vadbo na lokomatu niso bili sposobni hoje po tleh, ob koncu rehabilitacije pa so hodili, smo izračunali povprečno hitrost hoje in prehojeno razdaljo. Za primerjavo rezultatov pri pacientih, ki so bili sposobni hoje že pred vadbo na lokomatu, smo uporabili parni t-test. Meja statistične značilnosti je bila  $p \leq 0,05$ . Raziskavo je odobrila komisija za medicinsko etiko URI - Soča (št.: 80/2018). **Rezultati:** 23 pacientov ni bilo sposobnih hoditi po tleh na začetku in prav tako ne ob koncu rehabilitacije. Povprečna hitrost hoje 34 pacientov, ki pred obravnavo na lokomatu niso bili sposobni hoje po tleh, je bila ob koncu rehabilitacije 0,35 m/s (SO 0,23), povprečna prehojena razdalja pa 113 metrov (SO 70). Izboljšanje sposobnosti hoje 23 pacientov, ki so bili zmožni hoje že na začetku rehabilitacije, je bilo statistično značilno tako za hitrost hoje ( $p < 0,001$ ) kot za prehojeno razdaljo ( $p < 0,0001$ ). Pri treh pacientih so bili podatki pomanjkljivi, zato smo jih iz analize izločili. **Zaključki:** Ne moremo zaključiti, koliko je k ponovni vzpostavitvi hoje ali izboljšanju sposobnosti hoje prispevala vadba hoje na lokomatu. Pacienti lahko s to napravo vadijo hojo, preden je mišična zmogljivost zadostna za hojo po tleh, pri čemer je nepogrešljiva tudi delna razbremenitev telesne teže. Hitrost hoje in trajanje vadbe na lokomatu v kombinaciji z drugimi fizioterapevtskimi postopki sta morda prispevala k izboljšanju hitrosti hoje in prehojene razdalje.

**Ključne besede:** okvara hrbtenjače, vadba hoje, eksoskelet, rehabilitacija, fizioterapija

## Walking abilities of patients with incomplete spinal cord injury after lokomat training: retrospective research

**Background:** In patients with incomplete spinal cord injury within six months after the onset of injury lokomat training in combination with other physiotherapy procedures diminishes the need for assistive devices and improves muscle strength, independency and walking distance (1, 2, 3). Lokomat training has no effect on increased gait velocity within six months after the onset of injury, neither has the effect on improving walking abilities in patients more than one year after the onset (3). Purpose of the research was to find out the outcome of lokomat training in combination with other physiotherapeutic procedures in all patients, that were included in the lokomat during chosen period of time. **Methods:** All 83 patients with incomplete spinal cord injury, mean age 57.2 years (SD 17.6), were included into retrospective research. Besides the regular physiotherapeutic procedures, they were also included in lokomat training between 2014 and 2018 in the University Rehabilitation Institute of the Republic of Slovenia - Soča (URI - Soča). Walking abilities were assessed before and after rehabilitation period with the 10-meter walk test at comfortable speed and the 6-minute walk test. Median number of sessions on the lokomat was 19 (range from 1 to 47), mean walking speed was 0.44 m/s (SD 0.35), mean body weight support was 38.5 % (SD 23.6) and mean training time was 29.3 minutes (SD 13). In patients that were not able to walk before training, but did walk at the end of rehabilitation, we calculated mean gait speed and distance. For comparison of results in patients that were able to walk before training, we used paired t test. Statistical significance was set to  $p \leq 0.05$ . Research was approved by the Medical Ethics Committee of URI - Soča (No. 80/2018). **Results:** 23 patients were not able to walk before neither after the rehabilitation period. Mean values of walking speed and distance walked at the end of rehabilitation in 34 patients that were not able to walk before training was 0.35 m/s (SD 0.23) and 113 metres (SD 70), respectively. Improvement in 23 patients that were able to walk also before training was statistically significant for gait velocity ( $p < 0.001$ ) and distance walked ( $p < 0.0001$ ). In three patients, data were inadequate, thus we eliminated them from analysis. **Conclusions:** We cannot conclude, how much lokomat training contributed to restoring or improving walking. With the assistance of the lokomat patients can practice walking before strength is adequate, while partial body weight support is indispensable. Gait speed and duration during lokomat training in combination with other physiotherapeutic procedures may have contributed to improving walking velocity and distance walked.

