STUDI KASUS: PENERAPAN TERAPI *ELECTRICAL MUSCLE STIMULATION* (EMS) *BUTTERFLY* TERHADAP KEKUATAN OTOT PADA ATLET PASCA CEDERA AKUT

KARYA TULIS ILMIAH

Diajukan untuk memenuhi sebagai syarat memperoleh gelar

Ahli Madya Keperawatan

Oleh

Intan Yuliyanti

NIM 2109556

PROGRAM STUDI DIII KEPERAWATAN

FAKULTAS PENDIDIKAN OLAHRAGA DAN KESEHATAN

UNIVERSITAS PENDIDIKAN INDONESIA

2024

LEMBAR HAK CIPTA

STUDI KASUS: PENERAPAN TERAPI *ELECTRICAL MUSCLE STIMULATION* (EMS) *BUTTERFLY* TERHADAP KEKUATAN OTOT PADA ATLET PASCA CEDERA AKUT

Oleh

Intan Yuliyanti

NIM 2109556

sebuah karya tulis ilmiah yang diajukan untuk memenuhi sebagai syarat untuk memperoleh gelar Ahli Madya Keperawatan Fakultas Pendidikan Olahraga dan Kesehatan

Universitas Pendidikan Indonesia

Agustus 2024

HALAMAN PENGESAHAN

INTAN YULIYANTI

STUDI KASUS: PENERAPAN TERAPI *ELECTRICAL MUSCLE STIMULATION* (EMS) *BUTTERFLY* TERHADAP KEKUATAN OTOT PADA ATLET PASCA CEDERA AKUT

disetujui dan disahkan oleh pembimbing

Pembimbing Utama

Upik Rahmi, S.Kp., M.Kep
NIP 197501252014042001

Pembimbing Pendamping

Sehabudin Salasa, S.Kep., Ners., M.Kep
NIPT 920200119880419101

Mengetahui,
Ketua Program Studi DIII Keperawatan FPOK UPI

Dr. Lisna Anisa Fitriana, S.Kep., Ners., M.Kes, AIFO
NIP 198202222012122003

PERNYATAAN TENTANG KEASLIAN KARYA TULIS ILMIAH

Saya menyatakan bahwa Karya Tulis Ilmiah dengan judul "Studi Kasus: Penerapan Terapi *Electrical Muscle Stimulation* (EMS) *Butterfly* terhadap Kekuatan Otot pada Atlet Pasca Cedera Akut" ini beserta isinya adalah benar-benar karya saya sendiri. Saya tidak melakukan penjiplakan atau pengutipan dengan cara-cara yang tidak sesuai dengan etika ilmu yang berlaku dalam masyarakat keilmuan.

Atas pernyataan ini, saya siap menanggung resiko/sanksi apabila dikemudian hari ditemukan adanya pelanggaran etika keilmuan atau ada klaim dari pihak lain terhadap karya saya ini.

Bandung, Agustus 2024
Yang Menyatakan,

Intan Yuliyanti
NIM 2109556

UCAPAN TERIMA KASIH

Puji dan syukur saya panjatkan kehadirat Allah SWT, berkat rahmat dan bimbingan-Nya saya dapat menyelesaikan karya tulis ilmiah dengan judul "Studi Kasus: Penerapan Terapi *Electrical Muscle Stimulation* (EMS) *Butterfly* terhadap Kekuatan Otot Pada Atlet Pasca Cedera Akut" dengan baik.

Karya Tulis Ilmiah ini merupakan salah satu syarat untuk memperoleh gelar Ahli Madya Keperawatan (A.Md Kep) pada Program Studi DIII Keperawatan Fakultas Pendidikan Olahraga dan Kesehatan Universitas Pendidikan Indonesia.

Bersama ini perkenankanlah saya mengucapkan terimakasih yang sebesar-besarnya dengan hati yang tulus kepada:

1. Prof. Dr. R. Boyke Mulyana, M.Pd. selaku Dekan Fakultas Pendidikan Olahraga dan Kesehatan Universitas Pendidikan Indonesia.
2. Dr. H. Dian Budiana, M.Pd. selaku Wakil Dekan Bidang Akademik Fakultas Pendidikan Olahraga dan Kesehatan Universitas Pendidikan Indonesia.
3. Prof. Dr. Komarudin, M.Pd. selaku Wakil Dekan Bidang Sumber Daya, Keuangan dan Umum Fakultas Pendidikan Olahraga dan Kesehatan Universitas Pendidikan Indonesia.
4. Mustika Fitri, M.Pd., Ph.D. selaku Wakil Dekan Bidang Kemahasiswaan Fakultas Pendidikan Olahraga dan Kesehatan Universitas Pendidikan Indonesia.
5. Dr. Lisna Anisa Fitriana, S.Kep., Ners., M.Kes., AIFO. selaku Ketua Program Studi DIII Keperawatan Fakultas Pendidikan Olahraga dan Kesehatan Universitas Pendidikan Indonesia.
6. Upik Rahmi, S. Kp., M. Kep. selaku pembimbing utama yang telah meluangkan waktunya, memberikan bimbingan, saran serta mendukung saya sehingga dapat menyelesaikan Karya Tulis Ilmiah ini.
7. Sehabudin Salasa, S. Kep. Ners., M. Kep. selaku pembimbing pendamping yang telah meluangkan waktunya, memberikan bimbingan, saran serta mendukung saya sehingga dapat menyelesaikan Karya Tulis Ilmiah ini.

