

ELİT SPORCULARDA İZOKİNETİK VE ELEKTROMİYOGRAFİK DEĞERLENDİRMELER

Yazar

Dr. Hasan Hüseyin YILMAZ



© Copyright 2022

Bu kitabın, basım, yayın ve satış hakları Akademisyen Kitabevi A.Ş.'ye aittir. Amlan kuruluşun izni alınmadan kitabı tümü ya da bölümleri mekanik, elektronik, fotokopi, manyetik kağıt ve/veya başka yöntemlerle çoğaltılamaz, basılamaz, dağıtılamaz. Tablo, şekil ve grafikler izin alınmadan, ticari amaçlı kullanılamaz. Bu kitap T.C. Kültür Bakanlığı bandrolü ile satılmaktadır.

Bu kitapta yer alan fikirler ve düşünceler yazara ait olup, hiçbir kurum veya kuruluşun görünüşünü yansıtılmamaktadır. Bu kitap "Elit Sporcuların Farklı Açısal Hızlarda Kas Fonksiyonlarının Fiziksel ve Fizyolojik Olarak İncelenmesi" adlı doktora tezinden üretilmiştir.

ISBN

978-625-6965-00-3

Kitap Adı

Elit Sporcularda İzokinetic ve Elektromiyografik Değerlendirmeler

Editör

Murat KALDIRIMCI

ORCID iD: 0000-0002-4285-7307

Yazar

Hasan Hüseyin YILMAZ

ORCID iD: 0000-0003-1994-7731

Yayın Koordinatörü

Yasin DİLMEN

Sayfa ve Kapak Tasarımı

Akademisyen Dizgi Ünitesi

Yayınçı Sertifika No

47518

Baskı ve Cilt

Vadi Matbaacılık

Bisac Code

SPO000000

DOI

10.37609/akyva.2344

GENEL DAĞITIM

Akademisyen Kitabevi A.Ş.

Halk Sokak 5 / A

Yenişehir / Ankara

Tel: 0312 431 16 33

siparis@akademisyen.com

W W W . a k a d e m i s y e n . c o m

ÖN SÖZ

Sportif performans ve değerlendirme aşamalarında motorik özellikler çok fazla ön plana çıkmaktadır. Sporcuların üstün performans gösterebilmeleri için bu özelliklerini mümkün olan en yüksek düzeyde geliştirmeleri gerekmektedir. Sportif başarı ancak bu özellikler spor dalına uygun olarak geliştirildiğinde mümkün olabilmektedir. Bu açıdan düşünüldüğünde sportif performans için motorik özelliklerin incelenmesi ve geliştirilmesine yönelik çalışmaların yapılması oldukça önemlidir.

Teknolojik gelişmelere bağlı olarak spor ve egzersiz bilimlerinde de önemli gelişmeler meydana gelmektedir. Bu gelişmeler ışığında sportif performansı ölçme ve değerlendirme yöntemlerinde önemli gelişmeler yaşanmaktadır. Gelişen bu yöntemler kullanılarak elde edilen sonuçlar sportif performansın geliştirilmesinde, sporcuların geliştirilmeye açık yönlerinin belirlenmesinde, spor yaralanmalarının önlenmesinde, sportif yetenek tarama süreçlerinde ve sporcuların gelişimlerinde kullanılmaktadır. Sportif performansın en önemli belirleyicisi ise hareket sistemi- dir.

Bu kitap içerisinde hareket sisteminin temel ögesi olan kasla- ra yönelik olarak hem fiziksel hem de fizyolojik değerlendirme- ler bulunmaktadır. Aynı zamanda kasların fiziksel ve fizyolojik özellikler arasındaki ilişkiler, spor sakatlanmalarına yönelik değerlendirme-ler, sportif performansı artırmaya yönelik öneriler ve bilgiler yer almaktadır.

TEŞEKKÜR

Akademik ve sosyal hayatımın her noktasında her zaman desteklerini, bilgisini ve yardımcılarını tereddütsüz olarak paylaşan değerli büyüğüm, danışmanım Prof. Dr. Murat KALDIRIMCI'ya,

Çalışmanın gerçekleşmesinde maddi destek ve katkılarından dolayı; Atatürk Üniversitesi Bilimsel Araştırma Projeleri Koordinasyon (BAP) birimine,

Lisans ve lisansüstü eğitimim boyunca tecrübe, bilgi ve bireyimleri her zaman paylaşan, Prof. Dr. Fatih KIYICI, Doç. Dr. C. Tuğrulhan ŞAM, Doç. Dr. Özgür BOSTANCI'ya,

Tez çalışmamın ölçümlerinde ve yazım aşamasında desteklenmeyen arkadaşlarım Arş. Gör. Kemalettin SEREN, Arş. Gör. Gökhan ATASEVER, Arş. Gör. Gökhan AYDIN, Arş. Gör. Levent ÖNAL, Arş. Gör. Cebraeil GENÇOĞLU, Arş. Gör. Sonay Serpil ALPDOĞAN ve kardeşim Oğuzhan YILMAZ'a,

Tez çalışmamın ölçüm sonuçlarının istatistiksel analiz, değerlendirme ve tablolaştırma aşamalarında yardımcılarını ve desteklenmeyen Arş. Gör. Abdülkerim DARENDELİ'ye,

Bugünlere gelmemde hiç bir fedakarlıktan kaçınmayan, hayatımın her döneminde yanında olan, dualarını hep hissettiğim annem Seda YILMAZ ve babam Kemal YILMAZ'a teşekkürü bir borç bilirim.

Dr. Hasan Hüseyin YILMAZ

İÇİNDEKİLER

Bölüm 1

| | |
|-------------|---|
| Giriş | 1 |
|-------------|---|

Bölüm 2.....5

Kuramsal Çerçeve ve İlgili Araştırmalar5

| | |
|---|----|
| Kas Sistemi | 5 |
| İskelet Kasının Yapısı ve Fizyolojisi..... | 8 |
| Kas Lifi | 9 |
| Sarkoplazmik Retikulum ve T Tübülleri | 11 |
| Miyofibril ve Miyofilamentler..... | 12 |
| Sarkomer..... | 12 |
| Kalın ve İnce Filamentler | 14 |
| Kas Kasılması | 15 |
| Uyarılma-Kasılma Döngüsü ve Gevşeme | 17 |
| Uyarılma..... | 18 |
| Kasılma | 18 |
| Gevşeme | 19 |
| Kayan Filamentler Teorisi | 20 |
| Ya Hep Ya Hiç Prensibi | 21 |
| Kas Fibril Tipleri..... | 21 |
| Kasılma Özelliklerine Göre Kas Fibril Tipleri | 22 |
| Metabolik Özelliklerine Göre Kas Tipleri | 24 |
| Kasılma Tipleri..... | 25 |
| İzometrik (Statik) Kas Kasılması..... | 25 |
| İzotonik (Dinamik) Kas Kasılması..... | 26 |

