Pregledni naučni članak

POVREDE RUČNOG ZGLOBA KOD GIMNASTIČARA – SISTEMATSKO PREGLEDNO ISTRAŽIVANJE¹

UDK: 616-001:796.41
001.814:616.727.4-001"2010/2020"
DOI: 10.5937/snp2102083D

Dušan Đorđević^{2 3}

Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija

Mima Stanković⁴

Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija

Predrag Ilić⁵

Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija

Apstrakt: Cilj ovog istraživanja bio je sumiranje relevantne literature o povredama ručnog zgloba kod gimnastičara i da se na osnovu sistematskog pregleda dosadašnjih istraživanja utvrdi rasprostranjenost povrede. U sportskoj gimnastici, gornji ekstremiteti su nosioci celog tela, što sa sobom nosi posledice kao što su povrede ručnog zgloba. Tipovi povrede su različiti, u zavisnosti od njene prekomerne upotrebe. Kombinacija perioda brzog rasta i intenzivnog treninga stvaraju uslove da gimnastičari budu skloniji povredama, a naročito povredama ručnog zgloba. Elektronsko pretraživanje radova izvršeno je u bazama podataka: KoBSON, PubMed i Google Akademik, a studije su objavljene u vremenskom periodu od 2010. do 2020. godine, dok je za analizu dobijenih podataka primenjena deskriptivna metoda. Na osnovu pretrage baza podataka, 14 studija je zadovoljilo kriterijume. Ispitanici koji su se podvrgli različitim tipovima korektivnog tretmana, upitnicima i eksperimentima su imali za cilj da preveniraju dalji napredak povrede, a većina ispitanika je ostvarila veliki napredak u suzbijanju ili potpunog regresiji povrede ručnog zgloba. Stvaranje svesti o postojanju ove povrede je od velikog značaja u sportskoj gimnastici, pa je rana detekcija i prevencija povrede od velikog značaja.

Ključne reči: *gimnastičke povrede, ručni zglob, bol*

UVOD

Sportska gimnastika se sastoji od dramatičnih telesnih transformacija koje se dešavaju u veoma ranom dobu života. Takođe se sastoji i od procesa ovladavanja, kako jednostavnih, tako i kompleksnih gimnastičkih elemenata (Nattiv & Mandelbaum, 1993). Sve je veći broj dece koja se uključuju i koja ostaju u ovom sportu, da bi tokom godina došla do visokog nivoa sporta, odnosno elitnog ranga. Shodno tome, izvođenje teških elemenata u ranom uzrastu, može biti povezano sa povećanim rizikom stvaranja povrede (Meeuwisse, 1994). Većina vrhunskih gimnastičara nije prošla kroz detinjstvo i adolescenciju, a da nije imala povredu, gde se rizik povrede povećava sa dužinom

¹ Rad primljen: 1.12.2020, korigovan: 14.1.2021, prihvaćen za objavljivanje: 15.1.2021.

² ✉ dusandjordjevic1995@gmail.com

³ Dušan Đorđević je doktorand Fakulteta sporta i fizičkog vaspitanja Univerziteta u Nišu.

⁴ Mima Stanković je doktorand Fakulteta sporta i fizičkog vaspitanja Univerziteta u Nišu.

⁵ Predrag Ilić je doktorand Fakulteta sporta i fizičkog vaspitanja Univerziteta u Nišu.

trajanja treninga i težinom elemenata koji se izvodi (Tofler et al., 1996). Visoki zahtevi ovog sporta mogu dovesti do stvaranja povrede ukoliko se telo sportiste izloži prevelikim naporima, a ne reaguje korektivnim tretmanom u pravom trenutku. Kako se nivo samih veština povećava, učestalost akutnih povreda raste, a samim tim i opterećenje tokom vežbanja se povećava (Ashwell & Richardson, 2019).

Za razliku od nekih drugih sportova, u sportskoj gimnastici se koriste gornji ekstremiteti za kontrolu celog tela. Iz tog razloga, aktivnost ručnih zglobova je izložena mnogim vrstama stresa, uključujući repetitivna kretanja, velika opterećenja prilikom udara i aksijalne kompresije (Wolf et al., 2017). U odnosu na većinu drugih sportova, povreda ručnog zgloba je druga po učestalosti povređivana regija (Caine & Nassar, 2005). Prema nekim autorima (Daly et al., 2001; Westermann et al., 2015) da bi gimnastičari mogli da uspešno izvode elemente na spravama, potrebna je potpuna kontrola tela. Tada se gimnastičar stavlja u visok rizik povrede zgloba. U 50% slučajeva je prijavljen bol u zglobovima kod mladih gimnastičara, a u početnom periodu treniranja, ručni zglob je najviše povređivan deo tela u odnosu na ostatak skeletnog sistema (DiFiori et al., 2002), gde je prosečna starost gimnastičara koji osećaju bol u ručnom zglobovima, uz repetitivno opterećenje, 9-14 godina (Kox et al., 2015).

Kada govorimo o vrstama povrede, one najčešće variraju u zavisnosti od pola (Straccioli et al., 2015), sportskog modaliteta, intenziteta treninga, trenutnih godina i godina početka treniranja (Burt et al., 2013). Učestalost je različita, pa treneri treba da obrate pažnju na intenzitet i opterećenje, naročito u periodu puberteta. Povrede mogu biti akutnog (makrotrauma) i hroničnog (mikrotrauma) tipa, koje su povezane sa opterećenjem i prekomernom upotrebom. Promene izazvane prekomernom upotrebom, kao što su povrede skafoidne kosti ili ulnarnokarpalnog sindroma, mogu biti opasni po karijeru sportista (Koh & Dietz, 2005), zato je neophodna što ranija dijagnoza, da bi se povreda izlečila na pravi način, čime bi sportista mogao dugoročno da funkcioniše, kako u sportu, tako i kasnije, u svakodnevnom životu. Iako je učestalost ove povrede različita, treba imati na umu da su treninzi visokog intenziteta i opterećenja, u vremenskom periodu od 10. do 14. godine. Koristeći ovu vrstu povrede kao definiciju prekomerne upotrebe, preporučuje se identifikacija rizika, u cilju sprečavanja daljih komplikacija (Kox et al., 2015). Ukoliko dođe do povrede, treneri uglavnom preporučuju svojim sportistima da izbegavaju bilo kakve gimnastičke aktivnosti koji zahtevaju učešće ručnih zglobova, ali i drugih slobodnih aktivnosti van gimnastičke sale (Cornwall, 2010; Daly et al., 2001; Pengel, 2014; Webb & Rettig, 2008). S druge strane, najčešće prijavljene intervencije uključuju konzervativne metode, kao što su steznici i imobilizacija ili čak invazivnija metoda, kao što je hirurška intervencija (Daly et al., 2001; Pengel, 2014; Webb & Rettig, 2008).