8. Dr. Afianti Sulastri, S.Si., Apt, M.Pd. selaku penguji yang telah meluangkan waktu, memberikan bimbingan, saran, serta dukungan sehingga dapat menyelesaikan Karya Tulis Ilmiah ini.
9. Seluruh dosen dan staf Program Studi DIII Keperawatan Fakultas Pendidikan Olahraga dan Kesehatan Universitas Pendidikan Indonesia yang telah membekali ilmu pengetahuan yang sangat berguna selama perkuliahan.
10. Orangtua dan adik saya yang selalu mendampingi, mendoakan, dan memberikan semangat untuk saya. Semoga Allah SWT memberi saya kesempatan untuk membalas kebaikan kalian kelak.

Semoga Allah SWT membalas budi baik semua pihak yang telah memberi kesempatan, dukungan dan bantuan menyelesaikan Karya Tulis Ilmiah ini. Penulis sadari bahwa Karya Tulis Ilmiah ini jauh dari sempurna, tetapi kami berharap Karya Tulis Ilmiah ini bermanfaat bagi pembaca dan bagi keperawatan.

Bandung, Agustus 2024
Penulis

KATA PENGANTAR

Bismillahirrahmanirrahim,

Puji dan syukur saya panjatkan kehadirat Allah SWT, berkat rahmat dan bimbingan-Nya saya dapat menyelesaikan Karya Tulis Ilmiah dengan judul "Studi Kasus: Penerapan Terapi *Electrical Muscle Stimulation* (EMS) *Butterfly* terhadap Kekuatan Otot pada Atlet Pasca Cedera Akut" dengan baik.

Adapun tujuan saya dalam menyusun Karya Tulis Ilmiah ini untuk memperoleh gelar Ahli Madya Keperawatan (A.Md Kep) pada Program Studi DIII Keperawatan Fakultas Pendidikan Olahraga dan Kesehatan Universitas Pendidikan Indonesia.

Saya sebagai penulis mengakui bahwa ada banyak kekurangan pada Karya Tulis Ilmiah ini. Oleh karena itu, kritik dan saran dari seluruh pihak senantiasa saya harapkan demi kesempurnaan karya ini. Semoga Karya Tulis Ilmiah ini dapat membawa pemahaman dan pengetahuan bagi kita semua.

Bandung, Agustus 2024
Penulis

ABSTRAK

STUDI KASUS: PENERAPAN TERAPI *ELECTRICAL MUSCLE STIMULATION* (EMS) *BUTTERFLY* TERHADAP KEKUATAN OTOT PADA ATLET PASCA CEDERA AKUT

Intan Yuliyanti

NIM 2109556

E-mail: intanyuliyanti@upi.edu

Pendahuluan: Cedera dapat menurunnya kekuatan otot dikarenakan adanya kerusakan otot yang memerlukan waktu untuk kembali normal. Pada cedera akut yaitu cedera yang terjadi secara tiba-tiba dan perlu ditangani dengan serius agar tidak menjadi cedera kronis berulang. *Electrical Muscle Stimulation* (EMS) *butterfly* merupakan salah satu terapi latihan pasif yang dapat meningkatkan kekuatan otot dan mengurangi risiko cedera saat latihan fisik aktif. **Metode:** Metode yang digunakan adalah kualitatif dengan pendekatan studi kasus, dengan dua orang sampel penelitian yaitu atlet pasca cedera akut yang mengalami penurunan kekuatan otot/kekuatan otot pada kategori kurang sekali-kurang yang diukur oleh alat *back and leg dynamometer*. Intervensi EMS *butterfly* dilakukan selama 30 hari dengan intensitas dua kali seminggu selama 20 menit. **Hasil:** Terdapat peningkatan kekuatan otot tungkai pada kedua klien yang diukur dengan *back and leg dynamometer*, pada klien 1 yaitu 94 kg (kategori kurang) menjadi 102 kg (kategori kurang), sedangkan pada klien 2 yaitu 85 kg (kategori kurang) menjadi 95 kg (kategori kurang). Maka rata-rata peningkatan kekuatan otot sebanyak 9 kg selama 30 hari. **Diskusi:** Kontraksi untuk stimulus selama terus menerus sebelum latihan fisik aktif dapat meningkatkan kekuatan otot dan mengurangi risiko cedera saat latihan fisik aktif. **Kesimpulan:** Hasil penelitian didapatkan bahwa adanya peningkatan kekuatan otot pada kedua klien setelah dilakukan intervensi terapi EMS *butterfly* selama 30 hari dengan 8 kali intervensi.
Kata Kunci: *Electrical Muscle Stimulation* (EMS) *Butterfly*, Kekuatan Otot, Pasca Cedera Akut, Kekuatan Otot.

.