| | |
|--|----|
| Konsantrik Kasılma | 26 |
| Eksantrik Kasılma | 26 |
| İzokinetik Kasılmalar | 28 |
| Diz Eklemi Anatomisi | 28 |
| Diz Eklemi Kasları, Anatomisi ve Kinesiyolojisi | 30 |
| Diz Fleksör Kasları | 31 |
| Hamstrings Kası | 31 |
| Sartorius Kası | 31 |
| Gracilis Kası | 31 |
| Popliteus Kası | 31 |
| Gastrocnemius Kası | 32 |
| Diz Ekstansör Kasları | 32 |
| Quardiceps Kası | 32 |
| Elektromiyografi (EMG) | 32 |
| EMG Sinyallerini Etkileyen Faktörler | 33 |
| Dokuya İlgili Faktörler | 33 |
| Fizyolojik Faktörler | 33 |
| Elektrot ve Kas Yüzeyi Arasındaki Mesafe Değişiklikleri | 34 |
| Gürültü | 34 |
| Elektrot Seçimi ve Amplifikatör | 34 |
| Elektromiyografik Sinyalın Kaynağı | 34 |
| Elektrotların Deri Yüzeyine Yerleştirilmesi ve Hazırlığı | 35 |
| EMG Elektrot Yerleştirme Bölgeleri | 36 |
| İzokinetik Kuvvet Ölçümleri | 37 |
| İzokinetik Kuvvet Testlerinin Uygulanmasında Dikkat Edilmesi Gerekenler | 37 |
| Test Öncesi İşlemler | 38 |
| Test Sırasındaki İşlemler | 38 |
| İzokinetik Kuvvet Testlerinin Yorumlanması | 40 |
| Kas Aktivasyonu ve Kuvvet Üretimi İlişkisi | 41 |

Bölüm 3**Yöntem.....43**

| | |
|---|----|
| Çalışmanın Modeli ve Kapsamı..... | 43 |
| Çalışmanın Yöntemi..... | 44 |
| Isınma Prosedürü..... | 44 |
| Vücut Kompozisyon Ölçümü | 44 |
| Kas Aktivasyon Ölçümü..... | 44 |
| Sensör Seçimi ve Yerleştirilmesi..... | 45 |
| Kas Aktivasyon Ölçümü için Deri Yüzeyinin Hazırlanması..... | 46 |
| yEMG Ölçümü | 46 |
| yEMG Sinyallerinin Analizi..... | 46 |
| Kas Oksidasyon ve Kapillarizasyon Ölçümü..... | 47 |
| İzokinetik Ölçümler..... | 47 |
| İstatistiksel Analiz ve Değerlendirme..... | 49 |

Bölüm 4**Bulgular51****Bölüm 5****Tartışma ve Sonuç**73

| | |
|----------------|-----|
| Öneriler..... | 102 |
| Kaynaklar..... | 103 |

KISALTMALAR

| | |
|------------------------|----------------------------------|
| µm | : mikrometre |
| TnC | : Troponin C |
| TnI | : Troponin I |
| TnT | : Troponin T |
| ATP | : Adenosin Tri Fosfat |
| ADP | : Adenosin Di Fosfat |
| SO | : Slow Oksidative |
| FG | : Fast Glycolytic |
| FOG | : Fast Oksidative/Glycolytic |
| EMG | : Elektromiyografi |
| yEMG | : Yüzeysel Elektromiyografi |
| H/Q | : Hamstring/Quardiceps |
| VM | : Vastus Medialis |
| RF | : Rectus Femoris |
| VL | : Vastus Lateralis |
| MVC | : Maksimum Voluntary Contraction |
| THb | : Total Hemoglobin |
| SmO₂ | : Muscle Oxygen Saturation |
| ROM | : Range of Motion |

Kaynaklar

- Abulhasan, J. F., & Grey, M. J. (2017). Anatomy and physiology of knee stability. *Journal of Functional Morphology and kinesiology*, 2(4), 34.
- Alvares, T. S., Oliveira, G. V. d., Soares, R., & Murias, J. M. (2020). Near-infrared spectroscopy-derived total haemoglobin as an indicator of changes in muscle blood flow during exercise-induced hyperaemia. *Journal of sports sciences*, 38(7), 751-758.
- Amaral, G. M., Marinho, H. V., Ocarino, J. M., Silva, P. L., Souza, T. R. d., & Fonseca, S. T. (2014). Muscular performance characterization in athletes: a new perspective on isokinetic variables. *Brazilian journal of physical therapy*, 18, 521-529.
- Anders, J. P. V., Keller, J. L., Smith, C. M., Hill, E. C., Neltner, T. J., Housh, T. J., Schmidt, R. J., & Johnson, G. O. (2020). Performance fatigability and neuromuscular responses for bilateral and unilateral leg extensions in men. *Journal of Musculoskeletal & Neuronal Interactions*, 20(3), 325.
- Andrade, M. D. S., De Lira, C. A. B., Koffes, F. D. C., Mascarin, N. C., Benedito-Silva, A. A., & Da Silva, A. C. (2012). Isokinetic hamstrings-to-quadriceps peak torque ratio: The influence of sport modality, gender, and angular velocity. *Journal of sports sciences*, 30(6), 547-553.
- ArthritisHealth. (2020). <https://www.arthritis-health.com/types/joint-anatomy/knee-anatomy>. Erişim Tarihi: 27.01.2021
- Atabek, H. Ç., & Sönmez, G. A. (2009). The relationship between isokinetic strength of knee extensors/flexors, jumping and anaerobic performance. *Isokinetics and Exercise Science*, 17(2), 79-83.
- Augusto, V., Padovani, C. R., & Campos, G. E. R. (2017). Skeletal muscle fiber types in C57BL6J mice. *Journal of Morphological Sciences*, 21(2), 0-0.
- Barbero, M., Merletti, R., & Rainoldi, A. (2012). *Atlas of muscle innervation zones: understanding surface electromyography and its applications*. Springer Science & Business Media.
- Baumann, C. A., Hinckel, B. B., & Tanaka, M. J. (2019). Update on patellofemoral anatomy and biomechanics. *Operative Techniques in Sports Medicine*, 27(4), 150683.
- Baumgart, C., Kurz, E., Freiwald, J., & Hoppe, M. W. (2021). Effects of Hip Flexion on on Knee Extension and Flexion Isokinetic Angle-Specific Torques and HQ-Ratios. *Sports Medicine-Open*, 7(1), 1-10.
- Beck, T. W., Housh, T. J., Johnson, G. O., & Weir, J. P. (2007). Effects of two days of isokinetic training on strength and electromyographic amplitude in the agonist and antagonist muscles. *Journal of strength and conditioning research*, 21(3), 757.
- Beck, T. W., Stock, M. S., & DeFreitas, J. M. (2012). Differences in muscle activation patterns among the quadriceps femoris muscles during fatiguing isokinetic leg extensions. *Isokinetics and Exercise Science*, 20(1), 5-12.
- Benninger, B. (2016). 20 Knee joint. *Bergman's Comprehensive Encyclopedia of Human Anatomic Variation*, 181.

