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Pregledni rad

UTICAJ PLESNIH AKTIVNOSTI NA OPORAVAK I UNAPREĐENJE MOTORIČKIH FUNKCIJA OSOBA NAKON MOŽDANOG UDARA: PREGLEDNO ISTRAŽIVANJE

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Apstrakt: Moždani udar predstavlja klinički sindrom i jedan je od vodećih uzročnika smrtnosti i invaliditeta, nastao pod dejstvom velikog broja faktora rizika, čiji se simptomi nalaze u korelaciji sa veličinom, vremenom i mestom nastanka lezije. Rehabilitacija, koja obuhvata primenu konvencionalnih i dopunskih metoda, u vezi je sa procenom sposobnosti, stepenom oštećenja zahvaćenih funkcija pojedinca i adekvatno dizajniranim programom. Primena plesa, kao rehabilitacionog postupka, zahteva slušanje i aktivno učešće pojedinca sa određenom motoričkom reakcijom na stimuluse. Cilj rada jeste da prikaže značaj i efekte primene plesa u procesu rehabilitacije osoba nakon moždanog udara, a posebno za unapređenje motoričkih sposobnosti i funkcija. U skladu sa postavljenim kriterijumima i ciljem rada, izvršeno je prikupljanje i analiza stručno-naučnih istraživačkih radova, dostupnih u bazama PubMed/MEDLINE, Science Direct i Oxford Academic, objavljenih u

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periodu od 2010. do 2019. godine. Rezultati istraživanja pokazuju da ples, koji je u osnovi sportsko-rekreativna aktivnost, primenjen u terapijske svrhe kod osoba nakon moždanog udara, doprinosi razvoju i oporavku motoričkih sposobnosti, ravnoteže, pokretljivosti, izdržljivosti, koordinacije, motoričkih veština, posture, hoda i preciznosti. Takođe, ples je od izuzetnog značaja za unapređenje funkcionisanja celog organizma, koji na direktan ili indirektan način utiče na oporavak motoričkih funkcija i sveukupno blagostanje pojedinca.

Ključne reči: *motorni oporavak, motoričke sposobnosti, motoričke veštine, moždani udar, rehabilitacija*

UVOD

Savremen način života, prevelika izloženost stresu i faktorima rizika, poput nezdrave ishrane, neredovne i nedovoljne fizičke aktivnosti, konzumiranja alkohola i cigareta, samo su neki od promenljivih i nepromenljivih faktora rizika, koji dovode do pojave moždanog udara. Pored navedenog, na pojavu ovog medicinskog fenomena, značajno utiču pol i godine starosti (Arsić, 2015). Incidenca akutnog moždanog udara varijabilna je u različitim zemljama i kreće se od 100 do 300 novih slučajeva na 100 000 stanovnika godišnje i tendencijom rasta sa porastom godina starosti (Mandić, 2014). Svetska zdravstvena organizacija moždani udar definiše kao „klinički sindrom vaskularne etiologije koji se karakteriše naglim nastankom fokalnog ili globalnog moždanog deficita, koji traje duže od 24 sata ili se završava smrtnim ishodom" (Aho, Harmsen, Hatano, Marquardsen, Smirnov & Strasser, 1980). Prema patologiji koja je u osnovi fokalnog oštećenja mozga, razlikujemo ishemični i hemoragični moždani atak. Osim što se radi o sindromu sa veoma visokom stopom mortaliteta, podjednako je ozbiljna i zabrinjavajuća činjenica da je ovo klinički sindrom koji kao posledicu ima visoku stopu invaliditeta, kognitivne poremećaje različite težine (Pavlović, 2016) i funkcionalnu invalidnost (Arsić, Konstantinović, Eminović & Pavlović, 2016). Pored navedenog, usled fokalnog oštećenja centralnog nervnog sistema i gubitka pojedinih funkcija, dolazi do pojave oduzetosti jedne polovine tela (potpuna ili delimična- hemiplegija, hemipareza), nemogućnosti obavljanja elementarnih svakodnevnih životnih aktivnosti, poremećaja govora, vida, sluha, gutanja, kontrole sfinktera (Matović, Glinac i Šarić, 2010), promena u motoričkom funkcionisanju pojedinca, mobilnosti, stabilnosti, izvođenja motoričkih veština, sposobnosti motoričkog učenja, planiranja i izvođenja pokreta, koje su u korelaciji sa veličinom, vremenom i mestom nastanka lezije.

Cilj rehabilitacije osoba nakon moždanog udara, koji je često potrebno modifikovati (Mandić, 2014), jeste korekcija abnormalnih obrazaca ponašanja i

omogućavanje izvođenja adekvatnih, kao i ponovno osposobljavanje pojedinca za svakodnevno funkcionisanje u društvenoj sredini. Uspešnost procesa rehabilitacije zavisi od niza faktora, poput motivacije, premorbidnih faktora, faktora vezanih za oštećenje, vremena započinjanja restitucije izgubljenih funkcija, starosne dobi osobe, strukture ličnosti, opšteg stanja organizma. Plastičnost mozga (neuroplastičnost) predstavlja veoma dobru osnovu za rehabilitacioni proces, posebno za proces motoričkog učenja i motorni oporavak (Park & Lee, 2016), koji je grupisan u dve kategorije: lokalni procesi (rani oporavak) i reorganizacija (kasniji oporavak) centralnog nervnog sistema (Ruiz Olaya & Lopez Delis, 2015; Sharma, Classen & Cohen, 2013). Stereotipne faze motornog oporavka prema Brunstromu (flakcidnost, pojava spasticiteta, povećan spasticitet sa sinergijskim voljnim pokretima, složeni pokreti sa smanjenim spasticitetom, nestanak spasticiteta i potpuni oporavak) povezane su sa neuroplastičnim promenama (Li, 2017; Park & Lee, 2016). Pored urgentne, medikamentozne terapije, značaj u krajnjem ishodu ovog kliničkog sindroma, ima medicinska rehabilitacija, kao i sve češća primena komplementarnih i suportivnih metoda i tehnika rehabilitacije. Primena plesa, kao metode rehabilitacije zasnovane na kombinaciji motoričke aktivnosti i muzike, značajna je za sveukupno blagostanje pojedinca. Ples predstavlja oblik fizičke aktivnosti, koja je zbog zabave održiva, doprinosi povećanju fleksibilnosti, mišićnog tonusa i snage, ravnoteže, prostore orijentacije (Alpert, 2010). Prethodno navedeni autor ističe da ples sadrži niz repetitivnih pokreta, koji su od izuzetnog značaja za razvoj pokretljivosti ekstremiteta i čitavog organizma. Prilikom primene plesa u terapijske svrhe, posebna pažnja mora se obratiti na karakteristike, intenzitet i sadržaj istog.