ABSTRACT

CASE STUDY: APPLICATION OF BUTTERFLY ELECTRICAL MUSCLE STIMULATION (EMS) THERAPY ON MUSCLE STRENGTH IN ATHLETES POST ACUTE INJURY

Intan Yuliyanti

NIM 2109556

Email: intanyuliyanti@upi.edu

Introduction: *Injuries can decrease muscle strength due to muscle damage that takes time to return to normal. Acute injuries are injuries that occur suddenly and need to be taken seriously so that they do not become chronic repetitive injuries. Electrical Muscle Stimulation (EMS) butterfly is one of the passive exercise therapies that can increase muscle strength and reduce the risk of injury during active physical exercise.* ***Methods:*** *The method used was qualitative with a case study approach, with two research samples, namely post-acute injury athletes who experienced a decrease in muscle strength / muscle strength in the very-lack category as measured by the back and leg dynamometer. EMS butterfly intervention was carried out for 30 days with intensity twice a week for 20 minutes.* ***Results:*** *There was an increase in leg muscle strength in both clients measured by a back and leg dynamometer, in client 1, 94 kg (category less) to 102 kg (category less), while in client 2, 85 kg (category less) to 95 kg (category less). So the average increase in muscle strength was 9 kg over 30 days.* ***Discussion:*** *Contraction to a continuous stimulus before active physical exercise can increase muscle strength and reduce the risk of injury during active physical exercise.* ***Conclusion:*** *The results showed that there was an increase in muscle strength in both clients after the EMS butterfly therapy intervention for 30 days with 8 interventions.*

Keywords: *Electrical Muscle Stimulation (EMS) Butterfly, Muscle Strength, Post Acute Injury, Muscle Strength.*

DAFTAR ISI

DAFTAR TABEL

DAFTAR GAMBAR

DAFTAR LAMPIRAN

DAFTAR PUSTAKA

Aamann, L., Dam, G., Borre, M., Drljevic-Nielsen, A., Overgaard, K., Andersen, H., Vilstrup, H., & Aagaard, N. K. (2020). Resistance Training Increases Muscle Strength and Muscle Size in Patients With Liver Cirrhosis. *Clinical Gastroenterology and Hepatology*, *18*(5), 1179-1187.e6. https://doi.org/10.1016/j.cgh.2019.07.058

Aardiman, J. P., Moodie, N., Siedlik, J. A., Kudrna, R. A., Graham, Z., & Gallagher, P. (2015). Short-Wave Diathermy Pretreatment and Inflammatory Myokine Response After High-Intensity Eccentric Exercise. *Journal of Athletic Training*, *50*(6), 612–620. https://doi.org/10.4085/1062-6050-50.1.12

Aarden, J. J., van der Schaaf, M., van der Esch, M., Reichardt, L. A., van Seben, R., Bosch, J. A., Twisk, J. W. R., Buurman, B. M., & Engelbert, R. H. H. (2019). Muscle strength is longitudinally associated with mobility among older adults after acute hospitalization: The Hospital-ADL study. *PLOS ONE*, *14*(7), e0219041. https://doi.org/10.1371/journal.pone.0219041

Adelnia, F., Urbanek, J., Osawa, Y., Shardell, M., Brennan, N. A., Fishbein, K. W., Spencer, R. G., Simonsick, E. M., Schrack, J. A., & Ferrucci, L. (2019). Moderate-to-Vigorous Physical Activity Is Associated With Higher Muscle Oxidative Capacity in Older Adults. *Journal of the American Geriatrics Society*, *67*(8), 1695–1699. https://doi.org/10.1111/jgs.15991

Allen, C. B., Williamson, T. K., Norwood, S. M., & Gupta, A. (2023). Do Electrical Stimulation Devices Reduce Pain and Improve Function?—A Comparative Review. *Pain and Therapy*, *12*(6), 1339–1354. https://doi.org/10.1007/s40122-023-00554-6

Alonez, T., Seiler, S., Sandbakk, Ø., & Tønnessen, E. (2019). The Training and Development of Elite Sprint Performance: an Integration of Scientific and Best Practice Literature. *Sports Medicine - Open*, *5*(1), 44. https://doi.org/10.1186/s40798-019-0221-0

Anggraini, N., & Kushartanti, wara. (2014). Pengaruh Terapi Masase, Terapi Latihan, Dan Terapi. *Medikora*, *XII*(1), 1–12.

Anis, N., Hasmia, Maskur, & Lufsyi, M. (2021). Desain Alat Terapi Fraktur Berbasis Medan Elektromagnetik. *Gravitasi*, *20*(1), 1–4. https://doi.org/10.22487/gravitasi.v20i1.15453

Aras, D., Arsyad, A., & Hasbiah, N. (2017). Hubungan Antara Fleksibilas dan Kekuatan Otot Lengan Dengan Kecepatan Renang. *Media Kesehatan Masyarakat Indonesia*, *13*(4), 380.

https://doi.org/10.30597/mkmi.v13i4.3160

Astuerz, V., Türkmen, M., Esfahani, M., Zadeh, R. A., Talib, A. M., & Azimkhani, A. (2021). The effect of muscle electrical stimulation on muscle stiffness problems and musculoskeletal pain caused by muscle imbalance: A systematic review. *Progress in Nutrition*, *23*(2). https://doi.org/10.23751/pn.v23i2.10070

Basiran. (2014). Massage Untuk Atlet. *Jurnal Kepelatihan Olahraga*, *I*, 71–81.