- Biga, L. M., Dawson, S., Harwell, A., Hopkins, R., Kaufmann, J., LeMaster, M., Matern, P., Morrison-Graham, K., Quick, D., & Runyeon, J. (2020). Anatomy & physiology.
- Biodex. (2020). https://www.biodex.com/sites/default/files/835000man_06159.pdf. Erişim Tarihi: 12.02.2021
- Bogdanis, G., & Kalapotharakos, V. (2016). Knee extension strength and hamstrings-to-quadriceps imbalances in elite soccer players. *International journal of sports medicine*, 37(02), 119-124.
- Bompa, T., & Buzzichelli, C. (2015). Periodization training for sports, 3e. Human kinetics.
- Bond, C. W., Cook, S. B., Swartz, E. E., & Laroche, D. P. (2017). Asymmetry of lower extremity force and muscle activation during knee extension and functional tasks. *Muscle & nerve*, 56(3), 495-504.
- Boone, T. (2014). *Introduction to exercise physiology*. Jones & Bartlett Publishers.
- Borges, V. S., Domingues, J. M., Dias, R. C., Garcia, P. A., & Dvir, Z. (2015). Strength and torque consistency of the hip and knee flexors and extensors: A comparative study of elderly and young individuals. *Isokinetics and Exercise Science*, 23(1), 45-51.
- Bradic, A., Bradic, J., Pasalic, E., & Markovic, G. (2009). Isokinetic leg strength profile of elite male basketball players. *The Journal of Strength & Conditioning Research*, 23(4), 1332-1337.
- Braithwaite, B., Plamondon, R., & Begon, M. (2020). Muscle activation profiles based on the proportionality hypothesis of the Kinematic Theory of Human Movements. 2020 17th International Conference on Frontiers in Handwriting Recognition (ICFHR),
- Brenner, J. S. (2016). Sports specialization and intensive training in young athletes. *Pediatrics*, 138(3).
- Brown, S. R., Brughelli, M., Griffiths, P. C., & Cronin, J. B. (2014). Lower-extremity isokinetic strength profiling in professional rugby league and rugby by union. *International journal of sports physiology and performance*, 9(2), 358-361.
- Buckworth, J. (2013). *Exercise psychology*. Human kinetics.
- Bujalance-Moreno, P., Latorre-Román, P. A., Ramírez-Campillo, R., & García-Pinillos, F. (2020). Acute responses to 4 vs. 4 small-sided games in football players. *Kinesiology*, 52(01), 46-53.
- Calderón, J. C., Bolaños, P., & Caputo, C. (2014). The excitation-contraction coupling mechanism in skeletal muscle. *Biophysical reviews*, 6(1), 133-160.
- Cardoso, E., Bottaro, M., Rodrigues, P., Souza, I. E., Durigan, J., Lima, R. M., Júnior, S. A. O., & Carregaro, R. L. (2015). Effects of six weeks of resistance exercise with reciprocal contractions on knee extensors neuromuscular performance: Randomized controlled trial. *Isokinetics and Exercise Science*, 23(2), 109-116.
- Carvalhais, V. O. d. C., Santos, T. R. T. d., Araújo, V. L., Leite, D. X., Dias, J. M. D., & Fonseca, S. T. d. (2013). Muscular strength and fatigue index of knee

- extensors and flexors of professional soccer players according to their positioning in field. *Revista Brasileira de Medicina do Esporte*, 19(6), 452-456.
- Carvalho, A., Caserotti, P., Carvalho, C., Abade, E., & Sampaio, J. (2014). Effect of a short time concentric versus eccentric training program on electromyography activity and peak torque of quadriceps. *Journal of human kinetics*, 41, 5.
- Cerrah, A. O., Ertan, H., & Soylu, A. R. (2010). Spor Bilimlerinde Elektromiografi Kullanımı. *Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi*, 8(2), 43-49.
- Chan, K., & Maffulli, N. (1996). Principles and practice of isokinetics. *Sports Medicine and Rehabilitation*. Korkia, P, and Li, R, eds. Baltimore, MD: Williams & Wilkins, 22-30.
- Cheung, R. T., Smith, A. W., & Wong, D. P. (2012). H: Q ratios and bilateral leg strength in college field and court sports players. *Journal of human kinetics*, 33, 63.
- Ciciliot, S., Rossi, A. C., Dyar, K. A., Blaauw, B., & Schiaffino, S. (2013). Muscle type and fiber type specificity in muscle wasting. *The international journal of biochemistry & cell biology*, 45(10), 2191-2199.
- Clarke, M. (2010). Muscle sliding filaments. *Nature Reviews Molecular Cell Biology*, 9(1), s7-s7.
- Coban, O., Yildirim, N. U., Yasa, M. E., Akinoglu, B., & Kocahan, T. (2021). Determining the number of repetitions to establish isokinetic knee evaluation protocols specific to angular velocities of 60°/second and 180°/second. *Journal of Bodywork and Movement Therapies*, 25, 255-260.
- Cometti, C., Deley, G., & Babault, N. (2011). Effects of between-set interventions on neuromuscular function during isokinetic maximal concentric contractions of the knee extensors. *Journal of sports science & medicine*, 10(4), 624.
- Comfort, P., Graham-Smith, P., Matthews, M. J., & Bamber, C. (2011). Strength and power characteristics in English elite rugby league players. *The Journal of Strength & Conditioning Research*, 25(5), 1374-1384.
- Cotte, T., & Chatard, J. (2011). Isokinetic strength and sprint times in English premier league football players. *Biology of Sport*, 28(2), 89.
- Cozette, M., Leprêtre, P.-M., Doyle, C., & Weissland, T. (2019). Isokinetic strength ratios: Conventional methods, current limits and perspectives. *Frontiers in physiology*, 10, 567.
- Cresswell, A., & Overdal, A. (2002). Muscle activation and torque development during maximal unilateral and bilateral isokinetic knee extensions. *Journal of sports medicine and physical fitness*, 42(1), 19.
- Criswell, E. (2010). *Cram's introduction to surface electromyography*. Jones & Bartlett Publishers.
- Crum, E., O'Connor, W., Van Loo, L., Valckx, M., & Stannard, S. (2017). Validity and reliability of the Moxy oxygen monitor during incremental cycling exercise. *European journal of sport science*, 17(8), 1037-1043.