Na osnovu teorijskih postavki, cilj ovog preglednog rada je, prikupljanjem i analizom istraživanja, prikazati značaj i efekte primene plesa, u procesu rehabilitacije, za unapređenje motoričkih sposobnosti i funkcija kod osoba nakon moždanog udara.

METOD

U skladu sa predmetom rada, svi stručno-naučni radovi prikupljeni za potrebe ovog rada, morali su odgovarati istom. Metodom selekcije vršen je odabir radova, pretragom elektronskih baza podataka (PubMed/MEDLINE, Science Direct i Oxford Academic), kao i analizom referenci odabranih radova na postavljenu temu, objavljenih u celosti. Radi što preciznijeg obuhvata literature, postavljeni su kriterijumi u pretrazi, odnosno svi objavljeni i analizirani radovi morali su biti objavljeni u celosti i istraživačkog karaktera, pri čemu se bar jedna varijabla morala odnositi na primenu plesa u rehabilitaciji osoba nakon moždanog udara i oporavak motoričkih funkcija i veština. Klasifikacija radova izvršena je na osnovu predmeta i cilja realizovanog istra-

živanja. Obim analiziranih radova ograničen je na šest istraživačkih radova, objavljenih u celosti u periodu od 2010. do 2019. godine. Korišćene ključne reči u pretrazi bile su: moždani udar (engl. stroke), ples (engl. dance), terapija zasnovana na plesu (engl. dance based therapy), motorni oporavak (engl. motor recovery), motoričke sposobnosti (engl. motor abilities), motoričke veštine (engl. motor skills). Primenjene metode za odabir radova bile su: metod selekcije, metod deskripcije, metod sistematizacije, metod analize, metod sinteze i metod komparacije.

REZULTATI

Slika 1. *Proces prikupljanja podataka*

Na Slici 1, prikazan je proces prikupljanja podataka, odnosno istraživačkih radova. U skladu sa postavljenim ciljem i kriterijumima ovog rada, odabrano je šest radova, koji ukazuju na uticaj plesa na oporavak motoričkih funkcija osoba nakon moždanog udara (Tabela 1).

Tabela 1. *Prikaz analiziranih istraživanja*

Prvi autor i godina	Karakteristike uzorka				Procenjeni elementi	Zaključak
	N	Br. grupa	Starost	Pol		
Thornberg, 2013	17	1	38-78	7 Ž 10 M	Izvođenje specifičnih pokreta u skladu sa ritmom, izvođenje motoričkih zadataka	Utvrđen je pozitivan uticaj terapije zasnovane na izvođenju pokreta u skladu sa ritmom muzike (ples), primenjene jednom nedeljno u trajanju od 10 nedelja kod osoba sa moždanim udarom, na učenje novih pokreta, razvoj telesne percepcije, pronalaženje alternative za izvođenje pokreta, njihovu koordinaciju i simultano izvođenje.
Demers i sar., 2015	9	1	AS 63.7 ± 11.7	2 M 7 Ž	Participacija, ravnoteža, izdržljivost, ritmičnost, kvalitet pokreta, pamćenje aktivnosti	Primena modifikovanih časova plesa u trajanju od četiri nedelje (dva puta nedeljno), doprinosi oporavku osoba nakon moždanog udara, kao i poboljšanju ravnoteže, unapređenju kvaliteta pokreta (aktivacija ekstremiteta, fluidnost pokreta), izdržljivosti, ali i razvoju socijalnih kompetencija.

Subramaniam i sar. 2015	11	1	AS 60.75	5 M 6 Ž	Ravnoteža, motorička aktivnost, karakteristike hoda, funkcionalni oporavak	Primena časova virtuelnog plesa, u trajanju od šest nedelja (20 sesija), kod osoba nakon moždanog udara, doprinosi poboljšanju vremena reakcije, brzine, nivou fizičke aktivnosti, vremenu odgovora na stimuluse i brzini pokreta. Takođe, ova metoda izuzetno je značajna za unapređenje karakteristika hoda i smanjenje rizika od padova.
Dursun i sar., 2016	45	2	1. AS 47,75 (± 15,5) 2. AS 49,21 (± 12.7)	1. 6 M 10 Ž 2. 7 M 12 Ž	Mišićni tonus, motorni oporavak, mobilnost, statička i dinamička ravnoteža	Primena modifikovanog tanga, u trajanju od četiri nedelje (pet puta nedeljno), u kombinaciji sa programom rehabilitacije i injekcijama botulinum toxin A, dovodi do poboljšanja mišićnog tonusa, mobilnosti, statičke i dinamičke ravnoteže i sveukupnom motornom oporavku.
Wolff i sar., 2017	4	1	50-86	3 M 1 Ž	Hod, ravnoteža, transfer, preciznost pokreta gornjih i donjih ekstremiteta, koordinacija	Primena plesa tokom tri godine (jednom nedeljno), doprinosi kvalitetu pokretljivosti, napretku u izvođenju jednostavnih i složenih pokreta ekstremiteta, sveukupnoj pokretljivosti, obrascima hoda i transferu.
Patterson i sar., 2018	20	1	AS 62.4	11 M 9 Ž	Prostorno vremenski parametri hoda i ravnoteža	Primena plesa u trajanju od 10 nedelja (dva puta nedeljno), doprinosi poboljšanju ravnoteže, ali ne i prostorno vremenskim karakteristikama hoda.