Autori smatraju da postoji potreba za sumiranjem rezultata na jednom mestu, odnosno potreba za sistematskim pregledom. Na osnovu saznanja autora, ne postoji sistematsko pregledno istraživanje koji se tiče povreda ručnog zgloba kod gimnastičara, pa je zato cilj ovog istraživanja bio sumiranje relevantne literature o povredama ručnog zgloba kod gimnastičara, te da se na osnovu sistematskog pregleda dosadašnjih istraživanja utvrdi rasprostranjenost povrede.

METOD

Elektronsko pretraživanje radova izvršeno je u sledećim bazama podataka: KoBSON, PubMed, Google Akademik. Radovi su objavljeni u periodu od 2010. do 2020. godine. Pretraživanje je bilo ograničeno na sledeće ključne reči: "gimnastičke povrede", "bol u ručnom zglobovima", "deca i adolescenti", ili kombinacija navedenih ključnih reči na engleskom jeziku: "gymnastics injuries", "children and adolescents", "wrist pain".

Za analizu dobijenih podataka primenjena je deskriptivna metoda. Svi naslovi i apstrakti su pregledani za potencijalne radove koji će biti uključeni u sistematski pregled. Takođe, pregledane su liste referenci prethodnih preglednih i originalnih istraživanja. Relevantne studije su dobijene nakon detaljnog pregleda, ukoliko su ispunile kriterijume za uključivanje.

Strategija pretraživanja bila je modifikovana i prilagođena svakoj bazi i pretraživanju, gde je to bilo moguće, u cilju povećanja senzitivnosti pretraživanja.

Kriterijumi za uključivanje

Kriterijumi za uključivanje studija bili su:

1. Vrsta studije: kontrolisane studije, gde je uzorak ispitanika namerno ili nasumično podeljen, uključene su u dalju analizu, dok su nekontrolisane studije isključene. Radovi objavljeni na engleskom jeziku su uključeni u studiju;
2. Uzorak ispitanika: osobe muškog i ženskog pola, uzrasta od 7 do 28 godina;
3. Vrsta dobijenih rezultata: primarno dobijeni rezultat za potrebe sistematskog pregleda bile su povrede ručnog zgloba kod gimnastičara.

Kriterijumi za isključivanje

Kriterijumi za isključivanje radova bili su:

1. Studije pisane na nekom drugom jeziku osim engleskog jezika;
2. Duplikati;
3. Studije sa ispitanicima ispod 7 godina..

REZULTATI

Nakon generalne pretrage baze podataka identifikovana su 53 rada. Na osnovu naslova i duplikata, eliminisane su 32 studije. Preostali radovi su detaljno pregledani. Još tri studije su bile eliminisane, jer su napisane na drugom jeziku osim engleskog i dodatne četiri studije na osnovu apstrakata. Ukupno je 14 studija zadovoljilo definisane kriterijume i uključeno u sistematski pregled. Sve studije ispituju povrede ručnog zgloba kod gimnastičara, a studije su se realizovale u zemljama: Sjedinjene Američke Države, Brazil, Japan, Iran, Holandija i Australija.

Detaljan prikaz procesa prikupljanja adekvatnih radova na osnovu unapred definisanih kriterijuma nalazi se na Dijagramu 1, dok se studije uključene u sistematski pregled nalaze u Tabeli 1.

Dijagram 1. Prikaz procesa prikupljanja adekvatnih radova

Tabela 1. Pregled istraživanja

Prvi autor i godina publikacije	Ispitanici		Varijable	Rezultati
	Broj	Uzrast		
Nakamoto et al. (2011)	M=1	18	FP, HT	Na završnoj proceni, šest meseci nakon operacije, sportista se takmičio bez ikakvih problema
O'Kane et al. (2011)	Ž=96	7-17	Up	Povrede gornjih ekstremiteta su na drugom mestu po rasprostranjenosti (21.6%)
Poletto et al. (2012)	Ž=1	13	FP, MR, R	Jedino rešenje je prestanak stvaranja uzročno-posledičnog stresa, iako će bol uvek biti prisutan na radijalnu epifizu
Sathyendra et al. (2013)	M=1	24	R	Ispitanik se vratio gimnastici nakon osam meseci, bez bolova. Na završnom pregledu, ispitanik je u potpunosti mogao da oporuži sve prste, sa opterećenjem, u neutralnom položaju zgloba
Ghasempour et al. (2014)	M=41	16-28	Up, In	Telesna težina je jedina antropometrijska karakteristika koja je imala značajnu vezu sa povredom ručnog zgloba
Westermann et al. (2014)	N=119 M=64 Ž=55	18-22	Up	Anatomska regija najčešće povređivanog dela tela kod muškaraca je ručni zglob (24%)
McLaren et al. (2015)	Ž=50	8-15	Up	Udarni ugao prilikom premeta nazad bio je 95°. Prijavljen je bol u ručnom zglobu od strane 15 ispitanika. Ugao u ramenima i godine treniranja koreliraju sa udarnim uglom zgloba tokom izvedbe elementa
Guerra et al. (2016)	M=19	9-18	R, Up, FP	Prevalenca bola u 82%, a 53% je bilateralno. Od toga, 47% su bili ograničeni u performansu, 82% na konju sa hvataljkama, 17% na parteru i 12% na paralelnom razboju
Boucher et al. (2017)	M=1	10	SFP	Znatno poboljšanje snage i motorne kontrole. Program je omogućio povratak gimnastičkim aktivnostima
Trevithick et al. (2018)	N=399	10-18	Up	Gimnastički steznici su preporučeni kao primarni metod prevencije bolova u zglobu
Kox et al. (2018)	-	-	Up	Otkriveno je 17 signala i tri ograničavajuća faktora koja ukazuju na prekomernu povredu zgloba
Ashwell et al. (2018)	Ž=1	12	FP, MR, R	Imobilizacija zgloba, odmor, povratak na sport odložen
Trevithick et al. (2019)	M=48	8-22	ST	Značajno smanjenje bola za vreme nošenja steznika, na konju sa hvataljkama, parteru i paralelnom razvoju
Fujioka et al. (2019)	M=1	11	MR, R, Im	Nakon osmonedeljne imobilizacije gipsom, ispitaniku je dozvoljeno da se postepeno vrati redovnim aktivnostima, da bi se, nakon četiri meseca od prve posete lekara, vratio gimnastičkim aktivnostima na istom nivou, bez ikakvih komplikacija