- Cuadra, C., Wojnicz, W., Kozinc, Z., & Latash, M. L. (2020). Perceptual and motor effects of muscle co-activation in a force production task. *Neuroscience*, 437, 34-44.
- Cyjekovic, D. D., Bijeljac, S., Palija, S., Talic, G., Radulovic, T. N., Kosanovic, M. G., & Manojlovic, S. (2015). Isokinetic testing in evaluation rehabilitation outcome after ACL reconstruction. *Medical Archives*, 69(1), 21.
- Da Silva, B. G., Bottaro, M., Weber, F. S., Radaelli, R., Gaya, A. R., Cardoso, M. S., Brown, L. E., Carregaro, R., & Pinto, R. S. (2013). Comparison of hamstring/quadriceps ratio between isoinertial and isokinetic measurements. *Isokinetics and Exercise Science*, 21(2), 107-112.
- Daneshjoo, A., Rahnama, N., Mokhtar, A. H., & Yusof, A. (2013). Bilateral and unilateral asymmetries of isokinetic strength and flexibility in male young professional soccer players. *Journal of human kinetics*, 36, 45.
- Dauty, M., Menu, P., Mesland, O., & Fouasson-Chailloux, A. (2020). Muscle strength particularity of grand tour cyclists from knee isokinetic assessment. *SCIENCE & SPORTS*, 35(2), 82-90.
- Davis, P. R., Yakel, J. P., & Anderson, D. J. (2020). Muscle oxygen demands of the vastus lateralis in back and front squats. *International Journal of Exercise Science*, 13(6), 734.
- de Lira, C. A., Mascarin, N. C., Vargas, V. Z., Vancini, R. L., & Andrade, M. S. (2017). Isokinetic knee muscle strength profile in Brazilian male soccer, futsal, and beach soccer players: a cross-sectional study. *International journal of sports physical therapy*, 12(7), 1103.
- De Luca, C. (2006). Electromyography. *Encyclopedia of medical devices and instrumentation*.
- De Ste Croix, M. B., Deighan, M. A., Ratel, S., & Armstrong, N. (2009). Age-and sex-associated differences in isokinetic knee muscle endurance between young children and adults. *Applied Physiology, Nutrition, and Metabolism*, 34(4), 725-731.
- Deighan, M. A., Serpell, B. G., Bitcon, M. J., & Croix, M. D. S. (2012). Knee joint strength ratios and effects of hip position in rugby players. *The Journal of Strength & Conditioning Research*, 26(7), 1959-1966.
- Deli, C. K., Paschalis, V., Theodorou, A. A., Nikolaidis, M. G., Jamurtas, A. Z., & Koutedakis, Y. (2011). Isokinetic knee joint evaluation in track and field events. *The Journal of Strength & Conditioning Research*, 25(9), 2528-2536.
- Dellagrana, R. A., Diefenthaler, F., Carpes, F. P., Hernandez, S. G., & de Campos, W. (2015). Evidence for isokinetic knee torque asymmetries in male long distance-trained runners. *International journal of sports physical therapy*, 10(4), 514.
- Denadai, B. S., Greco, C. C., Tufik, S., & de Mello, M. T. (2007). Effects of high intensity running to fatigue on isokinetic muscular strength in endurance athletes. *Isokinetics and Exercise Science*, 15(4), 281-285.
- Dold, A. P., Swensen, S., Strauss, E., & Alaia, M. (2017). The posteromedial corner of the knee: anatomy, pathology, and management strategies. *J-*

- AOS-Journal of the American Academy of Orthopaedic Surgeons*, 25(11), 752-761.
- Douglas, J., Pearson, S., Ross, A., & McGuigan, M. (2017). Eccentric exercise: physiological characteristics and acute responses. *Sports Medicine*, 47(4), 663-675.
- Draper, N., & Marshall, H. (2014). *Exercise physiology: for health and sports performance*. Routledge.
- Drum, S. N., Weatherwax, R., & Dixon, J. B. (2016). Physiology of skeletal muscle. In *Muscular Injuries in the Posterior Leg* (pp. 13-25). Springer.
- Durmus, B., Emre, S., Sahin, N., Karincaoglu, Y., Dogan, E., Baysal, O., Ersoy, Y., & Altay, Z. (2015). Isokinetic evaluation of knee extensor/flexor muscle strength in Behcet's patients. *Acta reumatologica portuguesa*, 40(4).
- Edouard, P., Samozino, P., Julia, M., Cervera, S. G., Vanbiervliet, W., Calmels, P., & Gremeaux, V. (2011). Reliability of isokinetic assessment of shoulder-rotator strength: a systematic review of the effect of position. *Journal of sport rehabilitation*, 20(3), 367-383.
- Ehrman, J. K., Kerrigan, D., & Keteyian, S. (2018). *Advanced Exercise Physiology: Essential Concepts and Applications*. Human Kinetics.
- El-Ashker, S., Carson, B. P., Ayala, F., & Croix, M. D. S. (2017). Sex-related differences in joint-angle-specific functional hamstring-to-quadriceps strength ratios. *Knee Surgery, Sports Traumatology, Arthroscopy*, 25(3), 949-957.
- Enoka, R., & Duchateau, J. (2016). Physiology Activation And Of Muscle Force Generation. *Surface Electromyography: Physiology, Engineering, and Applications*, 1.
- Erdemir, I. (2013). Comparative analysis of isokinetic leg strength in professional soccer and basketball players. *South African Journal for Research in Sport, Physical Education and Recreation*, 35(2), 73-82.
- Ergün, M., İsllegen, C., & Taşkiran, E. (2004). A cross-sectional analysis of sagittal knee laxity and isokinetic muscle strength in soccer players. *International journal of sports medicine*, 25(08), 594-598.
- Eustace, S. J., Page, R. M., & Greig, M. (2017). Contemporary approaches to isokinetic strength assessments in professional football players. *Science and Medicine in Football*, 1(3), 251-257.
- Exell, T., Irwin, G., Gittoes, M., & Kerwin, D. (2017). Strength and performance asymmetry during maximal velocity sprint running. *Scandinavian journal of medicine & science in sports*, 27(11), 1273-1282.
- Fan, J.-Z., Liu, X., & Ni, G.-X. (2014). Angular velocity affects trunk muscle strength and EMG activation during isokinetic axial rotation. *BioMed research international*, 2014.
- Farina, D., Negro, F., Gazzoni, M., & Enoka, R. M. (2008). Detecting the unique representation of motor-unit action potentials in the surface electromyogram. *Journal of neurophysiology*, 100(3), 1223-1233.
- Flandry, F., & Hommel, G. (2011). Normal anatomy and biomechanics of the knee. *Sports medicine and arthroscopy review*, 19(2), 82-92.