Legenda: N- ukupan broj ispitanika, AS- aritmetička sredina, M- muški pol, Ž- ženski pol

Istraživanje realizovano od strane Tornbergove (Thornberg, 2013), kojim je obuhvaćeno 17 ispitanika oba pola, imalo je za cilj utvrđivanje rezonovanja participacije u terapiji baziranoj na primeni ritma, muzike i pokreta (plesnih aktivnosti) osoba nakon moždanog udara. Terapija je primenjivana tokom 10 nedelja, jednom nedeljno. Polustruktuiranim intervjuom ocenjena su iskustva ispitanika o učešću u terapiji, razumevanju i procesu učenja motoričkih zadataka. Fenomenografskom metodom ispitano je rezonovanje participacije i promene u oblasti izvođenja motoričkih zadataka i sveukupnog motoričkog funkcionisanja. Na osnovu analiziranih odgovora ispitanika, utvrđeno je da primena terapije, odnosno njena složenost, doprinosi prilagođavanju promenama nastalim u telu i procesu učenja novih motoričkih zadataka. Takođe, rezultati pokazuju da ovakav vid terapije doprinosi pronalaženju alternative za izvođenje motoričkih zadataka, kao i koherentnom doživljaju telesne celovitosti. Kombinacijom muzike, pokreta i ritma u terapijske svrhe kod osoba nakon moždanog udara povećava se nivo simultanog i koordinisanog izvođenja pokreta.

Demers i MekKinli (Demers & McKinley, 2015), pilot studijom, nastojali su da ispitivanju značaja primene modifikovane terapije plesom, kao dodatne metode u rehabilitacionom procesu osoba sa subakutnim moždanim udarom. Istraživanjem je obuhvaćeno devet ispitanika, koji su pored okupacione i fizikalne terapije u trajanju od 45 minuta dnevno, pohađali časove plesa, dva puta nedeljno, tokom četiri sedmice. Kombinacijom džeza i merenge plesa, aktivnosti su usmerene na razvoj različitih sposobnosti. Instruktori plesa sprovodili su nestandardizovanu procenu određenih elemenata ponašanja učesnika koja je obuhvatala: participaciju i socijalnu interakciju, ravnotežu, izdržljivost, ritmičnost, kvalitet pokret i pamćenje rutine (Demers & McKinley, str. 3215). Procena sposobnosti i funkcija izvršena je nedelju dana pre i nakon intervencije. Primenom deskriptivne i komparativne metode, utvrđeno je da su skorovi na Berg Balans Skali (BBS) dobijeni finalnom procenom, znatno viši od skorova dobijenih inicijalnom. Kvalitativnom analizom podataka dobijenih iz medicinske dokumentacije, autori ističu da je kod ispitanika značajno ubrzan proces oporavka motoričkih funkcija, kao i svih sposobnosti i funkcija sadržanih u plesnim aktivnostima.

Subramaniam i Bat (Subramaniam & Bhatt, 2015), realizovali su istraživanje sa ciljem utvrđivanja efekata terapije plesom zasnovane na virtuelnoj realnosti, u poboljšanju ravnoteže i nivoa fizičke aktivnosti kod osoba sa hroničnom hemiparezom, nastalom kao posledica moždanog udara. Istraživanjem je obuhvaćeno 11 osoba, oba pola, koje su tokom šest nedelja bile uključene u terapiju plesom. Tokom prve dve nedelje tretmana, sesije su realizovane pet puta nedeljno, tokom druge dve tri puta, a tokom poslednje dve nedelje sesije su realizovane dva puta nedeljno. Prosečno vreme trajanja sesija kretalo se u rasponu od jednog sata i 25 minuta do jednog sata i 45 minuta, za sve ispitanike. Procena elemenata motoričkog funkcionisanja, vršena je pre tretmana, tokom (u desetoj nedelji) i po završetku. Primenom Protokola za procenu ograničenja u stabilnosti (The Limits of Stability), procenjena je kontrola ravnoteže, dok je Testom motorne kontrole procenjena reaktivna kontrola ravnoteže, zasnovana na oceni mogućnosti za brzo dovođenje tela u ravnotežni položaj nakon iznenadnih izvođenja iz istog. Promene u nivou fizičke aktivnosti ocenjene su korišćenjem pedometra (Omran HJ-321 Tri-Axiz Pedometer), dok je funkcionalni oporavak procenjen primenom Berg Balans Skale (BBS za procenu ravnoteže), Timed Up and Go testa (TUG, za procenu bazične mobilnosti i rizika od padova) i Fall Eficiency Skale (FES, za procenu straha od padova). Primenom jednofaktorske analize varijanse (ANOVA) uočene su značajne razlike između intervala procene u oblasti kontrole ravnoteže (vreme odgovora ($F(2,20)= 6,659$, $p< 0,05$), brzine motoričkog odgovora ($F(2,20)= 15,313$, $p< 0,01$) i maksimalne ekskurzije pokreta ($F(2,20)= 3,863$, $p< 0,01$)). Nivo fizičke aktivnosti, primenom regresione analize, procenjen na osnovu porasta broja koraka tokom sesija, koji je tokom vremena znatno

povišen (R2=0,0528, p<0, 05). Statistički značajne razlike između inicijalnog i finalnog merenja, uočene su u funkcionalnom oporavku (skorovi na BBS, TUG i FES; p< 0,01).