Legenda: N - ukupan broj ispitanika, M - muški pol, Ž - ženski pol, MR - magnetna rezonanca, R - radiografija, Up - upitnik, In - intervju, FP - fizikalna procena, SFP - specifična fizikalna procena, ST - steznik, Im - imobilizacija, HT - hirurški tretman

DISKUSIJA

Cilj istraživanja bio je identifikacija i sumiranje relevantne literature o povredama ručnog zgloba kod gimnastičara i njena rasprostranjenost. Starost ispitanika se kretala od sedam godina, u istraživanju O'Kane et al. (2011), do 28 godina, u istraživanju Ghasempour et al. (2014), dok je ukupan broj ispitanika u ovom istraživanju bio 778.

Kombinacija nedovoljno razvijenog posturalnog sistema i intenzivnog treninga može biti ključna za stvaranje povrede, a s obzirom na to da se cela telesna težina kontroliše gornjim ekstremitetima, pa i ručnim zglobovima, može se javiti problem ako je opterećenje veliko (Ashwell & Richardson, 2018). DiFiori et al. (2014) su takođe zaključili da se između 10 i 14 godina mogu desiti ozbiljne povrede ručnog zgloba, što dokazuje visok rizik prekomerne upotrebe ručnog zgloba kod mladih gimnastičara u periodu rasta i razvoja. Takođe, Dobyns & Gabel (1990) su došli do zaključka da između 10. i 12. godine starosti, gimnastičari ulaze u fazu brzog rasta, te imaju veću tendenciju da povređuju distalnu radijalnu epifizu.

Sathyendra et al. (2013) su imali ispitanika koji je imao frakturu ručnog zgloba usled komplikacije faze prehvata na vratilu. Ispitanik se nakon 12 meseci od operacije aktivno vratio gimnastici bez ikakvih problema, dok se ispitanik studije Nakamoto et al. (2011) vratio regularnim gimnastičkim aktivnostima posle šest meseci, nakon preloma skafoidne kosti. Wolf et al. (2017) su zaključili da treba češće proveravati gimnastičku opremu namenjenu za vratilo, jer je ona od krucijalnog značaja za bezbednost gimnastičara, dok staru opremu treba odmah odbaciti. Autori takođe zaključuju da se skoro svi ispitanici vrate aktivnom bavljenju sportskom gimnastikom nakon operativnog procesa.

Ashwell & Richardson (2018) i Poletto et al. (2012) su svojim ispitanicama predložili odmor, tj. prestanak stvaranja uzročno-posledičnih stresova, imobilizaciju zgloba, a povratak na sport je bio odložen. Može se reći da su autori nekih studija (Fujioka et al., 2019; Boucher et al., 2017; Wolf et al., 2017) primenili identična rešenja, tj. preporučili odmor u vremenskom periodu od tri do šest meseci i imobilizaciju šest nedelja, nakon čega je primenjena fizikalna procena i terapija, koja je omogućila povratak prvobitne snage i pokretljivosti.

Guerra et al. (2016) su procentualno predstavili modalitet bola ručnog zgloba po spravama, tj. 82% konj sa hvataljkama, 17% parter i 12% paralelni razboj, dok su druge studije (DiFiori et al., 1996; DiFiori et al., 2002) predstavile aktivnosti koje su povezane sa bolom u ručnim zglobovima, a one su parter i konj sa hvataljkama. Povrede gornjih ekstremiteta, tj. ručnog zgloba je druga po učestalosti povređivana regija lokomotornog aparata, što studije O'Kane et al. (2011) i Caine & Nassar (2005) opravdavaju.

U studiji autora Kox et al. (2018), grupa sportskih lekara došla je do brojke od 17 signala i tri važna ograničenja koja mogu ukazati na prekomernu upotrebu ručnog zgloba. Prema autorima, svest sportskih lekara se poslednjih godina povećala, jer su oni ti koji brinu o povredama sportista, pa i o povredama gimnastičara, te je radi efikasnije procene povrede, stvorena osnova za prepoznavanje prekomerne upotrebe ručnih zglobova. Identični simptomi su predstavljeni i u studiji Wolf et al. (2017), polazeći od činjenice da je ručni zglob višestruk i kompleksan entitet koji se stalno opterećuje u sportskoj gimnastici. Dve navedene studije se slažu oko činjenice da je potrebno veće razumevanje ove povrede i efikasnije sprečavanje prevremenog prekidanja gimnastičke karijere.

Nošenje bandažera smanjuje rizik od povrede zgloba, pucanja i istegnuća ligamenata, prilikom padova, tako što blokiraju da zglob ode u položaj hiperekstenzije. To je jedan od načina prevencije povrede, gde se zbog velikog broja repeticije elementa mogu ublažiti konstantne aksijalne kompresije, koje su naročito izražene na konju sa hvataljkama, jer je ta sprava opštepoznata po najvećem broju povreda ručnog zgloba, zatim paralelni razboj, parter i preskok (Trevithick et al., 2018; Trevithick et al., 2019). Do sličnog zaključka su došli Kox et al. (2015), koji kažu da kada se uzme u obzir da gimnastičari često mogu da optereće zglobove kada padaju na uobičajenim gimnastičkim aktivnostima, bilo koji dizajn bandažera, kao prevencija i zaštita je veoma važna.