- Fortin, J.-F., & Billaut, F. (2019). Blood-flow restricted warm-up alters muscle hemodynamics and oxygenation during repeated sprints in American football players. *Sports*, 7(5), 121.
- Fox, E. L., Bowers, R. W., Foss, M. L., Cerit, M., & Yaman, H. (2011). *Beden eğitimi ve sporun fizyolojik temelleri*. Bağırgan Yayinevi.
- Frank, G. B., Bianchi, C. P., & Keurs, H. (2012). *Excitation-contraction coupling in skeletal, cardiac, and smooth muscle* (Vol. 311). Springer Science & Business Media.
- Frontera, W. R., & Ochala, J. (2015). Skeletal muscle: a brief review of structure and function. *Calcified tissue international*, 96(3), 183-195.
- Gabriel, D. A., Kamen, G., & Frost, G. (2006). Neural adaptations to resistive exercise. *Sports Medicine*, 36(2), 133-149.
- Garcia, M. C., & Vieira, T. (2011). Surface electromyography: Why, when and how to use it. *Revista andaluza de medicina del deporte*, 4(1), 17-28.
- Geeves, M. A., & Holmes, K. C. (2005). The molecular mechanism of muscle contraction. *Advances in protein chemistry*, 71, 161-193.
- Gómez-Carmona, C. D., Bastida-Castillo, A., Rojas-Valverde, D., de la Cruz Sánchez, E., García-Rubio, J., Ibáñez, S. J., & Pino-Ortega, J. (2020). Lower-limb dynamics of muscle oxygen saturation during the back-squat exercise: Effects of training load and effort level. *The Journal of Strength & Conditioning Research*, 34(5), 1227-1236.
- González-Ravé, J. M., Juárez, D., Rubio-Arias, J. A., Clemente-Suarez, V. J., Martínez-Valencia, M. A., & Abian-Vicen, J. (2014). Isokinetic leg strength and power in elite handball players. *Journal of human kinetics*, 41, 227.
- Gorsuch, J., Long, J., Miller, K., Primeau, K., Rutledge, S., Sossong, A., & Durocher, J. J. (2013). The effect of squat depth on multiarticular muscle activation in collegiate cross-country runners. *The Journal of Strength & Conditioning Research*, 27(9), 2619-2625.
- Green, B., Bourne, M. N., & Pizzari, T. (2018). Isokinetic strength assessment offers limited predictive validity for detecting risk of future hamstring strain in sport: a systematic review and meta-analysis. *British journal of sports medicine*, 52(5), 329-336.
- Greising, S. M., Gransee, H. M., Mantilla, C. B., & Sieck, G. C. (2012). Systems biology of skeletal muscle: fiber type as an organizing principle. *Wiley Interdisciplinary Reviews: Systems Biology and Medicine*, 4(5), 457-473.
- Groeber, M., Staflidis, S., & Baca, A. (2021). The effect of stretch-shortening magnitude and muscle-tendon unit length on performance enhancement in a stretch-shortening cycle. *Scientific Reports*, 11(1), 1-14.
- Günay, M., Şıktar E., & E., Ş. (2018). *Antrenman Bilimi* (Vol. 1). Gazi Kitavevi.
- Günay, M., Tamer, K., Cicioğlu, H., & Şıktar, E. (2019). Spor fizyolojisi ve performans ölçüm testleri.
- Hadžić, V., Erçulj, F., Bračić, M., & Dervišević, E. (2013). Bilateral concentric and eccentric isokinetic strength evaluation of quadriceps and hamstrings in basketball players. *Collegium antropologicum*, 37(3), 859-865.

- Hadzic, V., Sattler, T., Markovic, G., Veselko, M., & Dervisevic, E. (2010). The isokinetic strength profile of quadriceps and hamstrings in elite volleyball players. *Isokinetics and Exercise Science*, 18(1), 31-37.
- Haff, G. G., & Triplett, N. T. (2015). *Essentials of strength training and conditioning 4th edition*. Human kinetics.
- Harbo, T., Brincks, J., & Andersen, H. (2012). Maximal isokinetic and isometric muscle strength of major muscle groups related to age, body mass, height, and sex in 178 healthy subjects. *European journal of applied physiology*, 112(1), 267-275.
- Harput, G. (2020). Kinesiology of the knee joint. In *Comparative Kinesiology of the Human Body* (pp. 393-410). Elsevier.
- Harrison, B., Firth, W., Rogers, S., Tipple, J., Marsden, J., Freeman, J. A., Hough, A. D., & Shum, G. L. (2013). The relationship between isokinetic performance of hip and knee and jump performance in university rugby players. *Isokinetics and Exercise Science*, 21(2), 175-180.
- Hart, N. H., Nimphius, S., Weber, J., Spiteri, T., Rantalainen, T., Dobbin, M., & Newton, R. U. (2016). Musculoskeletal asymmetry in football athletes: a product of limb function over time. *Medicine and science in sports and exercise*, 48(7), 1379-1387.
- Hashim, H. A., Hanafi, H., & Yusof, A. (2011). The effects of progressive muscle relaxation and autogenic relaxation on young soccer players' mood states. *Asian journal of sports medicine*, 2(2), 99.
- Havolli, J., Bahtiri, A., Kambič, T., Idrizović, K., Bjelica, D., & Pori, P. (2020). Anthropometric Characteristics, Maximal Isokinetic Strength and Selected Handball Power Indicators Are Specific to Playing Positions in Elite Kosovar Handball Players. *Applied Sciences*, 10(19), 6774.
- Hegyi, A., Csala, D., Péter, A., Finni, T., & Cronin, N. J. (2019). High-density electromyography activity in various hamstring exercises. *Scandinavian journal of medicine & science in sports*, 29(1), 34-43.
- Hepple, R. T., & Rice, C. L. (2016). Innervation and neuromuscular control in ageing skeletal muscle. *The Journal of physiology*, 594(8), 1965-1978.
- Hernández-Davó, J., Sabido, R., Moya-Ramón, M., & Blazevich, A. (2015). Load knowledge reduces rapid force production and muscle activation during maximal-effort concentric lifts. *European journal of applied physiology*, 115(12), 2571-2581.
- Herzog, W. (2018). The mysteries of eccentric muscle action. *Journal of sport and health science*, 7(3), 253.
- Herzog, W., Leonard, T. R., Joumaa, V., DuVall, M. M., & Panchangam, A. (2012). The three filament model of skeletal muscle stability and force production.
- Herzog, W., Leonard, T. R., Joumaa, V., & Mehta, A. (2008). Mysteries of muscle contraction. *Journal of applied biomechanics*, 24(1), 1-13.
- Herzog, W., Powers, K., Johnston, K., & Duvall, M. (2015). A new paradigm for muscle contraction. *Frontiers in physiology*, 6, 174.