Bennett, J., Das, J. M., & Emmady, P. D. (2024). Spinal Cord Injuries. In *Spinal Cord Injuries*. StatPearls. https://www.ncbi.nlm.nih.gov/books/NBK560721/#__NBK560721_dtls__

Bennie, J. A., Shakespear-Druery, J., & De Cocker, K. (2020). Muscle-strengthening Exercise Epidemiology: a New Frontier in Chronic Disease Prevention. *Sports Medicine - Open*, *6*(1), 40. https://doi.org/10.1186/s40798-020-00271-w

Bohannon, R. W. (2019). Considerations and Practical Options for Measuring Muscle Strength: A Narrative Review. *BioMed Research International*, *2019*, 1–10. https://doi.org/10.1155/2019/8194537

Brett Sears. (2022). *Muscle Strength Scale in Physical Therapy*. very well. https://www.verywellhealth.com/muscle-strength-measurement-2696427

Cho, S.-I., Kim, J.-W., Nam, S.-S., Moon, H.-W., & Jung, W.-S. (2023). Effects of a Rehabilitation Exercise Program Using Electro Muscle Stimulation following Anterior Cruciate Ligament Reconstruction on the Circumference, Activity, and Function of the Quadriceps Muscle. *Applied Sciences*, *13*(7), 4153. https://doi.org/10.3390/app13074153

Ciesla, N., Dinglas, V., Fan, E., Kho, M., Kuramoto, J., & Needham, D. (2011). Manual Muscle Testing: A Method of Measuring Extremity Muscle Strength Applied to Critically Ill Patients. *Journal of Visualized Experiments*, *50*. https://doi.org/10.3791/2632

Cin, M. (2023). *Effects of electromyostimulation (EMS) on athlete Performance : Systematic review Effects of Electromyostimulation (EMS) on Athlete Performance : Systematic Review Elektromiyostimülasyon (EMS) A ntrenmanının Sporcu Performansı Üzerindeki E tkileri : 2*, 11–20.

Coelho-Júnior, H. J., Marques, F. L., Sousa, C. V., Marzetti, E., & Aguiar, S. da S. (2024). Age- and sex-specific normative values for muscle mass parameters in 18,625 Brazilian adults. *Frontiers in Public Health*, *11*. https://doi.org/10.3389/fpubh.2023.1287994

Covier, M. (2024). *Effects of electromyostimulation (EMS) on athlete*

Performance : Systematic review Effects of Electromyostimulation (EMS) on Athlete Performance : Systematic Review Elektromiyostimülasyon (EMS) A ntrenmanının Sporcu Performansı Üzerindeki E tkileri : 2, 11–26.

D'Souza, A., Bucchi, A., Johnsen, A. B., Logantha, S. J. R. J., Monfredi, O., Yanni, J., Prehar, S., Hart, G., Cartwright, E., Wisloff, U., Dobryznski, H., DiFrancesco, D., Morris, G. M., & Boyett, M. R. (2014). Exercise training reduces resting heart rate via downregulation of the funny channel HCN4. *Nature Communications*, *5*(1), 3775. https://doi.org/10.1038/ncomms4775

de Oliveira, E. P., Burini, R. C., & Jeukendrup, A. (2014). Gastrointestinal Complaints During Exercise: Prevalence, Etiology, and Nutritional Recommendations. *Sports Medicine*, *44*(S1), 79–85. https://doi.org/10.1007/s40279-014-0153-2

Depdikbud. (1996). *Ketahuilah Tingkat Kesehatan Jasmani Anda*. Depdikbud Pusat Kesegaran Jasmani dan Rekreasi.

Dewi, K. (2023). *Ini Cara Menggunakan Electrical Muscle Stimulation (EMS) Agar Tetap Fit*. Dasaeon. https://dasaeon.com/review/bagaimana-mendapatkan-badan-fit-dengan-menggunakan-electrical-muscle-stimulation-ems/

Dr. Pradeep Kriplani. (2023). *Why Is Physiotherapy Essential After An Injury?* Neem Tree. https://www.neemtreehealthcare.com/blog/physiotherapy-essential-after-an-injury/

Farooqi, M. A. M., Killian, K., & Satia, I. (2020). The impact of muscle strength on exercise capacity and symptoms. *ERJ Open Research*, *6*(4), 00089–02020. https://doi.org/10.1183/23120541.00089-2020

Fernandes, T. L., Pedrinelli, A., & Hernandez, A. J. (2016). Muscle Injury – Phisiopathology, Diagnosis, Treatment And Clinical Presentation. *Revista Brasileira de Ortopedia (English Edition)*, *46*(3), 247–255. https://doi.org/10.1016/S2255-4971(15)30190-7

Flint, J. H., Wade, A. M., Giuliani, J., & Rue, J.-P. (2014). Defining the Terms Acute and Chronic in Orthopaedic Sports Injuries. *The American Journal of Sports Medicine*, *42*(1), 235–241. https://doi.org/10.1177/0363546513490656

Fransiska Oktaviani. (2017). *Pengkajian Sistem Muskuloskeletal*. Slide Share. https://www.slideshare.net/FransiskaOktafiani/pengkajian-sistem-muskuloskeletal

Gerovasili, V., Tripodaki, E., Karatzanos, E., Pitsolis, T., Markaki, V., Zervakis, D., Routsi, C., Roussos, C., & Nanas, S. (2019). Short-term Systemic Effect

of Electrical Muscle Stimulation in Critically Ill Patients. *Chest*, *136*(5), 1249–1256. https://doi.org/10.1378/chest.08-2888

Gibson, W., Wand, B. M., Meads, C., Catley, M. J., & O'Connell, N. E. (2019). Transcutaneous electrical nerve stimulation (TENS) for chronic pain - an overview of Cochrane Reviews. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD011890.pub3

Gurau, T. V., Gurau, G., Musat, C. L., Voinescu, D. C., Anghel, L., Onose, G., Munteanu, C., Onu, I., & Iordan, D. A. (2023). Epidemiology of Injuries in Professional and Amateur Football Men (Part II). *Journal of Clinical Medicine*, *12*(19), 6293. https://doi.org/10.3390/jcm12196293