„Da li kombinacija terapeutskog plesa, konvencionalnih metoda rehabilitacije i injekcija Botulinum Toksina A, doprinosi oporavku sposobnosti hoda i ravnoteže kod osoba nakon moždanog udara?" predstavlja pitanje čiji je odgovor cilj istraživanja realizovanog od strane Dursuna i saradnika (Dursun et al., 2016). Ukupan broj ispitanika (N= 45), podeljen je u dve grupe, eksperimentalnu (N= 26), kod koje je pored konvencionalnih metoda rehabilitacije i injekcija Botulinum Toksina A (BTX-A), primenjivan ples (tango) u terapijske svrhe i kontrolnu (N= 19), kod koje su primenjivane konvencionalne metode rehabilitacije i injekcije. Nedelju do deset dana nakon injekcije BTX-A, obe grupe ispitanika bile su uključenje u tronedeljni rehabilitacioni program (pet puta nedeljno, po 45 minuta dnevno) (Dursun et al., 2016, p. 126). Po završetku programa ispitanici eksperimentalne grupe, uključeni su u časove plesa (modifikovani tango, u trajanju od četiri nedelje, pet puta nedeljno), dok su ispitanici druge grupe uključeni u rekreativne aktivnosti, u skladu sa potrebama, 30 minuta dnevno. Promene mišićnog tonusa procenjene su primenom Modifikovane Ešvort Skale (Modified Ashwort Scale, MAS), Burnnstorm skalom ocenjen je nivo motornog oporavka, dok su funkcionalna mobilnost, statička i dinamička ravnoteža procenjene primenom BBS i TUG-a. Pored metoda deskriptivne statistike, za utvrđivanje razlika u intervalima merenja korišćen je t-test za zavisne uzorke, dok su razlike između grupa ispitane primenom t-testa za nezavisne uzorke i $\chi 2$ testom. Nakon primene tretmana, uočen je značajan napredak u svim oblastima, unutar obe grupe ispitanika. Retrospektivno, utvrđena je statistički značajna razlika između grupa na svim testovima (p< 0,05), u korist eksperimentalne grupe.

Volf i saradnici (Wolff, Santos Delabary & Hass, 2017), analizirali su uticaj plesa na fizičko, emocionalno i socijalno funkcionisanje osoba nakon moždanog udara. Studijom slučaja, kojom su obuhvaćena četiri ispitanika, oba pola, sa hemiparezom nastalom kao posledicom moždanog udara, ispitivan je uticaj na funkcionisanje trogodišnje primene plesa, jednom nedeljno. Aktivnosti planirane u skladu sa inicijalno procenjenim somatskim statusom ispitanika obuhvatale su različite vrste plesova, koji su uključivali vežbe za razvoj hoda, ravnoteže, transfer težine, pokretljivost gornjih i donjih ekstremiteta, napredak u izvođenju pokreta (od jednostavnih ka složenim, od sporih ka bržim), telesnu percepciju i razvoj simetrije pokreta. Procena je izvršena primenom polu-struktuiranog intervjua, čija su se pitanja odnosila na percepciju ispitanika o promenama u sferama telesnog, emocionalnog i socijalnog funkcionisanja. Dobijene informacije su klasifikovane, kategorisane i interpretirane primenom tehnike Bardin. Kvalitativnom analizom, zasnovanom na opservaciji individualnih i kontekstualnih karakteristika ispitanika

i dobijenim odgovorima, utvrđeno je da primena plesa doprinosi poboljšanju funkcionisanja svih delova tela, posebno gornjih i donjih ekstremiteta, kao i unapređenju ravnoteže, hoda, agilnosti, poboljšanju govora (oralnoj praksiji), kao i sveukupnom emocionalnom i socijalnom blagostanju.

Paterson i saradnici (Patterson, Wong, Nguyen & Brooks, 2018), ispitivali su uticaj plesa kod osoba nakon moždanog udara na promene u oblasti ravnoteže i hoda. Istraživanjem je obuhvaćeno 20 ispitanika, uključenih u 60-minutne časove plesa (balet, folk, džez, savremeni plesovi), dva puta nedeljno, tokom 10 nedelja. Svi časovi sadržali su aktivnosti poput zagrevanja, koreografiju u sedećem ili stojećem položaju, kružne vežbe sa postepenim usložnjavanjem veština i uvođenjem kompleksnih motoričkih zadataka. Inicijalnom i finalnom procenom, ocenjeni su prostorno-vremenski parametri hoda (korišćenjem platforme osetljive na pritisak, pri čemu su parametri hoda sagledani kroz dužinu koraka, vreme zamaha, kadencu, stav) i ravnoteža (Mini Balance Evaluation Systems Test (MiniBESTest)) sagledana kroz posturalnu kontrolu, kompenzatornu posturalnu kontrolu, senzornu orijentaciju i dinamiku hoda. Razlike u vrednostima dobijenim pre i post-testom, utvrđene su primenom t-testa za nezavisne uzorke. Statističkom obradom i analizom dobijenih rezultata uočene su značajne razlike između rezultata dobijenih pre i post-testom u oblasti ravnoteže (ukupan skor MiniBESTest $p< 0.005$) i subskali dinamika hoda ($p< 0.0001$). Procenom u oblasti hoda, dobijeni rezultati pokazuju da primena plesa ne dovodi do značajnih promena u oblasti prostorno-vremenskih parametara hoda

DISKUSIJA

Ljudski mozak je u stanju da razlikuje muziku i buku, reaguje na ritam, ponavljanje, tonove i melodije. Slušni nerv prenosi signale do auditivnog korteksa u temporalnom lobusu, dok su neuralne mreže zadužene za dekodiranje i tumačenje različitih vrsta muzike (Simon, 2015). Postojanje auditivno-motornih puteva (npr. preko retikulo-spinalnih veza), može uticati na prag ekscitabilnosti motornih neurona, odnosno stvaranje takozvanog primarnog efekta muzike na segmente motornog sistema putem auditivnog inputa (Thaut & McIntosh, 2014). Vestibularni sistem jedan je od bitnijih sistema zaduženih za nastanak motoričkog odgovora. Naime, tokom slušanja muzike, percepcijom auditivnih signala aktivira se veliki broj centara u mozgu. Prilikom kognitivne obrade auditivnih signala, istovremeno dolazi do aktivacije descedentnih puteva, kojima se informacije prenose do efektora u mišićima, što za posledicu ima pojavu ritmičnih pokreta ekstremiteta. Pokreti izvedeni tokom plesa, mogu biti od značaja za unapređenje sposobnosti i veština osoba nakon moždanog udara.