- Hopkins, P. M. (2006). Skeletal muscle physiology. *Continuing Education in Anaesthesia, Critical Care & Pain*, 6(1), 1-6.
- Hori, M., Suga, T., Terada, M., Tanaka, T., Kusagawa, Y., Otsuka, M., Nagano, A., & Isaka, T. (2021). Relationship of the knee extensor strength but not the quadriceps femoris muscularity with sprint performance in sprinters: a reexamination and extension. *BMC Sports Science, Medicine and Rehabilitation*, 13(1), 1-10.
- Huddart, H. (2013). *The comparative structure and function of muscle*. Elsevier.
- Hug, F., Hodges, P. W., & Tucker, K. (2015). Muscle force cannot be directly inferred from muscle activation: illustrated by the proposed imbalance of force between the vastus medialis and vastus lateralis in people with patellofemoral pain. *Journal of orthopaedic & Sports physical therapy*, 45(5), 360-365.
- Iannotti, J. P., & Parker, R. (2012). *The Netter Collection of Medical Illustrations: Musculoskeletal System, Volume 6, Part II-Spine and Lower Limb E-Book*. Elsevier Health Sciences.
- Irving, M. (2017). Regulation of contraction by the thick filaments in skeletal muscle. *Biophysical journal*, 113(12), 2579-2594.
- Jones, P. A., & Bampouras, T. M. (2010). A comparison of isokinetic and functional methods of assessing bilateral strength imbalance. *The Journal of Strength & Conditioning Research*, 24(6), 1553-1558.
- Kabaciński, J., Fryzowicz, A., Błaszczyk, A., Murawa, M., Gorwa, J., & Ogurkowska, M. B. (2020). Comparison of isokinetic knee torque and bioelectrical activity for hamstrings, quadriceps and erector spinae muscles in elite rowers. *Sports biomechanics*, 1-11.
- Kalata, M., Maly, T., Hank, M., Michalek, J., Bujnovsky, D., Kunzmann, E., & Zahalka, F. (2020). Unilateral and Bilateral Strength Asymmetry among Young Elite Athletes of Various Sports. *Medicina*, 56(12), 683.
- Kato, K., Muraoka, T., Higuchi, T., Mizuguchi, N., & Kanosue, K. (2014). Interaction between simultaneous contraction and relaxation in different limbs. *Experimental brain research*, 232(1), 181-189.
- Kenhub. (2021). <https://www.kenhub.com/en/library/anatomy/the-knee-joint>. Erişim Tarihi: 24.01.2021
- Kenney, W. L., Wilmore, J. H., & Costill, D. L. (2015). *Physiology of sport and exercise*. Human kinetics.
- Kim, C.-G., & Jeoung, B. J. (2016). Assessment of isokinetic muscle function in Korea male volleyball athletes. *Journal of exercise rehabilitation*, 12(5), 429.
- Kim, D., & Hong, J. (2011). Hamstring to quadriceps strength ratio and non-contact leg injuries: A prospective study during one season. *Isokinetics and Exercise Science*, 19(1), 1-6.
- Klusiewicz, A., Rębiś, K., Ozimek, M., & Czaplicki, A. (2021). The use of muscle near-infrared spectroscopy (NIRS) to assess the aerobic training loads of world-class rowers. *Biology of Sport*, 38(4), 713-719.
- Kocahan, T., & Akinoğlu, B. (2018). Determination of the relationship between

- core endurance and isokinetic muscle strength of elite athletes. *Journal of exercise rehabilitation*, 14(3), 413.
- Kodejška, J., Michailov, M. L., & Baláš, J. (2016). Forearm muscle oxygenation during sustained isometric contractions in rock climbers. *Auc Kinanthropologica*, 51(2), 48-55.
- Kofotolis, N. D., & Kellis, E. (2007). Cross-training effects of a proprioceptive neuromuscular facilitation exercise programme on knee musculature. *Physical Therapy in Sport*, 8(3), 109-116.
- Koley, S. (2020). *Physiology of Exercise*. Friends Publications (India).
- Kong, P. W., & Burns, S. F. (2010). Bilateral difference in hamstrings to quadriceps ratio in healthy males and females. *Physical Therapy in Sport*, 11(1), 12-17.
- Konrad, P. (2005). The abc of emg. *A practical introduction to kinesiological electromyography*, 1(2005), 30-35.
- Kotrljanovic, A., Atanasov, D., Veljovic, D., & Drid, P. (2016). An isokinetic profile in senior female and male karate athletes national team level.
- Kraemer, W. J., Fleck, S. J., & Deschenes, M. R. (2011). *Exercise physiology: integrating theory and application*. Lippincott Williams & Wilkins.
- Krishna, S. A., Alwar, T. K., Sibeko, S., Ranjit, S., & Sivaraman, A. (2019). Plyometric-based training for isokinetic knee strength and jump performance in cricket fast bowlers. *International journal of sports medicine*, 40(11), 704-710.
- Kuan, J.-Y., Pasch, K. A., & Herr, H. M. (2014). Design of a knee joint mechanism that adapts to individual physiology. 2014 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society.
- Kuo, I. Y., & Ehrlich, B. E. (2015). Signaling in muscle contraction. *Cold Spring Harbor perspectives in biology*, 7(2), a006023.
- Kurdak, S. S., Özgünen, K., Adas, Ü., Zeren, C., Aslangiray, B., Yazıcı, Z., & Korkmaz, S. (2005). Analysis of isokinetic knee extension/flexion in male elite adolescent wrestlers. *Journal of sports science & medicine*, 4(4), 489.
- Lehnert, M., Stastny, P., Tufano, J. J., & Stolfa, P. (2017). Changes in isokinetic muscle strength in adolescent soccer players after 10 weeks of pre-season training. *The Open Sports Sciences Journal*, 10(1).
- Li, T., Gu, Y. T., & Oloyede, A. (2014). Molecular sliding filament model for muscular contraction based on multiscale investigation. *Science of Advanced Materials*, 6(7), 1346-1350.
- Lieber, R. L. (2002). *Skeletal muscle structure, function, and plasticity*. Lippincott Williams & Wilkins.
- Lindstedt, S. L. (2016). Skeletal muscle tissue in movement and health: positives and negatives. *Journal of Experimental Biology*, 219(2), 183-188.
- Lockie, R. G., Schultz, A. B., Jeffriess, M. D., & Callaghan, S. J. (2012). The relationship between bilateral differences of knee flexor and extensor isokinetic strength and multi-directional speed. *Isokinetics and Exercise Science*, 20(3), 211-219.