Što se tiče ograničenja, one su adaptacija na program treninga, uticaj sportskog performansa na treningu i uticaj sportskog performansa na takmičenju. U zavisnosti od prirode povrede, kao i vremenskog perioda njenog trajanja, operativni proces može biti rešenje, ali primarno treba smanjiti obim i intenzitet treninga i organizovati proces rehabilitacije. Još jedan ograničavajuć faktor ove studije je i nemogućnost apsolutnog pristupa svim bazama podataka, što se ogleda i u malom broju studija koje su uključene u ovo istraživanje.

ZAKLJUČAK

Još u predškolskom uzrastu, lokomotorni aparat nije dovoljno jak, da bi se izborio sa opterećenjima trenažnog procesa. Ta opterećenja su konstantna, s obzirom na to da se radi o većem broju repeticije elemenata, zatim kompresije i specifičnog sabijanja prilikom vežbanja. Zbog prirode sporta, kombinacija rasta i intenzivnog treninga stvara uslove da gimnastičari budu skloniji povredama ručnog zgloba. Fizički zahtevi su veći kod vrhunskih gimnastičara, što je navelo eksperte da hronične povrede treba pravilnije navesti kao posledice učestvovanja u sportu, sa naglaskom da su povrede ovakvog tipa neizbežne.

Rana detekcija povrede je ključna radi što ranije realizacije faze lečenja, a ukoliko dođe do toga da se sportista ponovo povredi, nakon akutne povrede, može doći do smanjenja procesa rehabilitacije, pa je od velike važnosti da se stvori svest kod trenera o postojanju ove povrede, radi pravilnog reagovanja sa ciljem prevencije i suzbijanja povrede ovakvog tipa.

Na osnovu navedenih činjenica se može zaključiti da je rasprostranjenost ove povrede velika i da je vrsta povrede ručnog zgloba individualna za svakog gimnastičara ponaosob. Zato je doziranje obima i intenziteta, ali i stalna komunikacija između trenera i vežbača od ključnog značaja, gde bi se makro i mikrotraume svele na minimum, a samim tim, proces postizanja vrhunskog rezultata bio brži. Rezultati ove studije mogu koristiti budućim istraživanjima u cilju pronalaženja adekvatne literature na temu povreda ručnog zgloba kod gimnastičara, a ovo istraživanje može imati i praktičnu primenu, tako što će pomoći trenerima i gimnastičarima u prevenciji, rehabilitaciji i pravilnim delovanjem, ukoliko dođe do povrede ručnog zgloba.

LITERATURA

1. Ashwell, Z. R., & Richardson, M. L. (2019). Gymnast's wrist in a 12-year-old female with MRI correlation. *Radiology case reports*, 14(3), 360-364.
2. Boucher, B., & Smith-Young, B. (2017). Examination and physical therapy management of a young gymnast with bilateral wrist pain: A case report. *Physical Therapy in Sport*, 27, 38-49.
3. Burt, L. A., Ducher, G., Naughton, G. A., Courteix, D., & Greene, D. A. (2013). Gymnastics participation is associated with skeletal benefits in the distal forearm: A 6-month study using peripheral Quantitative Computed Tomography. *J Musculoskelet Neuronal Interact*, 13(4), 395-404.
4. Caine, D. J., & Nassar, L. (2005). Gymnastics injuries. In *Epidemiology of pediatric sports injuries* (Vol. 48, pp. 18-58). Karger Publishers.
5. Cornwall, R. (2010). The painful wrist in the pediatric athlete. *Journal of Pediatric Orthopaedics*, 30, S13-S16.
6. Daly, R. M., Bass, S. L., & Finch, C. F. (2001). Balancing the risk of injury to gymnasts: how effective are the counter measures?. *British Journal of Sports Medicine*, 35(1), 8-19.
7. DiFiori, J. P., Benjamin, H. J., Brenner, J. S., Gregory, A., Jayanthi, N., Landry, G. L., & Luke, A. (2014). Overuse injuries and burnout in youth sports: a position statement from the American Medical Society for Sports Medicine. *British journal of sports medicine*, 48(4), 287-288.
8. DiFiori, J. P., Puffer, J. C., Aish, B., & Dorey, F. (2002). Wrist pain, distal radial physeal injury, and ulnar variance in young gymnasts: does a relationship exist?. *The American Journal of Sports Medicine*, 30(6), 879-885.
9. DiFiori, J. P., Puffer, J. C., Mandelbaum, B. R. & Mar, S. (1996). Factors associated with wrist pain in the young gymnast. *The American journal of sports medicine*, 24(1), 9-14.
10. Dobyns, J., & Gabel, G. (1990). Gymnast's wrist. *Hand Clinics*, 6(3), 493-505.
11. Fujioka, H., Nishikawa, T., Takagi, Y., Oi, T., & Yoshiya, S. (2019). Stress Fracture of the Ossification Center of the Scaphoid in a Skeletally Immature Gymnast. *The Journal of Hand Surgery (Asian-Pacific Volume)*, 24(03), 386-388.
12. Ghasempour, H., Rajabi, R., Alizadeh, M. H., & Nikro, H. (2014). Correlation between elite male Iranian gymnast's wrist injuries and their anthropometric characteristics. *Electronic physician*, 6(4), 932.
13. Guerra, M. R. V., Estelles, J. R. D., Abdouni, Y. A., Falcochio, D. F., Rosa, J. R. P., & Catani, L. H. (2016). Frequency of wrist growth plate injury in young gymnasts at a training center. *Acta ortopedica brasileira*, 24(4), 204-207.
14. Koh, J., & Dietz, J. (2005). Osteoarthritis in other joints (hip, elbow, foot, ankle, toes, wrist) after sports injuries. *Clinics in sports medicine*, 24(1), 57-70.
15. Kox, L. S., Kuijer, P. P. F., Kerkhoffs, G. M., Maas, M., & Frings-Dresen, M. H. (2015). Prevalence, incidence and risk factors for overuse injuries of the wrist in young athletes: A systematic review. *Br J Sports Med*, 49(18), 1189-1196.
16. Kox, L. S., Kuijer, P. P. F., Opperman, J., Kerkhoffs, G. M., Maas, M., & Frings-Dresen, M. H. (2018). Overuse wrist injuries in young athletes: What do sports physicians consider important signals and functional limitations?. *Journal of sports sciences*, 36(1), 86-96.