Haizlip, K. M., Harrison, B. C., & Leinwand, L. A. (2015). Sex-Based Differences in Skeletal Muscle Kinetics and Fiber-Type Composition. *Physiology*, *30*(1), 30–39. https://doi.org/10.1152/physiol.00024.2014

Hanief, Y. N., Widiawati, P., Supriatna, S., Abdullah, A., & Sumartiningsih, S. (2021). Injury characteristics of Indonesian para-athletes prior to Tokyo Olympics 2020: a cross-sectional study. *Revista Pesquisa em Fisioterapia*, *11*(4), 679–690. https://doi.org/10.17267/2238-2704rpf.v11i4.4065

Haugen, T., Seiler, S., Sandbakk, Ø., & Tønnessen, E. (2019). The Training and Development of Elite Sprint Performance: an Integration of Scientific and Best Practice Literature. *Sports Medicine - Open*, *5*(1), 44. https://doi.org/10.1186/s40798-019-0221-0

Haizlip, K. M., Harrison, B. C., & Leinwand, L. A. (2015). Sex-Based Differences in Skeletal Muscle Kinetics and Fiber-Type Composition. *Physiology*, *30*(1), 30–39. https://doi.org/10.1152/physiol.00024.2014

Helfen, T., & Fischer, M. (2022). Sports injuries. *Notfall und Rettungsmedizin*, *25*(7), 455–456. https://doi.org/10.1007/s10049-022-01084-y

Hong, T. C. (2020). *Telling Them Apart: Chronic and Acute Sports Injuries*. Mount Elizabeth. https://www.mountelizabeth.com.sg/health-plus/article/telling-them-apart-chronic-and-acute-sports-injuries

Howard, E. E., Margolis, L. M., Fussell, M. A., Rios, C. G., Meisterling, E. M., Lena, C. J., Pasiakos, S. M., & Rodriguez, N. R. (2022). Effect of High-Protein Diets on Integrated Myofibrillar Protein Synthesis before Anterior Cruciate Ligament Reconstruction: A Randomized Controlled Pilot Study. *Nutrients*, *14*(3), 563. https://doi.org/10.3390/nu14030563

Järvinen, T. A., Järvinen, M., & Kalimo, H. (2014). Regeneration of injured skeletal muscle after the injury. *Muscles Ligaments Tendons Journal*, *3*. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3940509/

Kaler, E., Valkenberg, H., & Verhagen, E. (2023). More people more active, but there is a counter site. Novice athletes are at highest risk of injury in a large population-based retrospective cross-sectional study. *BMJ Open Sport & Exercise Medicine*, *8*(1), e001255. https://doi.org/10.1136/bmjsem-2021-001255

Kaya, F., & Erzeybek, M. S. (2016). Electrical Muscle Stimulation and Its Use for Sports Training Programs : A review. In *Recent Advances in Health Sciences* (Nomor November). https://www.researchgate.net/profile/Fatih_Kaya5/publication/310599614_Electrical_Muscle_Stimulation_and_Its_Use_for_Sports_Training_Programs_A_review/links/5832ce0d08aef19cb81b3476.pdf

Keep, H., Luu, L., Berson, A., & Garland, S. J. (2016). Validity of the Handheld Dynamometer Compared with an Isokinetic Dynamometer in Measuring Peak Hip Extension Strength. *Physiotherapy Canada*, *68*(1), 15–22. https://doi.org/10.3138/ptc.2014-62

Kemler, E., Valkenberg, H., & Verhagen, E. (2022). More people more active, but there is a counter site. Novice athletes are at highest risk of injury in a large population-based retrospective cross-sectional study. *BMJ Open Sport & Exercise Medicine*, *8*(1), e001255. https://doi.org/10.1136/bmjsem-2021-001255

Kim, Y.-S., Kim, D.-Y., & Ha, M.-S. (2016). Effect of the push-up exercise at different palmar width on muscle activities. *Journal of Physical Therapy Science*, *28*(2), 446–449. https://doi.org/10.1589/jpts.28.446

Kirwan, R., McCullough, D., Butler, T., Perez de Heredia, F., Davies, I. G., & Stewart, C. (2020). Sarcopenia during COVID-19 lockdown restrictions: long-term health effects of short-term muscle loss. *GeroScience*, *42*(6), 1547–1578. https://doi.org/10.1007/s11357-020-00272-3

Kim, Y.-S., Kim, D.-Y., & Ha, M.-S. (2016). Effect of the push-up exercise at different palmar width on muscle activities. *Journal of Physical Therapy Science*, *28*(2), 446–449. https://doi.org/10.1589/jpts.28.446

Knight, K. L. (2008). Editorial. More Precise Classification of Orthopaedic Injury Types and Treatment Will Improve Patient Care. *Journal of Athletic Training*, *43*(2), 117–118. https://doi.org/10.4085/1062-6050-43.2.117

Lance, & Dalleck. (2020). The Science Of Post Exercise Recovery. *American Council of Exercise*, *161*, 10–14. http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=59968051&lang=es&site=ehost-live

Landen, S., Hiam, D., Voisin, S., Jacques, M., Lamon, S., & Eynon, N. (2023).