Ples, koji je u osnovi sportsko-rekreativna aktivnost, doprinosi razvoju i oporavku velikog broja motoričkih sposobnosti i veština (Tabela 1). U okviru analiziranih istraživanja utvrđen je pozitivan uticaj plesa na: proces motoričkog učenja (učenja novih motoričkih zadataka) (Thornberg, 2013; Demers et al., 2015), mobilnost i proces motornog oporavka (Subramaniam & Bhatt, 2015; Dursun el al., 2016), sve aspekte ravnoteže (Demers et al, 2015; Subramaniam & Bhatt, 2015; Dursun el al., 2016; Wollf et al., 2017; Patterson et al., 2018). Pozitivan uticaj plesa na parametre i sposobnost hoda uočen je u svim istraživanjima, izuzev istraživanja Patersona i saradnika (Patterson et al., 2018), kojim je pokazano da ples ne utiče na razvoj prostorno-vremenskih parametara hoda.

Neka od mogućih ograničenja analiziranih istraživanja ogledaju se u relativno maloj veličini uzorka, različitom trajanju primene plesa kod različitih grupa ispitanika, kao i uticaju dodatnih terapijskih procedura. Realizacijom istraživanja koja za cilj imaju utvrđivanje različitih terapijskih procedura, komplementarnih ili suportivnih, doprinosi se naučno-istraživačkom radu, proširivanju znanja i unapređenju dijagnostičkih, terapijskih, ali i edukativnih aktivnosti. Kontinuiranim i relevantnim prikupljanjem podataka doprinosi se razvoju standarda i metodologije u radu sa populacijom nakon moždanog udara i invaliditetom, kao i sveukupnom jačanju funkcionalnih kapaciteta, strukture ličnosti i blagostanju društvene zajednice.

ZAKLJUČAK

Analiziranim istraživanjima pokazano je da ples kao terapijska metoda, doprinosi oporavku motoričkih sposobnosti i funkcija osoba nakon moždanog udara. Nakon moždanog udara, neuroplastične promene povezane su sa funkcionalnim oporavkom i u najvećoj meri zavise od aktivnosti koje se realizuju. Ples predstavlja aktivnost koja zahteva aktivaciju preostalih motoričkih kapaciteta pojedinca i njegovo aktivno uključivanje u izvođenje pokreta, koji se mogu realizovati kao jednostavni (elementarni) i složeni (kompleksni), različitog tempa, intenziteta i ritma, u skladu sa individualnim karakteristikama pojedinca. Imajući u vidu da pokret predstavlja osnovno sredstvo izražavanja pojedinca u kombinaciji sa pravilno planiranim, programiranim i prilagođenim aktivnostima, dolazi do podsticanja procesa motoričkog učenja i ponašanja, restauracije, restitucije i kompenzacije oštećenih funkcija. Značaj ovog rada ogleda se u pružanju doprinosa i stvaranju celine o uticaju plesa na oporavak osoba nakon moždanog udara. Međutim, kod nas i u svetu, realizovan je mali broj istraživanja koja pružaju odgovor na pojedina pitanja, a samim tim predstavljaju pogodnu osnovu za sveobuhvatno razmatranje problema u daljim istraživanjima.

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Review paper

THE INFLUENCE OF DANCE-BASED ACTIVITIES ON RECOVERY AND IMPROVEMENT OF MOTOR FUNCTIONS IN POST-STROKE PATIENTS: A SYSTEMATIC REVIEW

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Abstract: Stroke is a clinical syndrome, and one of the leading causes of death and disability, occurring under the influence of a large number of risk factors. The symptoms of a stroke are in correlation with the size, time and location of the lesion. Rehabilitation, which involves the application of conventional and supplementary methods, relates to the assessment of the ability, the level of damage of the affected functions, and an adequately designed rehabilitation program. The use of dance, as a rehabilitation procedure in post-stroke patients, requires listening and active participation of an individual with a specific motor reaction to the stimulus. The primary aim of this article is to demonstrate the importance and effects of the application of dance in the rehabilitation process in post-stroke patients, with a special emphasis on the process of improving motor skills and

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functions. In accordance with the set criteria and purpose of study, scientific research papers were collected and analysed from the PubMed/MEDLINE, Science Direct and Oxford Academic databases, all published in the period between 2010 and 2019, and all indicating the importance of the application of dance when treating post-stroke conditions. The obtained results suggest that dance, which is basically a sports-recreational activity, when applied for therapeutic purposes in persons after stroke, contributes to the development and recovery of motor abilities, balance, mobility, endurance, coordination, motor skills, stance, walking and precision. Also, dancing is of great importance for the improvement of the functioning of the whole organism, which directly or indirectly affects the recovery of motor functions and the overall welfare of an individual.