17. McLaren, K., Byrd, E., Herzog, M., Polikandriotis, J. A., & Willimon, S. C. (2015). Impact shoulder angles correlate with impact wrist angles in standing back handsprings in preadolescent and adolescent female gymnasts. *International journal of sports physical therapy*, 10(3), 341.
18. Meeuwisse, W. H. (1994). Assessing causation in sport injury: A multifactorial model. *Clinical Journal of Sport Medicine*, 4(3), 166-170.
19. Nakamoto, J. C., Saito, M., Medina, G., & Schor, B. (2011). Scaphoid stress fracture in high-level gymnast: A case report. *Case reports in orthopedics*, 2011. <https://doi.org/10.1155/2011/492407>
20. Nattiv, A., & Mandelbaum, B. R. (1993). Injuries and special concerns in female gymnasts: detecting, treating, and preventing common problems. *The Physician and sportsmedicine*, 21(7), 66-82.
21. O'Kane, J. W., Levy, M. R., Pietila, K. E., Caine, D. J., & Schiff, M. A. (2011). Survey of injuries in Seattle area levels 4 to 10 female club gymnasts. *Clinical Journal of Sport Medicine*, 21(6), 486-492.
22. Pengel, K. B. (2014). Common overuse injuries in the young athlete. *Pediatric annals*, 43(12), e297-e308.
23. Poletto, E. D., & Pollock, A. N. (2012). Radial epiphysitis (aka gymnast wrist). *Pediatric emergency care*, 28(5), 484-485.
24. Sathyendra, V., & Payatakes, A. (2013). Grip lock injury resulting in extensor tendon pseudorupture: case report. *The Journal of hand surgery*, 38(12), 2335-2338.
25. Stracciolini, A., Casciano, R., Friedman, H. L., Meehan III, W. P., & Micheli, L. J. (2015). A closer look at overuse injuries in the pediatric athlete. *Clinical Journal of Sport Medicine*, 25(1), 30-35.
26. Tofler, I. R., Stryer, B. K., Micheli, L. J., & Herman, L. R. (1996). Physical and emotional problems of elite female gymnasts. *New England Journal of Medicine*, 335(4), 281-283.
27. Trevithick, B., Mellifont, R., & Sayers, M. (2019). Wrist pain in gymnasts: Efficacy of a wrist brace to decrease wrist pain while performing gymnastics. *Journal of Hand Therapy: Official Journal of the American Society of Hand Therapists*, 33(3), 354-360.
28. Trevithick, B., Stuelcken, M., Mellifont, R., & Sayers, M. (2018). Epidemiology of wrist pain in Australian gymnasts. *Science of Gymnastics Journal*, 10(2), 179-188.
29. Webb, B. G., & Rettig, L. A. (2008). Gymnastic wrist injuries. *Current sports medicine reports*, 7(5), 289-295.
30. Westermann, R. W., Giblin, M., Vaske, A., Grosso, K., & Wolf, B. R. (2015). Evaluation of men's and women's gymnastics injuries: A 10-year observational study. *Sports health*, 7(2), 161-165.
31. Wolf, M. R., Avery, D., & Wolf, J. M. (2017). Upper extremity injuries in gymnasts. *Hand clinics*, 33(1), 187-197.

Review paper

WRIST INJURIES IN GYMNASTS - SYSTEMATIC REVIEW¹

UDC: 616-001:796.41

001.814:616.727.4-001"2010/2020"

DOI: 10.5937/snp2102083D

Dušan Đorđević^{2 3}

Faculty of Sports and Physical Education, University of Niš, Serbia

Mima Stanković⁴

Faculty of Sports and Physical Education, University of Niš, Serbia

Predrag Ilić⁵

Faculty of Sports and Physical Education, University of Niš, Serbia

Abstract: The aim of this research was to summarize the relevant literature on wrist injuries in gymnasts and to determine the prevalence of injuries based on a systematic review of previous research. In sports gymnastics, the upper extremities are the bearers of the whole body, which leads to consequences such as wrist injuries. The types of injuries are different, depending on its excessive use. The combination of a period of rapid growth and intensive training creates the conditions for gymnasts to be more prone to injuries, especially wrist injuries. Electronic search of papers was performed in databases: KoBSON, PubMed and Google Academic, and the studies were published in the period from 2010 to 2020, while a descriptive method was used to analyse the obtained data. Based on the database search, 14 studies met the criteria. Subjects who participated in questionnaires and experiments and different types of corrective treatment, sought to prevent further progression of the injury, and most subjects made major progress in suppressing or completely regressing their wrist injury. Raising awareness of the existence of this injury is of great importance in sport gymnastics, so early detection and prevention of injury is crucial.

Keywords: *gymnastics injuries, wrist, pain*

INTRODUCTION

Sports gymnastics consists of dramatic body transformations that take place at a very early period of life. It also consists of a process of mastering both simple and complex gymnastic elements (Nattiv & Mandelbaum, 1993). There is an increasing number of children who get involved and stay in this sport, in order to become top, i.e. elite athletes, over the years. Consequently, the performance of severe elements at an early age may be associated with an increased risk of injury (Meeuwisse, 1994). Most top gymnasts have not gone through childhood and adolescence without an injury, where the risk of injury increases with the duration of training and the severity of

¹ Paper received: 1 December 2020, edited: 14 January 2021, accepted for publication: 15 January 2021.

² ✉ dusandjordjevic1995@gmail.com

³ Dušan Đorđević is a PhD student at the Faculty of Sports and Physical Education, University of Niš.

⁴ Mima Stanković is a PhD student at the Faculty of Sports and Physical Education, University of Niš.

⁵ Predrag Ilić is a PhD student at the Faculty of Sports and Physical Education, University of Niš.

the elements performed (Toffler et al., 1996). The high demands of this sport can lead to an injury, if the athlete's body is exposed to excessive effort, and corrective treatment is not introduced at the right time. As the skill level itself increases, the incidence of acute injuries increases, and thus the load during exercise increases (Ashwell & Richardson, 2019).

Unlike some other sports, sports gymnastics uses the upper extremities to control the whole body. For this reason, wrist activity is exposed to many types of stress, including repetitive movements, high impact loads, and axial compression (Wolf et al., 2017). Compared to most other sports, wrist injury is the second most commonly injured region of the body (Caine & Nassar, 2005). According to some authors, (Daly et al., 2001; Westermann et al., 2015) in order for gymnasts to be able to successfully perform elements on gymnastic equipment, complete control of the body is required. Then a gymnast is put at a high risk of joint injury. In 50% of cases, joint pain has been reported in young gymnasts, and in the initial period of training, the wrist is the most often injured part of the body compared to the rest of the skeletal system (DiFiori et al., 2002), where the average age of gymnasts feeling pain in the wrist, with repetitive loading, is 9-14 (Kox et al., 2015).