**Key words:** spinal cord injury, gait training, exoskeleton, rehabilitation, physiotherapy

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## **Uporaba navidezne resničnosti pri rehabilitaciji roke po možganski kapi**

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**Uvod:** Uporaba navidezne resničnosti (VR) pri rehabilitaciji nam omogoča, da povečamo nadzor nad izvajanjem nalog in jih lažje prilagodimo posamezniku. BiMeo je naprava, ki omogoča različne načine rehabilitacije roke v dveh ali treh ravninah v VR. Dosedanje raziskave so pokazale, da je BiMeo koristno orodje pri rehabilitaciji (1). Namen naše raziskave je bil oceniti uporabnost naloge seganja BiMeo za izboljšanje gibanja zgornjega uda. **Metode:** V raziskavo smo vključili 39 bolnikov, ki so se zdravili v zdravilišču po ishemični možganski kapi. Povprečna ocena na modificirani Rankinovi lestvici (mRS) je bila 2,6 s (SO: 1,2 s). Bolniki so opravili vsaj dve vadbi seganja z BiMeo, ki sta trajali v povprečju 123 s (SO 49 s). Bolniki so sedeli pred zaslonom in držali BiMeo v okvarjeni roki. Na zaslonu se je pojavila tarča, ki so jo morali čim hitreje in čim natančneje doseči. Za vsakega pacienta je naprava BiMeo izmerila učinkovitost, čas, hitrost, gladkost, optimalnost in napako seganja. Izračun je bil indeks kakovosti seganja in skupna ocena. Vsi parametri razen skupne ocene so bili normalizirani na lestvici od 0 do 10, pri čemer 10 predstavlja optimalno. Razlike med prvo in drugo sejo smo ugotavljali s parnim t-testom. Izmerjene parametre druge vadbe, indeks kakovosti seganja in skupno oceno smo korelirali (Pearsonov koeficient korelacije) s kumulativnim časom vadbe (vsota trajanja prve in druge vadbe) ter številom dni med prvo in drugo vadbo. Vsi bolniki so bili vključeni v standardizirano fizioterapijo in delovno terapijo. **Rezultati:** Čas vadbe in hitrost posameznega giba se med prvo in drugo vadbo nista razlikovala. Preiskovanci so seganje v drugi vadbi izvedli učinkoviteje, v krajšem času, bolj gladko, z optimalnejšo krivuljo seganja in manjšo napako. Vse skupaj je vplivalo na končni rezultat, izražen v točkah ( $222,1 \pm 111,9$  proti  $257,9 \pm 125,0$ ;  $p < 0,01$ ) in indeksu kakovosti seganja ( $5,6 \pm 1,9$  proti  $6,4 \pm 1,7$ ;  $p < 0,005$ ). Nobena korelacija ni bila statistično značilna. **Zaključek:** Rezultati naše raziskave kažejo, da lahko uporaba BiMea z nalogo seganja v VR izboljša gibljivost okvarjenega zgornjega uda po dveh vadbah. Glede na rezultate korelacij to najverjetneje ni posledica učenja. S prihodnjimi raziskavami je treba ugotoviti optimalno število vadb in njihovo trajanje za izboljšanje gibljivosti zgornjega uda.