Key words: *motor recovery, motor abilities, motor skills, rehabilitation, stroke*

INTRODUCTION

Different modern lifestyle patterns, excessive exposure to stress and risk factors, such as unhealthy diet, irregular and insufficient physical activity, alcohol and cigarette consumption, gender are just some of the variable and invariable risk factors that lead to stroke. In addition, age is another factor that could affect the appearance of this medical syndrome (Arsić, 2015). The incidence of acute stroke is variable across countries and ranges from 100 to 300 new cases per 100 000 inhabitants yearly and the tendency of growth with higher age (Mandić, 2014). Stroke is defined by the World Health Organization as 'a clinical syndrome consisting of rapidly developing clinical signs of focal (or global in case of coma) disturbance of cerebral function lasting more than 24 hours or leading to death with no apparent cause other than a vascular origin' (Aho, Harmsen, Hatano, Marquardsen, Smirnov & Strasser, 1980). According to the pathology, which is in the base of focal brain damage, we can differentiate ischemic and haemorrhagic brain attack (stroke). Except that it is a syndrome with very high mortality rate, an equally serious concern is the fact, that this is a clinical syndrome resulting with high rates of disability, cognitive disturbances of various severity (Pavlović, 2016), as well as functional disability (Arsić, Konstantinović, Eminović & Pavlović, 2016). In addition, due to the focal damage of the central nervous system and loss of certain functions, weakness and limitations can affect one half of the body (complete or partial- hemiplegia or hemiparesis), inability to perform basic activities of daily living, speech disorders, vision, hearing, swallowing, sphincter control (Matović, Glinac & Šarić, 2010), as well as changes in motor functions of an individual, their mobility, stability, performance of motor skills, process of motor learning, planning and performance of movement, which are in correlation with the size, time and location of the lesion.

The aim of the rehabilitation process of post-stroke patients, which is often necessary to modify (Mandić, 2014), is a correction of abnormal patterns of behaviour and providing adequate performance, as well as re-training the person to be operational in their social environment. The effectiveness of the rehabilitation process depends on different factors, such as motivation, premorbid factors, factors related to damage, the beginning of the restoration of lost functions, the person's age, their personality structure, the general state of the organism. The plasticity of the brain (neuroplasticity), represents a good basis for the rehabilitation process, especially for the motor learning process and motor recovery (Li, 2017; Park & Lee, 2016), which can be grouped into two categories: local CNS process (early recovery) and CNS reorganization (later recovery) (Ruiz Olaya & Lopez Delis, 2015; Sharma, Classen & Cohen, 2013). Brunnstrom empirically described stereotypical stages of motor recovery: (1) flaccidity; (2) appearance of spasticity; (3) increased spasticity with synergistic voluntary movement; (4) synergic movement patterns and reduced spasticity; (5) more complex movements with reduced spasticity; (6) spasticity disappears; and (7) full recovery of normal function with coordinated voluntary movements (Li, 2017). Apart from the urgent, medication therapy, medical rehabilitation holds particular significance for the final results of this clinical syndrome, and this includes the increasingly common use of complementary and supportive methods and techniques of rehabilitation. Using dance as a rehabilitation method based on the combination of motor activities and music, is significant for the overall wellbeing of the individual. Dance is a form of physical activity, which is sustainable because it is "entertaining", and important for increasing the flexibility, muscle strength and tone, endurance, balance and spatial awareness (Alpert, 2010). The aforementioned author points out that dance contains a series of repetitive movements, which are of great importance for the development of the mobility of the extremities and the whole organism. During the implementation of dance, for therapeutic approaches, specific attention must be paid to its characteristics, intensity and content.

Based on theoretical assumptions, and by collecting and analysing the existing research, the aim of this review paper is to present the importance and effects of dance-based therapy in the process of rehabilitation, for improving and recovery of motor skills and functions in post-stroke patients.

METHOD

All collected and analysed scientific data had to be in accordance with the purpose and aim of this article. Analysed papers were selected by researching electronic databases (PubMed / MEDLINE, Science Direct and Oxford Academic), as well as after analysing the references of selected papers concerning the set topic, published in entirety. For this purpose a method of selection was used.

In order to cover the bibliography more precisely, the criteria set for the purposes of the research were: research papers published in their entirety, with at least one research variable referring to the use of dance in the rehabilitation process of persons after stroke and recovery of motor functions and/or skills. The scope of the analysed papers was limited to six research papers, published in their entirety in the period between 2010 and 2019. The following keywords were used to search for the papers: stroke, dance, dance-based therapy, motor recovery, motor abilities, and motor skills. The applied methods for the selection of articles included: the selection method, the description method, the systematization method, the analysis method, the synthesis method, and the comparison method.

RESULTS

Illustration 1. *Data collection process*

Illustration 1 shows the process of collecting data from research articles. In accordance with the aim and the set criteria of this article, six articles were selected, all indicating the influence of dance on the recovery of motor functions and skills in post-stroke patients (Table 1).

Table 1. *An overview of the collected and analysed research studies*

First author	Sample characteristics				Assessed elements	Conclusion
	N	Groups	Age	Gender		
Thornberg, 2013	17	1	38-78	7 F 10 M	Performance of specific movements according to rhythm, Performance of motor tasks	Conducted therapy based on movement performance according to the music rhythm, applied for ten weeks, once a week, contributes to the process of learning new movements, body awareness, finding alternatives for performing a movement, coordination and simultaneous movement in post-stroke patients.
Demers et al., 2015	9	1	AS 63.7 ± 11.7	7 F 2 M	Participation, Balance, Endurance, Rhythm, Quality of movements, Learning activities	Using modified dance lessons for four weeks (twice a week), contributes to the recovery of post-stroke patients, as well as the improvement of balance, movement quality, endurance, and development of social skills.