When we talk about the types of injuries, they usually vary depending on gender (Straccioli et al., 2015), sports modality, training intensity, current years and years of training (Burt et al., 2013). The frequency varies, so coaches should pay attention to the intensity and load, especially during puberty. Injuries can be of acute (macrotrauma) and chronic (microtrauma) type, which are associated with load and overuse. Changes caused by overuse, such as scaphoid bone injuries or ulnar carpal tunnel syndrome, can jeopardize athletes' careers (Koh & Dietz, 2005), so early diagnosis is necessary for the injury to heal properly, allowing the athlete to function, both in sports and later, in everyday life. Although the frequency of this injury is different, it should be kept in mind that the trainings are of high intensity and load, in the period between 10 and 14 years of age. Using this type of injury as a definition of overuse, risk identification is recommended, in order to prevent further complications (Kox et al., 2015). In the event of an injury, coaches generally recommend that their athletes avoid any gymnastic activities that require the use of wrists, but also other leisure activities outside the gym (Cornwall, 2010; Daly et al., 2001; Pengel, 2014; Webb & Rettig, 2008). On the other hand, the most commonly reported interventions include conservative methods, such as braces and immobilization, or even more invasive methods, such as surgical interventions (Daly et al., 2001; Pengel, 2014; Webb & Rettig, 2008).

The authors believe that there is a need to summarize the results in one place, or the need for a systematic review. Based on the author's cognition, there is no systematic review research concerning wrist injuries in gymnasts, so the aim of this research was to summarize the relevant literature on wrist injuries in gymnasts and to determine the prevalence of injuries based on a systematic review of previous research.

METHOD

Electronic search of papers was performed in the following databases: KoBSON, PubMed, Google Academic. The papers were published in the period from 2010 to 2020. The search was limited to the following keywords: "gymnastics injuries", "wrist pain", "children and adolescents".

A descriptive method was used to analyse the obtained data. All titles and abstracts were reviewed for potential papers to be included in the systematic review. Also, the lists of references of previous review and original research were reviewed. Relevant studies were obtained after a detailed review, if they met the inclusion criteria.

The search strategy was modified and adapted to each database and search, where possible, in order to increase search sensitivity.

Inclusion criteria

The criteria for inclusion of the study were:

1. Type of study: controlled studies, where the sample of subjects was intentionally or randomly divided, were included in further analysis, while uncontrolled studies were excluded. Papers published in English were included in the study;
2. Sample of respondents: males and females, aged 7 to 28;

3. Type of results obtained: the primary result obtained for the purposes of systematic examination were wrist injuries in gymnasts.

Exclusion criteria

The criteria for excluding papers were:

1. Studies written in a language other than English;
- 2 Duplicates;
3. Studies which involved subjects under 7 years of age.

RESULTS

After a general search of the database, 53 papers were identified. Based on titles and duplicates, 32 studies were eliminated. The remaining papers were reviewed in detail. Three more studies were eliminated because they were written in a language other than English and additional four studies were excluded because of abstracts. A total of 14 studies met the defined criteria and were included in the systematic review. All of the studies examined wrist injuries in gymnasts, and the research was conducted in the following countries: the United States of America, Brazil, Japan, Iran, the Netherlands and Australia.

A detailed overview of the process of collecting adequate papers based on predefined criteria can be found in Diagram 1 and researches that are included in the systematic review can be found in Table 1.

Diagram 1. *Presentation of the process of collecting adequate papers*

Table 1. *Research overview*

First author and year of publication	Respondents		Variables	Results
	Number	Age		
Nakamoto et al. (2011)	M=1	18	FP, HT	At the final assessment, 6 months after the surgery, the athlete competed without any problems
O'Kane et al. (2011)	F=96	7-17	Up	Upper limb injuries are the second most common type of injuries (21.6%)
Poletto et al. (2012)	F=1	13	FP, MR, R	The only solution is to stop creating cause-and-effect stress, although pain will always be present on the radial pineal gland
Sathyendra et al. (2013)	M=1	24	R	The subject returned to gymnastics after 8 months, without pain. At the final examination, the subject was able to fully extend all the fingers, with the load, in the neutral position of the wrist
Ghasempour et al. (2014)	M=41	16-28	Up, In	Body weight is the only anthropometric characteristic that had a significant relationship with wrist injury
Westermann et al. (2014)	N=119 M=64 F=55	18-22	Up	The anatomical region of the most commonly injured part of the body in men is the wrist (24%)
McLaren et al. (2015)	F=50	8-15	Up	The angle of impact when moving backwards was 95°. Wrist pain was reported by 15 subjects. The angle in the shoulders and the years of training correlate with the impact angle of the joint during the performance of the element
Guerra et al. (2016)	M=19	9-18	R, Up, FP	The prevalence of pain is 82%, and 53% is bilateral. Of these, 47% were limited in performance, 82% on a horse with grips, 17% on the parterre and 12% on a parallel loom
Boucher et al. (2017)	M=1	10	SFP	Significant improvement of power and motor control of the body. The programme enabled a return to gymnastic activities
Trevithick et al. (2018)	N=399	10-18	Up	Gymnastic braces were recommended as the primary method of preventing joint pain
Kox et al. (2018)	-	-	Up	17 signals and 3 limiting factors were detected, which indicate excessive joint injury
Ashwell et al. (2018)	F=1	12	FP, MR, R	Joint immobilization, rest, return to sports delayed
Trevithick et al. (2019)	M=48	8-22	ST	Significant reduction in pain while wearing braces, on a pommel horse, on parterre and parallel development
Fujioka et al. (2019)	M=1	11	MR, R, Im	After eight weeks of immobilization with plaster, the subject was allowed to gradually return to regular activities, and, after 4 months from the first visit to the doctor, to return to gymnastic activities at the same level, without any complications

Legend: N- total number of respondents, M- male, F - female, MR- magnetic resonance, R- radiography, Q- questionnaire, In- interview, PA- physical assessment, SPA- specific physical assessment, B- brace, Im- immobilization, ST- surgical treatment

DISCUSSION

The aim of the study was to identify and summarize the relevant literature on wrist injuries in gymnasts and its prevalence. The age of the respondents ranged from seven years, in a study by O'Kane et al. (2011), up to the age of 28, in a study by Ghasempour et al. (2014), while the total number of respondents encompassed by this study was 778.