**Ključne besede:** možganska kap, rehabilitacija roke, delovna terapija, fizioterapija, navidezna resničnost

## The use of virtual reality in rehabilitation of the arm after stroke

**Introduction:** Rehabilitation in virtual reality (VR) enables us to increase control and to personalize rehabilitation. BiMeo is a device designed for the rehabilitation of the upper limb. It enables different VR rehabilitation programs in two or three planes. Research has shown that BiMeo is a useful tool in rehabilitation (1). The purpose of our study was to evaluate the feasibility of rehabilitation of the arm using BiMeo in the reaching movement. **Methods:** 39 patients who were treated at the medical *rehabilitation centre* were included in the study. All patients suffered from ischemic stroke. The average modified Rankin scale score was 3 (SD 1.2 s). They had at least two sessions using BiMeo. Patients sat in front of the screen and held BiMeo in the affected arm. They were instructed to reach a target on the screen as quickly and as accurately as possible. Each exercise lasted on average 123 seconds (SD 49 s). For each patient effectiveness, time, speed, smoothness, optimality of the movement and accuracy were measured. The movement quality index and total score were calculated. All parameters except the total score were normalized on a scale from 0 to 10, where 10 is optimal. Differences between the first and second sessions were compared with the paired t test. The measured parameters of the second exercise, the index of the quality of the reaching and the overall score were correlated (Pearson correlation coefficient) with the cumulative exercise time (the sum of the duration of the first and second exercises) and the number of days between the first and second exercises. All patients performed standardized physio- and occupational therapy. **Results:** The exercise time and the speed of movement did not differ between the first and the second session. On average, patients performed more efficiently, in a shorter time, smoother, with a more optimal movement curve, and with a minor error in the second session. Better performance was evident in the higher total points ( $222.1 \pm 111.9$  vs.  $257.9 \pm 125.0$ ;  $p < 0.01$ ) and the higher movement quality index ( $5.6 \pm 1.9$  to  $6.4 \pm 1, 7$ ;  $p < 0.005$ ). None of the parameters measured correlated with the cumulative duration of the sessions or the number of days between the individual exercises. **Conclusion:** Results of our study suggest that the use of BiMeo with the reaching task in the VR can improve the movement of the damaged upper limb after two exercises. According to the results of correlations, this is probably not a consequence of learning. In the future, it is necessary to determine the optimal number of the sessions and their duration.

**Key words:** stroke, arm rehabilitation, occupational therapy, physiotherapy, virtual reality

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## **Zanesljivost slovenskega prevoda Wolfovega testa motoričnih funkcij**

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**Uvod:** Wolfov test motoričnih funkcij (angl. Wolf Motor Function Test – WMFT) je veljavno merilno orodje za ocenjevanje funkcijskih zmožnosti zgornjega uda pri pacientih po možganski kapi (1–3). Vključuje 17 nalog, pri katerih se meri čas in ocenjuje kakovost izvedbe funkcijskih gibov zgornjega uda, od katerih se pri dveh testira le mišična jakost (2). Za originalno različico WMFT so ugotovili odlično zanesljivost preiskovalca in odlično zanesljivost med preiskovalci (1). Namen prispevka je predstaviti izsledke o zanesljivosti posameznega preiskovalca in med preiskovalci pri uporabi slovenskega prevoda WMFT. **Metode:** V raziskavo je bil vključen priložnostni vzorec 30 pacientov (16 moških, 14 žensk), v povprečju starih 57,5 (SO 8,5) leta, v obdobju povprečno 28,8 (SO 16,4) tedna po možganski kapi. 17 pacientov je imelo levostransko, 13 pa desnostransko hemiparezo. Pri preverjanju zanesljivosti so sodelovali dva fizioterapevta in pet delovnih terapevtk. Ocenjevali smo kakovost izvedbe 15 testnih nalog z okvarjenim zgornjim udom z uporabo 6-stopenjske lestvice funkcijskih zmožnosti (angl. Functional Ability Scale – FAS), v skladu z metodologijo preteklih raziskav (1, 3, 4). En preiskovalec je za preverjanje zanesljivosti posameznega preiskovalca izvajal testiranje in ocenjeval kakovost izvedbe testnih nalog v živo in iz videoposnetka. Za preverjanje zanesljivosti med preiskovalci je vseh sedem preiskovalcev kakovost izvedbe hkrati ocenjevalo iz videoposnetkov. Za posamezne naloge in za končno oceno smo izračunali interklasne korelacijske koeficiente (ICC 2,1 in ICC 3,1 za zanesljivosti med preiskovalci). Raziskavo je odobrila komisija za medicinsko etiko URI - Soča 16. septembra 2016. **Rezultati:** Ugotovili smo odlično zanesljivost posameznega preiskovalca (ICC 0,97–0,99) in odlično zanesljivost med preiskovalci za celoten test (ICC 0,993–0,998) ter za vse posamezne testne naloge (ICC 0,96–0,99). **Zaključki:** Izsledki kažejo na odlično zanesljivost posameznega preiskovalca in med preiskovalci za slovenski prevod WMFT. WMFT je primerno merilno orodje za raziskovalno dejavnost, za klinično uporabo pa je verjetno ustrežnejša skrajšana različica WMFT.