Subramaniam et al. 2015	11	1	AS 60.75	6 F 6 M	Balance, Motor activity, Gait characteristics, Functional recovery	Using virtual dance lessons for six weeks (20 sessions) in post-stroke patients, is important for the improvement of the reaction time, agility, the level of physical activity, the response time to stimuli and the speed of movement performance. The used methods are moreover significant for the improvement of gait characteristics and reducing the risk of falls.
Dursun et al., 2016	45	2	1. AS 47.75 (±15.5) 2. AS 49.21 (±12.7)	1. 10 F 16 M 2 12 F 7 M	Muscle tone, Motor recovery, Mobility Static and dynamic balance	Applying modified tango for four weeks (five times a week), combined with the rehabilitation program and injections of Botulinum Toxin A, leads to the improvement of muscle tone, mobility, static and dynamic balance, and motor recovery.
Wolff et al., 2017	4	1	50-86	1 F 3 M	Gait, Balance, Transfer, Precision of movements, Coordination	Using dance for three years (once a week), contributes to the improvement of the motion quality, development and improvement of the elementary, and complex movements of the limbs, mobility in general, gait patterns and transfer.
Patterson et al., 2018	20	1	AS 62.4	9 F 11 M	Spatiotemporal parameters of gait, Balance	Using dance for ten weeks (twice a week), contributes to improving the balance, but not the spatiotemporal parameters of gait.

Legend: **N** - number of participants, **AS** - mean, **F** - female, **M** - male

A research study, conducted by Thornberg (2013), which included 17 examinees of both genders, aimed at determining the reasoning behind the participation of post-stroke patients in a treatment based on dance, rhythm, and music. The treatments were conducted once a week within ten weeks. Data has been collected by means of semi-structured interviews carried out for the assessment of examinees' participation in therapy, understanding, and learning motor tasks. The phenomenographic method was used to estimate the reasoning behind the participation, the changes in motor task performances, and motor functioning. The obtained results show that the therapy and its complexity contribute to the adaptations to changes in the body and the process of learning new movements. Also, the results show that this type of therapy contributes to finding alternative ways of performing motor tasks, as well as coherent body awareness. A combination of music, motion, and rhythm in therapeutic approaches in post-stroke patients increase the level of simultaneous and coordinated performances of movements.

In their pilot study, Demers and McKinley (2015) strive to determine the feasibility of a modified dance intervention as an adjunct therapy designed

for people with subacute stroke. The therapeutic procedure included nine participants, involved in a biweekly 45-min dance intervention, over four weeks, as well as in occupational and physical therapy (45 minutes per day). A combination of the elements of jazz dance and merengue, activities were focused on the development of flexibility, balance, endurance, upper and lower extremity function, and the quality of performed movements. The dance instructor completed an unstandardized observation grid for each participant, containing the following elements: participation and social interaction (interaction with other participants, ability to follow instructions), balance (use of external support, loss of balance), endurance (portion of the dance class performed in sitting/standing position, rest period needed), rhythm (ability to follow the music rhythm), quality of movements (use of the impaired limbs, fluidity and smoothness of movement, ability to reproduce dance steps), and memorization of the routine (with or without model) (Demers and McKinley, 2015, p. 3125). An assessment of abilities and functions was done the week prior and following the dance intervention. Using descriptive and comparative methods, it has established a difference between scores on the Berg Balance Scale (BBS), obtained on the initial and final assessment. For all participants with low BBS initial score, the BBS score improved after therapy. According to the participants' responses, and positive feedback, it was pointed to the improvement of motor abilities, as well as the total level of recovery.

An examination of the effects of a virtual reality-based dance training paradigm in improving the balance control and physical activity levels in persons with chronic hemiparesis caused by stroke, was the aim of a research conducted by Subramaniam and Bhatt (2015). During six weeks, 11 participants of both genders participated in a dance therapy. In the first two weeks, the treatment consisted of five sessions per week, the following two weeks it involved three sessions per week, and the last two weeks there were two sessions per week. The average time spent in rehabilitation ranged from one hour and twenty-five minutes to one hour and forty minutes for all participants. The assessment of balance control, physical activity, and functional measures was carried out one week before the intervention, on the 10th training session and one week after the intervention. Voluntary balance control was assessed using the Limits of Stability (LOS) test protocol, while the reactive balance control was assessed using the Motor Control test (MCT) protocol, of the Equitest (Computerized Dynamic Posturography) based on the evaluation of the participants' abilities to quickly recover balance control after an unexpected external imbalance. Changes in the level of physical activity were recorded using the Omran HJ-321 Tri-Axiz Pedometer. Standardized clinical outcome measures were used to assess functional recovery through balance control (Berg Balance Scale, BBS), risk of falls (Timed Up and Go Test, TUG) and fear of falling (Fall Efficacy Scale, FES). After using one way analysis of

variance (ANOVA), significant differences were found between the intervals of assessment in change in balance control (response time ($F(2,20)= 6.659$, $p< 0.05$), movement velocity ($F(2,20)= 15.313$, $p< 0.01$) and maximum movement excursion ($F(2,20)= 3.863$, $p< 0.01$)). The level of physical activity, using regression analysis and estimated on the basis of the increase in the number of steps during sessions, was significantly enhanced over time ($R2 = 0.0528$, $p <0.05$). Significant differences between the initial and final assessment were observed in the functional outcome scores on BBS, TUG, and FES ($p< 0.01$).

"Can a combination of therapeutic dance, conventional rehabilitation program and botulinum toxin A (BTX-A) injections, improve the walking ability and balance in post-stroke patients?'' Dursun and associates (Dursun et al., 2016) tried to answer this question in their research. A total of 45 examinees were divided into two groups: an experimental group - included into adapted tango classes and a conventional rehabilitation program combined with BTX-A injections (N= 26), and a control group (N= 19) - included into a conventional rehabilitation program combined BTX-A injections. One week to 10 days after the BTX-A injection both the patient in tango and control groups received a standard 45-minute rehabilitation program five times a week for three weeks (Dursun et al., 2016, p. 126). After the rehabilitation program, the participants from the experimental group are included into dance lessons (adapted tango), whereas the patients from the second group were included in recreational activities, according to their needs, for 30 minutes per day. The baseline and post-treatment muscle tone were evaluated using the Modified Ashworth Scale (MAS), the Brunnstrom approach was used in the evaluation of post-stroke motor recovery, while the functional mobility, balance ability, and static and dynamic balance abilities were assessed using BBS and TUG. According to the author's explanations, a comparison of pre- and post-treatment MAS, BBS and, TUG test results within each group was performed using the paired samples t-test. The comparisons between the tango and control groups were performed using the independent t-test and, the comparisons between tango and control groups were performed using the independent t or $\chi 2$ tests. After the treatment, a significant progress was noted in all assessed areas, within both groups of participants. Retrospectively, a statistically significant difference was found between the groups on all tests ($p <0.05$), in favour of the experimental group.