- Ludvig, D., Whitmore, M. W., & Perreault, E. J. (2020). Contributions of joint mechanics and neural control to the generation of torque during movement. 2020 42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC),
- Lynn, S. K., Watkins, C. M., Wong, M. A., Balfany, K., & Feeney, D. F. (2018). Validity and reliability of surface electromyography measurements from a wearable athlete performance system. *Journal of sports science & medicine*, 17(2), 205.
- MacDonald, G. Z., Penney, M. D., Mullaley, M. E., Cuconato, A. L., Drake, C. D., Behm, D. G., & Button, D. C. (2013). An acute bout of self-myofascial release increases range of motion without a subsequent decrease in muscle activation or force. *The Journal of Strength & Conditioning Research*, 27(3), 812-821.
- Maffulli, N. (1996). *Principles and practice of isokinetics in sports medicine and rehabilitation*. Human Kinetics 1.
- Malloggi, C., Catino, L., Rota, V., Scarano, S., & Tesio, L. (2019). Measuring voluntary activation of the Quadriceps femoris during isokinetic concentric contractions. *Isokinetics and Exercise Science*, 27(2), 125-134.
- Maloney, S. J. (2019). The relationship between asymmetry and athletic performance: A critical review. *The Journal of Strength & Conditioning Research*, 33(9), 2579-2593.
- Malý, T., Zahálka, F., & Malá, L. (2010). Isokinetic strength, ipsilateral and bilateral ratio of peak muscle torque in knee flexors and extensors in elite young soccer players. *Acta Kinesiologica*, 4(2), 17-23.
- Masouros, S., Bull, A., & Amis, A. (2010). (i) Biomechanics of the knee joint. *Orthopaedics and Trauma*, 24(2), 84-91.
- Massó, N., Rey, F., Romero, D., Gual, G., Costa, L., & Germán, A. (2010). Surface electromyography applications in the sport. *Apunts Med Esport*, 45(165), 121-130.
- Masumoto, J., & Inui, N. (2010). Control of increasing or decreasing force during periodic isometric movement of the finger. *Human movement science*, 29(3), 339-348.
- McArdle, W. D., Katch, F. I., & Katch, V. L. (2010). *Exercise physiology: nutrition, energy, and human performance*. Lippincott Williams & Wilkins.
- McCallie, M. S., Blum, C. M., & Hood, C. J. (2006). Progressive muscle relaxation. *Journal of human behavior in the social environment*, 13(3), 51-66.
- Melo, R. C., Takahashi, A. C., Quitério, R. J., Salvini, T. F., & Catai, A. M. (2016). Eccentric torque-producing capacity is influenced by muscle length in older healthy adults. *The Journal of Strength & Conditioning Research*, 30(1), 259-266.
- Menager, E., & Dauty, M. (2019). Isokinetic knee muscle strength profile in accordance with the practice of basketball, handball, volleyball, cycling or football at a professional level. *SCIENCE & SPORTS*, 34(6), 401-409.
- Menzel, H.-J., Chagas, M. H., Szmuchrowski, L. A., Araujo, S. R., de Andrade, A. G., & de Jesus-Moraleida, F. R. (2013). Analysis of lower limb asymmetries

- by isokinetic and vertical jump tests in soccer players. *The Journal of Strength & Conditioning Research*, 27(5), 1370-1377.
- Merletti, R., Botter, A., & Barone, U. (2016). Detection and conditioning of surface EMG signals. In *Surface Electromyography: Physiology, Engineering, and Applications* (pp. 54-90). Wiley.
- Merletti, R., & Farina, D. (2016). *Surface electromyography: physiology, engineering, and applications*. John Wiley & Sons.
- Merlo, A., & Campanini, I. (2010). Technical aspects of surface electromyography for clinicians. *The open rehabilitation journal*, 3(1).
- Metaxas, T. I., Koutlianatos, N., Sendelides, T., & Mandroukas, A. (2009). Preseason physiological profile of soccer and basketball players in different divisions. *The Journal of Strength & Conditioning Research*, 23(6), 1704-1713.
- Michaelides, M. A., Parpa, K. M., & Zacharia, A. I. (2019). Assessment of Lower Body and Abdominal Strength in Professional Soccer Players. *Journal of human kinetics*, 70, 15.
- Miller, C. (2020). 12.4 Muscle Contraction. *Human Biology*.
- Miller, S. C. (2014). *Mechanical factors affecting the estimation of tibialis anterior force using an EMG-driven modelling approach* Brunel University].
- Milner, C. E. (2019). *Functional Anatomy for Sport and Exercise: A Quick A-to-Z Reference* Routledge.
- Miranda-Fuentes, C., Chirosa-Ríos, L. J., Guisado-Requena, I. M., Delgado-Floody, P., & Jerez-Mayorga, D. (2021). Changes in muscle oxygen saturation measured using wireless near-infrared spectroscopy in resistance training: A systematic review. *International Journal of Environmental Research and Public Health*, 18(8), 4293.
- Montesano, P., Palermi, S., Massa, B., & Mazzeo, F. (2020). From “sliding” to “winding” filaments theory: A narrative review of mechanisms behind skeletal muscle contraction.
- Mueller, S., Mayer, P., Baur, H., & Mayer, F. (2011). Higher velocities in isokinetic dynamometry: A pilot study of new test mode with active compensation of inertia. *Isokinetics and Exercise Science*, 19(2), 63-70.
- Mukund, K., & Subramaniam, S. (2020). Skeletal muscle: A review of molecular structure and function, in health and disease. *Wiley Interdisciplinary Reviews: Systems Biology and Medicine*, 12(1), e1462.
- Mungal, S. U., Dube, S. P., Dhole, A., Mane, U., & Bondade, A. K. (2015). New hypothesis for mechanism of sliding filament theory of skeletal muscle contraction. *National Journal of Physiology, Pharmacy & Pharmacology*, 5(1), 72-75.
- Murray, R., & Kenney, W. L. (2016). *Practical guide to exercise physiology*. Human Kinetics.
- Nadzalan, A. M., Lee, J. L. F., Mohamad, N. I., Azzfar, M. S., Abd Malek, N. F., & Waqqash, E. (2020). The Effects of Focus Attention Instructions on the Movement Kinetics, Muscle Activation and Performance during Resistance Exercise. *Journal of Physics: Conference Series*,

- Nederveen, J. P., Ibrahim, G., Fortino, S. A., Snijders, T., Kumbhare, D., & Parise, G. (2020). Variability in skeletal muscle fibre characteristics during repeated muscle biopsy sampling in human vastus lateralis. *Applied Physiology, Nutrition, and Metabolism*, 45(4), 368-375.
- Nell, H. J., Castelli, L. M., Bertani, D., Jipson, A. A., Meagher, S. F., Melo, L. T., Zabjek, K., & Reid, W. D. (2020). The effects of hypoxia on muscle de-oxygenation and recruitment in the flexor digitorum superficialis during submaximal intermittent handgrip exercise. *BMC Sports Science, Medicine and Rehabilitation*, 12, 1-10.
- Nicholas, R. (2012). ACSM's Foundations of Strength Training and Conditioning. USA: American College of Sports Medicine.
- Nishikawa, K. (2016). Eccentric contraction: unraveling mechanisms of force enhancement and energy conservation. *Journal of Experimental Biology*, 219(2), 189-196.
- Nunes, R. F., Dellagrana, R. A., Nakamura, F. Y., Buzzachera, C. F., Almeida, F. A., Flores, L. J., Guglielmo, L. G., & da Silva, S. G. (2018). Isokinetic assessment of muscular strength and balance in Brazilian elite futsal players. *International journal of sports physical therapy*, 13(1), 94.
- Padulo, J., Laffaye, G., Ardigò, L. P., & Chamari, K. (2013). Concentric and eccentric: muscle contraction or exercise? *Journal of human kinetics*, 37, 5.
- Papagiannis, G. I., Triantafyllou, A. I., Roumpelakis, I. M., Zampeli, F., Garyfallia Eleni, P., Koulovaris, P., Papadopoulos, E. C., Papagelopoulos, P. J., & Babis, G. C. (2019). Methodology of surface electromyography in gait analysis: review of the literature. *Journal of medical engineering & technology*, 43(1), 59-65.
- Paraschos, I., Hassani, A., Bassa, E., Hatzikotoulas, K., Patikas, D., & Kotzamnidis, C. (2007). Fatigue differences between adults and prepubertal males. *International journal of sports medicine*, 28(11), 958-963.
- Patel, R. M., & Brophy, R. H. (2018). Anterolateral ligament of the knee: anatomy, function, imaging, and treatment. *The American journal of sports medicine*, 46(1), 217-223.
- Pattanakuhar, S., Pongchaidecha, A., Chattipakorn, N., & Chattipakorn, S. C. (2017). The effect of exercise on skeletal muscle fibre type distribution in obesity: from cellular levels to clinical application. *Obesity research & clinical practice*, 11(5), 112-132.
- Payton, C. J., & Burden, A. (2017). Biomechanical evaluation of movement in sport and exercise: the British Association of Sport and Exercise Sciences guide. Routledge.
- Physiopedia. (2020). <https://www.physio-pedia.com/Knee>. Erişim Tarihi: 24.01.2021
- Pietraszewski, P., Gołaś, A., Matusiński, A., Mrzygłód, S., Mostowik, A., & Maszczyk, A. (2020). Muscle Activity Asymmetry of the Lower Limbs During Sprinting in Elite Soccer Players. *Journal of human kinetics*, 75, 239.
- Pion, J., Lenoir, M., Vandorpé, B., & Segers, V. (2015). Talent in female gymnastics: a survival analysis based upon performance characteristics. *International journal of sports medicine*, 94(11), 935-940.