Physiological and molecular sex differences in human skeletal muscle in response to exercise training. *The Journal of Physiology*, *601*(3), 419–434. https://doi.org/10.1113/JP279499

Laumonier, T., & Menetrey, J. (2016). Muscle injuries and strategies for improving their repair. *Journal of Experimental Orthopaedics*, *3*(1), 15. https://doi.org/10.1186/s40634-016-0051-7

Leite, C. D. F. C., Zovico, P. V. C., Rica, R. L., Barros, B. M., Machado, A. F., Evangelista, A. L., Leite, R. D., Barauna, V. G., Maia, A. F., & Bocalini, D. S. (2023). Exercise-Induced Muscle Damage after a High-Intensity Interval Exercise Session: Systematic Review. *International Journal of Environmental Research and Public Health*, *20*(22), 7082. https://doi.org/10.3390/ijerph20227082

Lember, L.-M., Di Virgilio, T. G., Brown, E. M., & Rodriguez-Sanchez, N. (2021). Hill Runner's Physiology, Performance and Nutrition: A Descriptive Study. *Frontiers in Sports and Active Living*, *3*. https://doi.org/10.3389/fspor.2021.676212

Lemoyne, J., Poulin, C., Richer, N., & Bussières, A. (2017). Analyzing injuries among university-level athletes: Prevalence, patterns and risk factors. *Journal of the Canadian Chiropractic Association*, *61*(2), 83–87. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5596969/

Lenck, & Dalleck. (2013). The Science Of Post Exercise Recovery. *American Council of Exercise*, *161*, 10–14. http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=59968051&lang=es&site=ehost-live

Levider, C. D. F. C., Zovico, P. V. C., Rica, R. L., Barros, B. M., Machado, A. F., Evangelista, A. L., Leite, R. D., Barauna, V. G., Maia, A. F., & Bocalini, D. S. (2013). Exercise-Induced Muscle Damage after a High-Intensity Interval Exercise Session: Systematic Review. *International Journal of Environmental Research and Public Health*, *20*(22), 7082. https://doi.org/10.3390/ijerph20227082

Mardi, D. (2014). Nervous system : structure and control of movement". *Jurnal Manajemen Sains*, 177–198.

Masiero, S., Pignataro, A., Piran, G., Duso, M., Mimche, P., Ermani, M., & Del Felice, A. (2020). Short-wave diathermy in the clinical management of musculoskeletal disorders: a pilot observational study. *International Journal of Biometeorology*, *64*(6), 981–988. https://doi.org/10.1007/s00484-019-01806-x

Meeuwisse, W. H., Tyreman, H., Hagel, B., & Emery, C. (2007). A Dynamic

Model of Etiology in Sport Injury: The Recursive Nature of Risk and Causation. *Clinical Journal of Sport Medicine*, *17*(3), 215–219. https://doi.org/10.1097/JSM.0b013e3180592a48

Metter, E. J., Lynch, N., Conwit, R., Lindle, R., Tobin, J., & Hurley, B. (2020). Muscle quality and age: Cross-sectional and longitudinal comparisons. *Journals of Gerontology - Series A Biological Sciences and Medical Sciences*, *54*(5), 8207–8218. https://doi.org/10.1093/gerona/54.5.B207

Multimedia, Z. (2024). *Butterfly Ems Massager*. IndiaMART. https://m.indiamart.com/proddetail/butterfly-ems-massager-2851296236473.html

Micke, F., Kleinöder, H., Dörmann, U., Wirtz, N., & Donath, L. (2018). Effects of an Eight-Week Superimposed Submaximal Dynamic Whole-Body Electromyostimulation Training on Strength and Power Parameters of the Leg Muscles: A Randomized Controlled Intervention Study. *Frontiers in Physiology*, *9*(December). https://doi.org/10.3389/fphys.2018.01719

Muhtadi, I. K. (2017). *Topik ke-262: Stimulasi Otot Elektronik*. Artikel Kedokteran. https://www.indramuhtadi.com/blog-articles-2017/topik-ke-262-electronic-muscle-stimulation

Multimedia, Z. (2024). *Butterfly Ems Massager*. IndiaMART. https://m.indiamart.com/proddetail/butterfly-ems-massager-2851296236473.html

Muftar, F., Alex, H., Dörmann, U., Wirtz, N., & Donath, L. (2017). Effects of an Eight-Week Superimposed Submaximal Dynamic Whole-Body Electromyostimulation Training on Strength and Power Parameters of the Leg Muscles: A Randomized Controlled Intervention Study. *Frontiers in Physiology*, *9*(December). https://doi.org/10.3389/fphys.2018.01719

Nicolò, A., Massaroni, C., & Passfield, L. (2017). Respiratory Frequency during Exercise: The Neglected Physiological Measure. *Frontiers in Physiology*, *8*. https://doi.org/10.3389/fphys.2017.00922

Nugraha, D. A., Hamidah, N. A., & Rachmawati, N. D. (2021). Electrical Stimulation Dan Passive Exercise Efektif Dalam Meningkatkan Kekuatan Otot Pasien Lesi Nervus Radialis. *Physiotherapy Health Science (PhysioHS)*, *3*(2), 74–77. https://doi.org/10.22219/physiohs.v3i2.18969

Nico, A., Marck, C., & Passfield, L. (2019). Respiratory Frequency during Exercise: The Neglected Physiological Measure. *Frontiers in Physiology*, *8*. https://doi.org/10.3389/fphys.2017.00922

Panda, M., Rizvi, M. R., Sharma, A., Sethi, P., Ahmad, I., & Kumari, S. (2022).