Wolff and associates (Wolff, Santos Delabary & Hass, 2017) observed the effects of dance on the physical, emotional and social functioning of persons after stroke. In a case study which involved four persons of both genders, with hemiparesis caused by stroke, the authors analysed the effect of dance lessons conducted for one hour per week, for a period of three years. The activities were planned according to the initial assessed somatic status of the participants and included different forms of dances. The dance lessons

included a series of different dance techniques, including exercises for gait, balance, weight transfer and the movement of legs and arms with precision and coordination, individual movement quality, progressing from simple to more complex movements, from slow movements to progressively faster, in addition to building body awareness. Individual semi-structured interviews were audio-recorded and used for assessment. The questions and themes of the interview were related to the participants' perception of the changes to their body, as well as to changes in physical, social or emotional aspects of wellbeing after dance classes. The obtained information was classified, categorized and interpreted with the Bardin technique of content analysis. With qualitative analysis, based on the observation of the participants' individual and contextual characteristics and obtained responses, the authors established that dance contributes to the improvement of functions in all parts of the body, especially upper and lower extremities, as well as to the improvement of balance, gait, agility, speech functions, and emotional and social wellbeing.

Patterson and associates (Patterson, Wong, Nguyen & Brooks, 2018), examined the effects of dance on the changes in spatiotemporal gait parameters and balance. The research encompassed 20 participants, included in 60-min dance lessons (ballet, jazz, folk, contemporary and ballroom dances), twice a week, for ten weeks. All lessons included activities such as warm-up, choreography in sitting or standing position, circular exercises with gradual increase in skills and the complexity of choreography. Initial and final assessment included the assessment of spatiotemporal gait parameters (using a pressure-sensitive mat, whereby the gait parameters were examined through the velocity, cadence, step length, step ratio, stance ratio, and swing ratio) and balance (using the Mini-Balance Evaluation Systems Test (MiniBESTest)), examined through anticipatory control, compensatory control, sensory orientation, and gait dynamic. The paired t-test was used to evaluate the scores obtained on the pre-test and post-test assessments. Statistical analysis and the analysis of the obtained results revealed significant differences between the results obtained in the pre- and post- balance test (Mini-BESTest total $p< 0.005$) and subscale dynamic of gait ($p< 0.0001$). By assessing the gait parameters, the obtained results show that dance did not lead to significant changes in the spatiotemporal gait parameters.

DISCUSSION

The human brain is capable of distinguishing music from noise, responding to rhythm, repetition, tones, and melodies. The auditory nerve transmits the signals of music and other sounds to the auditory cortex in the temporal lobe, while the nerve networks in different parts of the brain be-

ar primary responsibility for decoding and interpreting different properties of music (Simon, 2015). The existence of auditory-motor pathways (e.g. via reticulospinal connections), can influence threshold excitability of motor neurons, creating the primary effect of music on the segmental motor system, via auditory input (Thaut & McIntosh, 2014). The vestibular system is one of the most fundamental systems accountable for the emergence of the motor response. Specifically, while listening to music, the perception of auditory signals activates a large number of centres in the brain. During the cognitive processing of the audio signals, there is a simultaneous activation of descendent pathways, which transmit information to the muscle effectors, resulting in the presence of rhythmical movements in the limbs. Movements performed while dancing can be important for the improvement of abilities and skills in post-stroke patients.

Dance, which is basically a sports-recreational activity, leads to the development and recovery of different motor abilities and skills (Table 1). The analysed research studies indicated the positive influence of dance on: motor learning process (learning new motor tasks) (Thornberg, 2013; Demers et al., 2015), mobility and motor recovery process (Subramaniam & Bhatt, 2015; Dursun et al., 2016), all aspects of balance (Demers et al, 2015; Subramaniam & Bhatt, 2015; Dursun et al., 2016; Wollf et al., 2017; Patterson et al., 2018). The positive effects of dance on gait parameters and ability were observed in all studies except the one conducted by Patterson and associates (Patterson et al., 2018), which indicated that dance did not lead to the improvement of spatiotemporal gait parameters. The limitations of the analysed studies were reflected in: a relatively small sample size, different duration of dance therapy within various participant groups, as well as the influence of the other therapeutic procedures.

Conducting a research aimed at examining the effect of various complementary or supportive therapeutic procedures contributes to scientific research, the expansion of knowledge and the improvement of diagnostic, therapeutic, and educational activities. Continuous and relevant data collection contributes to the development of standards and methodologies in work and treatment of post-stroke and disability populations, as well as to the overall strengthening of functional capacities, personality structure, and welfare of the community.

CONCLUSION

The analysed research has shown that dance as a therapeutic method contributes to the recovery of motor abilities and functions of post-stroke patients. After stroke, neuroplasticity changes are associated with functional re-

covery and depend on the extent of implemented activities. Dance represents an activity that requires the activation of residual motor capacities, and their active participation in the performance of movements, which can be simple (elementary), complex, of varying tempo, intensity, and rhythm, in line with the individual characteristics of each person. Having in mind that movement is a fundamental tool of expression, in combination with accurately planned, programmed and adapted activities, the processes of motor learning and behaviour, restoration, restitution and compensation of damaged functions are encouraged.

The importance of this systematic review article is oriented toward contributing to the creation of a general viewpoint on the influence and value of dance during the recovery of persons after stroke. However, in our country and around the world, a small number of research studies have been conducted to be able to answer certain questions. This fact represents a proper foundation for a comprehensive consideration of these problems in further studies.

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