The combination of an underdeveloped postural system and intensive training can be key to the occurrence of an injury, and since the entire body weight is controlled by the upper extremities, including the wrists, a problem can occur if the load is high (Ashwell & Richardson, 2018). DiFiori et al. (2014) also concluded that serious wrist injuries can occur between the ages of 10 and 14, proving a high risk of overuse of the wrist in young gymnasts during growth and development. Also, Dobyns & Gabel (1990) came to the conclusion that between the ages of 10 and 12 gymnasts enter a phase of rapid growth, and have a greater tendency to injure the distal radial pineal gland.

Sathyendra et al. (2013) had a subject who had a wrist fracture due to a complication that occurred during a bar grip. Twelve months after his surgery, the subject actively returned to gymnastics without any problems. The examinee of the study by Nakamoto et al. (2011) returned to regular gymnastic activities 6 months since the scaphoid bone fracture. Wolf et al. (2017) concluded that gymnastic equipment intended for the bars should be checked more frequently, because it is of crucial importance for the safety of gymnasts, while old equipment should be discarded immediately. The authors also conclude that almost all respondents return to active sports gymnastics after they undergo a surgery.

Ashwell & Richardson (2018) and Poletto et al. (2012) suggested their respondents to rest i.e. to cease to create causal stresses, and they also recommended the immobilization of joints, and delayed return to sport. It can be said that some studies (Fujioka et al., 2019; Boucher et al., 2017; Wolf et al., 2017) applied identical solutions: recommending rest for a period of 3-6 months and immobilization for 6 weeks; after that, physical assessment and therapy, which enabled the return of the original strength and mobility.

Guerra et al. (2016) presented the percentage modality of wrist pain by devices, i.e. 82% pommel horse, 17% parterre and 12% parallel bars, while other studies (DiFiori et al., 1996; DiFiori et al., 2002) presented activities associated with wrist pain, and they included parterre and pommel horse. Injuries to the upper extremities, i.e. wrist represent the second most frequently injured region of the locomotor system, and studies by O'Kane et al. (2011) and Caine & Nassar (2005) justify that.

Kox et al. (2018) is a study where a group of sports doctors came up with a figure of 17 signals and three important limitations that may indicate excessive use of the wrist. According to the authors, the awareness of sports doctors has increased in recent years, because they are the ones who take care of athletes' injuries, including gymnasts' injuries. The base for recognizing excessive use of wrists has been created for more efficient injury assessment. Identical symptoms were also presented in the study by Wolf et al. (2017), starting from the fact that the wrist is a multiple and complex entity that is constantly burdened in the sport gymnastics. These two studies agree on the fact that a greater understanding of this injury and more effective prevention of premature termination of a gymnastic career is needed.

Wearing a brace reduces the risk of joint injury, rupture and stretching of the ligaments, during falls, by blocking the joint from going into the position of hyperextension. This is one of the ways to prevent injury, where due to the large number of repetitions of the elements, constant axial compressions can be alleviated, which are especially pronounced on pommel horse, because this equipment is generally known for the largest number of wrist injuries, then parallel bars, parterre and vault. (Trevithick et al., 2018; Trevithick et al., 2019). A similar conclusion was reached by Kox et al. (2015), who say that when taken into account that gymnasts can often strain their joints when they fall during normal gymnastic activities, any brace design is very important for prevention and protection.

As for the limitations, they are adaptations to the training program, the impact of sports performance on training and the impact of sports performance on competition. Depending on the nature of the injury, as well as the time period of its duration, the operative process can be a solution, but primarily the scope and intensity of training should be reduced and a rehabilitation process should be organized. Another limiting factor of this study is the impossibility of absolute access to all databases, which is reflected in the small number of studies included in this review.

CONCLUSION

Even at preschool age, the locomotor system is not strong enough to cope with the loads of the training process. These loads are constant, considering that there is a larger number of repetitions of elements, then compression and specific compression during exercise. Due to the nature of the sport, the combination of growth and intensive training creates conditions for gymnasts to be more prone to wrist injuries. Physical demands are higher among

elite gymnasts, which has led experts to say that chronic injuries should be more correctly cited as a consequence of participation in sports, emphasizing that injuries of this type are inevitable.

Early detection of an injury is crucial for the earliest possible implementation of the treatment phase, and if an athlete is injured again, after an acute injury, there may be a reduction in the rehabilitation process, so it is important to raise awareness among coaches about the existence of this injury, in order to come up with a proper response in terms of prevention and suppression of this type of injuries.

Based on the given facts, it can be concluded that the prevalence of this injury is high and that the type of wrist injury is individual for each gymnast individually. Therefore, dosing the extent and intensity, but also constant communication between coaches and practitioners is of key importance, in order to reduce the number of macro and microtraumas to a minimum, and thus create a faster process of reaching top results. The results of this paper can be used in future research to find adequate literature on wrist injuries in gymnasts, and this research can have practical application by helping coaches and gymnasts in terms of prevention, rehabilitation and proper action in case a wrist injury occurs.