Effect of electromyostimulation and plyometrics training on sports-specific parameters in badminton players. *Sports Medicine and Health Science*, *4*(4), 280–286. https://doi.org/10.1016/j.smhs.2022.08.002

Peterson, M. D., Gordon, P. M., Smeding, S., & Visich, P. (2018). Grip Strength Is Associated with Longitudinal Health Maintenance and Improvement in Adolescents. *The Journal of Pediatrics*, *202*, 226–230. https://doi.org/10.1016/j.jpeds.2018.07.020

PPNI. (2016). *Standar Diagnosis Keperawatan Indonesia: Definisi dan Indikator Diagnostik* (1 ed.). DPP PPNI.

PPNI. (2018). *Standar Intervensi Keperawatan Indonesia: Definisi dan Tindakan Keperawatan* (1 ed.). DPP PPNI.

Pretice, W. (2017). *Rehabilitation techniques for sports medicine and athletic training*. McGraw Hill.

Priexqi, A., Bucchi, A., Johnsen, A. B., Logantha, S. J. R. J., Monfredi, O., Yanni, J., Prehar, S., Hart, G., Cartwright, E., Wisloff, U., Dobryznski, H., DiFrancesco, D., Morris, G. M., & Boyett, M. R. (2014). Exercise training reduces resting heart rate via downregulation of the funny channel HCN4. *Nature Communications*, *5*(1), 3775. https://doi.org/10.1038/ncomms4775

Prieto-González, P., Martínez-Castillo, J. L., Fernández-Galván, L. M., Casado, A., Soporki, S., & Sánchez-Infante, J. (2021). Epidemiology of Sports-Related Injuries and Associated Risk Factors in Adolescent Athletes: An Injury Surveillance. *International Journal of Environmental Research and Public Health*, *18*(9), 4857. https://doi.org/10.3390/ijerph18094857

Reggiani, C., & Schiaffino, S. (2020). Muscle hypertrophy and muscle strength: dependent or independent variables? A provocative review. *European Journal of Translational Myology*, *30*(3). https://doi.org/10.4081/ejtm.2020.9311

Rustiasari, U. J. (2017). Proses Penyembuhan Cedera Jaringan Lunak Muskuloskeletal. *Jorpres (Jurnal Olahraga Prestasi)*, *13*(1), 43–52. https://doi.org/10.21831/jorpres.v13i1.12883

Saatchian, V., Türkmen, M., Esfahani, M., Zadeh, R. A., Talib, A. M., & Azimkhani, A. (2021). The effect of muscle electrical stimulation on muscle stiffness problems and musculoskeletal pain caused by muscle imbalance: A systematic review. *Progress in Nutrition*, *23*(2). https://doi.org/10.23751/pn.v23i2.10070

Salim, A. T., & Saputra, A. W. (2021). Efektivitas Penggunaan Intervensi Fisioterapi Terapi Latihan dan Infrared Pada Kasus Dislokasi Sendi Bahu.

Indonesian Journal of Health Science, *1*(1), 20–30. https://doi.org/10.54957/ijhs.v1i1.49

Sant Anna, J. P. C., Pedrinelli, A., Hernandez, A. J., & Fernandes, T. L. (2022). Lesão muscular: Fisiopatologia, diagnóstico e tratamento. *Revista Brasileira de Ortopedia*, *57*(01), 001–013. https://doi.org/10.1055/s-0041-1731417

Saragiotto, B. T., Di Pierro, C., & Lopes, A. D. (2014). Risk factors and injury prevention in elite athletes: a descriptive study of the opinions of physical therapists, doctors and trainers. *Brazilian Journal of Physical Therapy*, *18*(2), 137–143. https://doi.org/10.1590/S1413-35552012005000147

Schuh Renner, A., Canham Chervak, M., Grier, T. L., Hauschild, V. D., & Jones, B. H. (2019). Expanding the injury definition: evidence for the need to include musculoskeletal conditions. *Public Health*, *169*, 69–75. https://doi.org/10.1016/j.puhe.2019.01.002

Setiawan, V. (2022). *Kenali Manfaat dan Resiko Latihan Fisik EMS Untuk Menurunkan Berat Badan Sebelum Mencoba*. Honestdocs. https://www.honestdocs.id/kenali-manfaat-dan-resiko-latihan-fisik-ems-untuk-menurunkan-berat-badan-sebelum-mencoba

Sifaq, A., Dewa Made Aryananda Wijaya Kusuma, I., Rizanul Wahyudi, A., Khamidi, A., Ferdita Yuhantini, E., & Pendidikan Kepelatihan Olahraga, J. (2020). The Effect of Plank Training With The Concept of Training from Home During The Covid-19 Pandemic. *Journal of Physical Education, Health and Sport*, *7*(2), 38–42. http://journal.unnes.ac.id/nju/index.php/jpehs

Siswanto, B. (2017). *Petunjuk Penggunaan Back and Leg Dynamometer*. 1–10.