**Ključne besede:** WMFT, možganska kap, zgornji ud, zanesljivost

## Reliability of the Slovene translation of the Wolf Motor Function Test

**Background:** Wolf motor function test (WMFT) is a valid and reliable outcome measure for upper extremity function for stroke patients (1-3). WMFT consists of 17 timed and functional tasks for the upper extremity, two of which only test muscle strength (2). Wolf Motor Function Test has demonstrated excellent test-retest reliability (ICC 0.9-0.99) and excellent inter-rater reliability (ICC 0.95-0.99). The purpose of this paper is to present the results of test-retest and inter-rater reliability test of the Slovene translation of WMFT. **Methods:** A convenience sample of 30 patients (16 male, 14 female), with the mean age of 57.5 (SD 8.5) years, during the period an average of 28.8 (SD 16.4) weeks after stroke, was included in the study. 17 patients with left-sided and 13 with right-sided (10) hemiparesis were included in the research sample. 2 physiotherapists and 5 occupational therapists took part in the reliability study. We evaluated the quality of movement for the 15 tasks with impaired upper extremity using 6 graded Functional Ability Scale (WMFT - FAS). One of the raters administered the test and assessed the quality of movement live and from the video clip for the evaluation of test-retest reliability. To evaluate the inter-rater reliability seven raters simultaneously assessed the subjects from the video clips. For individual tasks and for the final score we calculated the interclass correlation coefficients (ICC 2.1 and ICC 3.1 for inter-rater reliability). The study has been approved by the Medical Ethics Committee of the URI - Soča (16. 9. 2016). **Results:** We found the excellent test-retest reliability (ICC 0.97-0.99) and excellent inter-rater reliability for the entire test (ICC 0.993-0.998) and for all of the individual tasks (ICC 0.96-0.99). **Conclusion:** Evidence shows excellent test-retest reliability and inter-rater reliability for the Slovenian version of WMFT. The Slovenian version of WMFT is an appropriate outcome measure for the use in research, as for the clinical use a streamlined version of WMFT is more appropriate.

**Key words:** WMFT, stroke, upper extremity, reliability

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## **Sklepna mobilizacija roke in uporaba robotske rokavice gloreha pri pacientih po možganski kapi**

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**Uvod:** V raziskavi smo uporabili robotsko rokavico Gloreha Workstation in metodo sklepne mobilizacije po Kaltenbornu. Namen študije je bil raziskati kratkoročni vpliv terapije z robotsko rokavico Gloreha v primerjavi s standardno fizioterapijo roke po možganski kapi. Zanimala nas je morebitna razlika med skupinama v spremembi obsega gibljivosti (ROM), spastičnosti, jakosti prijema roke in funkcionalnosti roke. **Metode:** Raziskava je bila izvedena v desetih zaporednih delovnih dneh. Sodelovalo je 14 preiskovancev 2,2 leta ( $SD \pm 2,2$ ) po možganski kapi. Preiskovance smo naključno razdelili v študijsko in kontrolno skupino. Za ocenjevanje smo uporabljali modificirano lestvico Tardieu, goniometrijo, dinamometer Jamar, Wolfov test motoričnih funkcij (Wolf Motor Function Test – WMFT), test devetih zatičev (NHPT), vprašalnik za ocenjevanje motorične dejavnosti UE (Motor Activity Log – MAL) in anketo o prijetnosti uporabe robotske rokavice Gloreha. Meritve so bile izvedene pred obravnavami in po desetih obravnavah. Glede na zastavljen protokol smo se v obeh skupinah v prvi uri obravnave posvetili pripravi mehkih struktur zgornjega uda – UE (globinsko pregrevanje tkiva in sklepna mobilizacija po Kaltenbornu). Študijska skupina je v drugi uri obravnave prejela terapijo z robotsko rokavico, kontrolna pa standardno fizioterapijo roke po možganski kapi s specifičnimi elementi z omejevanjem spodbujajoče terapije (CIMT), pristopa Bobath s kombinacijo vaj v zaprti, polodprti in/ali odprti kinematični verigi. Vključena terapija CIMT pri kontrolni skupini je trajala od 10 do 30 minut. Odgovora etične komisije še nismo prejeli. Vsi preiskovanci so podpisali prostovoljni pristanek k sodelovanju v raziskavi. **Rezultati:** Terapija z robotsko rokavico Gloreha je pozitivno vplivala na znižanje spastičnosti, povečevanje jakosti prijema in pasivni obseg gibljivosti v smeri zunanje rotacije glenohumeralnega sklepa ter dorzalne fleksije zapestja ( $p < 0,05$ ). Standardna fizioterapija roke po možganski kapi je bila uspešnejša pri povečevanju PROM v smeri radialne deviacije v zapestju, AROM (aktivni ROM) v smeri abdukcije v GH-sklepu in pri testu NHPT ( $p < 0,05$ ). Ugotovili smo izboljšanje splošnega zadovoljstva in uporabo hemiparetične roke pri obeh skupinah (MAL in WMFT). Strinjali so se s trditvijo, da je terapija z robotsko rokavico Gloreha zabavna, zanimiva, motivacijska in prijetna (ocenili so jo s 7,9 od 10 možnih točk) ter bi jo z veseljem še kdaj ponovili. **Zaključek:** Izkazalo se je, da je kratkoročni vpliv terapije s sklepno mobilizacijo in robotsko rokavico Gloreha uspešneje zmanjšal spastičnost hemiparetične roke, povečal jakost prijema roke in obsega gibljivosti v smeri zunanje rotacije v glenohumeralnem sklepu ter dorzalne fleksije zapestja v primerjavi s standardno fizioterapijo roke po možganski kapi.