REFERENCES

1. Ashwell, Z. R., & Richardson, M. L. (2019). Gymnast's wrist in a 12-year-old female with MRI correlation. *Radiology case reports*, 14(3), 360-364.
2. Boucher, B., & Smith-Young, B. (2017). Examination and physical therapy management of a young gymnast with bilateral wrist pain: A case report. *Physical Therapy in Sport*, 27, 38-49.
3. Burt, L. A., Ducher, G., Naughton, G. A., Courteix, D., & Greene, D. A. (2013). Gymnastics participation is associated with skeletal benefits in the distal forearm: A 6-month study using peripheral Quantitative Computed Tomography. *J Musculoskelet Neuronal Interact*, 13(4), 395-404.
4. Caine, D. J., & Nassar, L. (2005). Gymnastics injuries. In *Epidemiology of pediatric sports injuries* (Vol. 48, pp. 18-58). Karger Publishers.
5. Cornwall, R. (2010). The painful wrist in the pediatric athlete. *Journal of Pediatric Orthopaedics*, 30, S13-S16.
6. Daly, R. M., Bass, S. L., & Finch, C. F. (2001). Balancing the risk of injury to gymnasts: how effective are the counter measures?. *British Journal of Sports Medicine*, 35(1), 8-19.
7. DiFiori, J. P., Benjamin, H. J., Brenner, J. S., Gregory, A., Jayanthi, N., Landry, G. L., & Luke, A. (2014). Overuse injuries and burnout in youth sports: a position statement from the American Medical Society for Sports Medicine. *British journal of sports medicine*, 48(4), 287-288.
8. DiFiori, J. P., Puffer, J. C., Aish, B., & Dorey, F. (2002). Wrist pain, distal radial physeal injury, and ulnar variance in young gymnasts: does a relationship exist?. *The American Journal of Sports Medicine*, 30(6), 879-885.
9. DiFiori, J. P., Puffer, J. C., Mandelbaum, B. R. & Mar, S. (1996). Factors associated with wrist pain in the young gymnast. *The American journal of sports medicine*, 24(1), 9-14.
10. Dobyns, J., & Gabel, G. (1990). Gymnast's wrist. *Hand Clinics*, 6(3), 493-505.
11. Fujioka, H., Nishikawa, T., Takagi, Y., Oi, T., & Yoshiya, S. (2019). Stress Fracture of the Ossification Center of the Scaphoid in a Skeletally Immature Gymnast. *The Journal of Hand Surgery (Asian-Pacific Volume)*, 24(03), 386-388.
12. Ghasempour, H., Rajabi, R., Alizadeh, M. H., & Nikro, H. (2014). Correlation between elite male Iranian gymnast's wrist injuries and their anthropometric characteristics. *Electronic physician*, 6(4), 932.
13. Guerra, M. R. V., Estelles, J. R. D., Abdouni, Y. A., Falcochio, D. F., Rosa, J. R. P., & Catani, L. H. (2016). Frequency of wrist growth plate injury in young gymnasts at a training center. *Acta ortopedica brasileira*, 24(4), 204-207.
14. Koh, J., & Dietz, J. (2005). Osteoarthritis in other joints (hip, elbow, foot, ankle, toes, wrist) after sports injuries. *Clinics in sports medicine*, 24(1), 57-70.
15. Kox, L. S., Kuijter, P. P. F., Kerkhoffs, G. M., Maas, M., & Frings-Dresen, M. H. (2015). Prevalence, incidence and risk factors for overuse injuries of the wrist in young athletes: A systematic review. *Br J Sports Med*, 49(18), 1189-1196.
16. Kox, L. S., Kuijter, P. P. F., Opperman, J., Kerkhoffs, G. M., Maas, M., & Frings-Dresen, M. H. (2018). Overuse wrist injuries in young athletes: What do sports physicians consider important signals and functional limitations?. *Journal of sports sciences*, 36(1), 86-96.

17. McLaren, K., Byrd, E., Herzog, M., Polikandriotis, J. A., & Willimon, S. C. (2015). Impact shoulder angles correlate with impact wrist angles in standing back handsprings in preadolescent and adolescent female gymnasts. *International journal of sports physical therapy*, 10(3), 341.
18. Meeuwisse, W. H. (1994). Assessing causation in sport injury: A multifactorial model. *Clinical Journal of Sport Medicine*, 4(3), 166-170.
19. Nakamoto, J. C., Saito, M., Medina, G., & Schor, B. (2011). Scaphoid stress fracture in high-level gymnast: A case report. *Case reports in orthopedics*, 2011. <https://doi.org/10.1155/2011/492407>
20. Nattiv, A., & Mandelbaum, B. R. (1993). Injuries and special concerns in female gymnasts: detecting, treating, and preventing common problems. *The Physician and sportsmedicine*, 21(7), 66-82.
21. O'Kane, J. W., Levy, M. R., Pietila, K. E., Caine, D. J., & Schiff, M. A. (2011). Survey of injuries in Seattle area levels 4 to 10 female club gymnasts. *Clinical Journal of Sport Medicine*, 21(6), 486-492.
22. Pengel, K. B. (2014). Common overuse injuries in the young athlete. *Pediatric annals*, 43(12), e297-e308.
23. Poletto, E. D., & Pollock, A. N. (2012). Radial epiphysitis (aka gymnast wrist). *Pediatric emergency care*, 28(5), 484-485.
24. Sathyendra, V., & Payatakes, A. (2013). Grip lock injury resulting in extensor tendon pseudorupture: case report. *The Journal of hand surgery*, 38(12), 2335-2338.
25. Stracciolini, A., Casciano, R., Friedman, H. L., Meehan III, W. P., & Micheli, L. J. (2015). A closer look at overuse injuries in the pediatric athlete. *Clinical Journal of Sport Medicine*, 25(1), 30-35.
26. Tofler, I. R., Stryer, B. K., Micheli, L. J., & Herman, L. R. (1996). Physical and emotional problems of elite female gymnasts. *New England Journal of Medicine*, 335(4), 281-283.
27. Trevithick, B., Mellifont, R., & Sayers, M. (2019). Wrist pain in gymnasts: Efficacy of a wrist brace to decrease wrist pain while performing gymnastics. *Journal of Hand Therapy: Official Journal of the American Society of Hand Therapists*, 33(3), 354-360.
28. Trevithick, B., Stuelcken, M., Mellifont, R., & Sayers, M. (2018). Epidemiology of wrist pain in Australian gymnasts. *Science of Gymnastics Journal*, 10(2), 179-188.
29. Webb, B. G., & Rettig, L. A. (2008). Gymnastic wrist injuries. *Current sports medicine reports*, 7(5), 289-295.
30. Westermann, R. W., Giblin, M., Vaske, A., Grosso, K., & Wolf, B. R. (2015). Evaluation of men's and women's gymnastics injuries: A 10-year observational study. *Sports health*, 7(2), 161-165.
31. Wolf, M. R., Avery, D., & Wolf, J. M. (2017). Upper extremity injuries in gymnasts. *Hand clinics*, 33(1), 187-197.