Soemarjono, A. (2015). *Terapi Stimulasi Listrik*. Flex-free. https://flexfreeclinic.com/layanan/detail/25

Suba Rao, H. R., Hamzaid, N. A., Ahmad, M. Y., & Hamzah, N. (2022). Physiological factors affecting the mechanical performance of peripheral muscles: A perspective for long COVID patients through a systematic literature review. *Frontiers in Physiology*, *13*. https://doi.org/10.3389/fphys.2022.958333

Suchomel, T. J., Nimphius, S., Bellon, C. R., & Stone, M. H. (2018). The Importance of Muscular Strength: Training Considerations. *Sports Medicine*, *48*(4), 765–785. https://doi.org/10.1007/s40279-018-0862-z

Surzeck, P., Martínez-Castillo, J. L., Fernández-Galván, L. M., Casado, A., Soporki, S., & Sánchez-Infante, J. (2021). Epidemiology of Sports-Related Injuries and Associated Risk Factors in Adolescent Athletes: An Injury Surveillance. *International Journal of Environmental Research and Public*

Health, *18*(9), 4857. https://doi.org/10.3390/ijerph18094857

Suja, I. N., & N Adi Putra, M. I. (2021). Pemberian Terapi Micro Wave Diathermy (Mwd) Dan Quadriceps Exercise (Qe) Lebih Baik Dari Pada Pemberian Terapi Ultrasonik (Us) Danquadriceps Exercise(Qe) Terhadap Pengurangan Nyeri Pada Penderita Osteoarthrosis Sendi Lutut. *Jurnal UDAYANA*, *2*(https://ojs.unud.ac.id/index.php/mifi/article/download/8428/6288/).

Takada, H., Yamashita, K., Osawa, L., Komiyama, Y., Muraoka, M., Suzuki, Y., Sato, M., Kobayashi, S., Yoshida, T., Takano, S., Maekawa, S., & Enomoto, N. (2024). Assessment of lower limb muscle strength can predict fall risk in patients with chronic liver disease. *Scientific Reports*, *14*(1), 1–10. https://doi.org/10.1038/s41598-023-50574-7

Tsai, S.-R., & Hamblin, M. R. (2017). Biological effects and medical applications of infrared radiation. *Journal of Photochemistry and Photobiology B: Biology*, *170*, 197–207. https://doi.org/10.1016/j.jphotobiol.2017.04.014

Ugonabo, N., Rambhia, P. H., You, J., Ibrahimi, O. A., & Chapas, A. (2024). Prospective study to assess the efficacy and safety of a noninvasive electro-muscular stimulation for improvement of muscle strength and muscle toning of the extremities. *Lasers in Surgery and Medicine*, *56*(1), 23–31. https://doi.org/10.1002/lsm.23711

Vardiman, J. P., Moodie, N., Siedlik, J. A., Kudrna, R. A., Graham, Z., & Gallagher, P. (2015). Short-Wave Diathermy Pretreatment and Inflammatory Myokine Response After High-Intensity Eccentric Exercise. *Journal of Athletic Training*, *50*(6), 612–620. https://doi.org/10.4085/1062-6050-50.1.12

Viona, S.-I., Kim, J.-W., Nam, S.-S., Moon, H.-W., & Jung, W.-S. (2023). Effects of a Rehabilitation Exercise Program Using Electro Muscle Stimulation following Anterior Cruciate Ligament Reconstruction on the Circumference, Activity, and Function of the Quadriceps Muscle. *Applied Sciences*, *13*(7), 4153. https://doi.org/10.3390/app13074153

Wiriawan, O. (2017). *Panduan Pelaksanaan Tes & Pengukuran Olahragawan*.

Wolfe, R. R. (2016). The role of dietary protein in optimizing muscle mass, function and health outcomes in older individuals. *British Journal of Nutrition*, *108*(S2), S88–S93. https://doi.org/10.1017/S0007114512002590

Wong, R. A. (2018). High Voltage Versus Low Voltage Electrical Stimulation. *Physical Therapy*, *66*(8), 1209–1214. https://doi.org/10.1093/ptj/66.8.1209

Xu, Y., Wen, Z., Deng, K., Li, R., Yu, Q., & Xiao, S.-M. (2021). Relationships of

sex hormones with muscle mass and muscle strength in male adolescents at different stages of puberty. *PLOS ONE*, *16*(12), e0260521. https://doi.org/10.1371/journal.pone.0260521

Yoo, H. J., Park, S., Oh, S., Kang, M., Seo, Y., Kim, B. G., & Lee, S.-H. (2023). Effects of electrical muscle stimulation on core muscle activation and physical performance in non-athletic adults: A randomized controlled trial. *Medicine*, *102*(4), e32765. https://doi.org/10.1097/MD.0000000000032765

Yunita, T. R. (2022). *Berapa Lama Proses Pembentukan Otot?* Klik Dokter. https://www.klikdokter.com/gaya-hidup/sehat-bugar/berapa-lama-proses-pembentukan-otot

Zifaq, A., Dewa Made Aryananda Wijaya Kusuma, I., Rizanul Wahyudi, A., Khamidi, A., Ferdita Yuhantini, E., & Pendidikan Kepelatihan Olahraga, J. (2020). The Effect of Plank Training With The Concept of Training from Home During The Covid-19 Pandemic. *Journal of Physical Education, Health and Sport*, *7*(2), 38–42. http://journal.unnes.ac.id/nju/index.php/jpehs

Zulzic, L., Dam, G., Borre, M., Drljevic-Nielsen, A., Overgaard, K., Andersen, H., Vilstrup, H., & Aagaard, N. K. (2020). Resistance Training Increases Muscle Strength and Muscle Size in Patients With Liver Cirrhosis. *Clinical Gastroenterology and Hepatology*, *18*(5), 1179-1187.e6. https://doi.org/10.1016/j.cgh.2019.07.058

Zoi'el, N., Dinglas, V., Fan, E., Kho, M., Kuramoto, J., & Needham, D. (2017). Manual Muscle Testing: A Method of Measuring Extremity Muscle Strength Applied to Critically Ill Patients. *Journal of Visualized Experiments*, *50*. https://doi.org/10.3791/2632