**Ključne besede:** možganska kap, robotika, nevrorehabilitacija, roka, robotska rokavica Gloreha

## Manual mobilization of the hand and use of the Gloreha robotic glove in stroke patients

**Background:** In the study, we used the Gloreha Workstation robotic glove and Kaltenborn's manual mobilization of hand. The aim of the study was to research the effectiveness of the Gloreha (the robotic hand rehabilitation glove) on hand rehabilitation in stroke patients in comparison with the standard physiotherapy of hand in stroke patients (conventional neurological hand rehabilitation). We were interested in the difference between the two groups (progress in range of motion, spasticity, hand and pinch grip strength and hand's functionality). **Methods:** The research was conducted over ten consecutive working days. The study included 14 patients 2.2 years ( $SD \pm 2.2$ ) after stroke. The patients were randomly divided into a treatment and a control group. To measure results we used the modified Tardieu scale, goniometry, a Jamar dynamometer, the Wolf Motor Function Test (WMFT), Nine-Hole Peg Test (NHPT), Motor Activity Log (MAL) and a survey about the Gloreha's usage comfort. These measurements were performed before and after ten days of treatment. Following the protocol, the first hour of the treatment in both groups was dedicated to soft tissue preparation (inducing deep heat) and joint mobilization of the upper limb (the Kaltenborn technique). In the second hour, the treatment group was treated with the Gloreha, while the control group received standard physiotherapy of hand in stroke patients combined with the Constraint Induced Movement Therapy (CIMT) and a personalized combination of exercises (closed, semi-opened and/or opened kinetic chain) aligned with the Bobath approach. We used the CIMT technique from 10 to 30 minutes per therapy. The ethics committee's answer has not arrived yet. All patients completed a form confirming voluntary participation. **Results:** The results show that the Gloreha therapy reduced spasticity, improved hand grip strength and positively affected PROM (passive range of motion) in the direction of external rotation in the glenohumeral joint and PROM in the direction of dorsal flexion in the wrist joint ( $p < 0.05$ ). Standard physiotherapy of hand in stroke patients was more successful at improving PROM in the direction of radial deviation in the wrist, AROM (active range of motion) in the direction of abduction in the glenohumeral joint and at the NHPT ( $p < 0.05$ ). The research questions were confirmed, as both groups noticed improved general satisfaction and better use of the paretic arm (the MAL and the WMFT). The therapy, which they would undergo again, was fun, interesting, motivational and pleasant (receiving 7.9 out of 10). **Conclusion:** It turned out that the short-term impact of the therapy with Kaltenborn's manual mobilization and the Gloreha robotic glove effectively reduced the spasticity of the hemiparetic arm, increased hand strength and passive range of motion in the direction of external rotation in the glenohumeral joint and in the direction of dorsal flexion in the wrist joint compared to the standard physiotherapy of the arm after stroke.

**Key words:** stroke, robotics, neurorehabilitation, arm, Gloreha (robotic hand rehabilitation glove).

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