- Plowman, S. A., & Smith, D. L. (2013). *Exercise physiology for health fitness and performance*. Lippincott Williams & Wilkins.
- Pollack, G. (2013). *Contractile mechanisms in muscle* (Vol. 37). Springer Science & Business Media.
- Porcari, J., Bryant, C., & Comana, F. (2015). *Exercise physiology*. FA Davis.
- Powers, S. K., Howley, E. T., & Quindry, J. (2018). *Exercise physiology: Theory and application to fitness and performance*. McGraw-Hill New York, NY.
- Pradhan, A., Malagon, G., Lagacy, R., Chester, V., & Kuruganti, U. (2020). Effect of age and sex on strength and spatial electromyography during knee extension. *Journal of physiological anthropology*, 39(1), 1-11.
- Presland, J., Timmins, R. G., Maniar, N., Tofari, P. J., Kidgell, D., Shield, A., Dickson, J., & Opar, D. (2021). Muscle activity and activation in previously strain-injured lower limbs: a systematic review. *Sports Medicine*.
- Rall, J. A. (2014). Birth of the sliding filament model of muscular contraction: proposal. In *Mechanism of muscular contraction* (pp. 29-57). Springer.
- Rannama, I., Port, K., Bazanov, B., & Pedak, K. (2015). Sprint cycling performance and asymmetry. *Journal of Human Sport and Exercise*, 10(1), S248-S258.
- Ratamess, N. (2021). ACSM's foundations of strength training and conditioning. Lippincott Williams & Wilkins.
- Rassier, D. E. (2017). Sarcomere mechanics in striated muscles: from molecules to sarcomeres to cells. *American Journal of Physiology-Cell Physiology*, 313(2), C134-C145.
- Ruas, C. V. (2021). Neuromuscular characteristics of eccentric contractions of the knee extensors and their muscle damage profiles.
- Ruas, C. V., Brown, L. E., Lima, C. D., Costa, P. B., & Pinto, R. S. (2018). Effect of three different muscle action training protocols on knee strength ratios and performance. *The Journal of Strength & Conditioning Research*, 32(8), 2154-2165.
- Ruas, C. V., Minozzo, F., Pinto, M. D., Brown, L. E., & Pinto, R. S. (2015). Lower-extremity strength ratios of professional soccer players according to field position. *The Journal of Strength & Conditioning Research*, 29(5), 1220-1226.
- Ruiz-Moreno, C., Lara, B., Brito de Souza, D., Gutiérrez-Hellín, J., Romero-Moraleda, B., Cuéllar-Rayó, Á., & Del Coso, J. (2020). Acute caffeine intake increases muscle oxygen saturation during a maximal incremental exercise test. *British journal of clinical pharmacology*, 86(5), 861-867.
- Rüegg, J. C. (2012). *Calcium in muscle contraction: cellular and molecular physiology*. Springer Science & Business Media.
- Saghiv, M. S., & Sagiv, M. S. (2020a). *Basic Exercise Physiology*. Springer.
- Saghiv, M. S., & Sagiv, M. S. (2020b). Introduction to Exercise Physiology. In *Basic Exercise Physiology* (pp. 1-31). Springer.
- Saghiv, M. S., & Sagiv, M. S. (2020c). Skeletal Muscles. In *Basic Exercise Physiology* (pp. 407-436). Springer.
- Sandberg, J. B., Wagner, D. R., Willardson, J. M., & Smith, G. A. (2012). Acute effects of antagonist stretching on jump height, torque, and electromyog-

- raphy of agonist musculature. *The Journal of Strength & Conditioning Research*, 26(5), 1249-1256.
- Schiltz, M., Lehance, C., Maquet, D., Bury, T., Crielaard, J.-M., & Croisier, J.-L. (2009). Explosive strength imbalances in professional basketball players. *Journal of athletic training*, 44(1), 39-47.
- Schons, P., Da Rosa, R. G., Fischer, G., Berriel, G. P., Fritsch, C. G., Nakamura, F. Y., Baroni, B. M., & Peyré-Tartaruga, L. A. (2018). The relationship between strength asymmetries and jumping performance in professional volleyball players. *Sports biomechanics*.
- Schulte-Mattler, W. (2011). Neurophysiological Methods for Motor Unit Number Estimation in Human Muscles. *Klinische Neurophysiologie*, 42(4), 221-225.
- Secchi, L. L., Muratt, M. D., Ciolac, E. G., & Greve, J. (2011). Knee muscles isokinetic evaluation in short distance elite swimmers: A comparison between symmetric and asymmetric swimming styles. *Isokinetics and Exercise Science*, 19(4), 261-264.
- Sekulic-Jablanovic, M., Palmowski-Wolfe, A., Zorzato, F., & Treves, S. (2015). Characterization of excitation-contraction coupling components in human extraocular muscles. *Biochemical Journal*, 466(1), 29-36.
- Seniam. (2020). *Sensor Locations* <http://www.seniam.org/>. Erişim Tarihi: 14.01.2021
- Seo, M.-W., Jung, H.-C., Song, J.-K., & Kim, H.-B. (2015). Effect of 8 weeks of pre-season training on body composition, physical fitness, anaerobic capacity, and isokinetic muscle strength in male and female collegiate taekwondo athletes. *Journal of exercise rehabilitation*, 11(2), 101.
- Śliwowski, R., Grygorowicz, M., Hojszyk, R., & Jadczał, Ł. (2017). The isokinetic strength profile of elite soccer players according to playing position. *PLoS One*, 12(7), e0182177.
- Śliwowski, R., Marynowicz, J., Grygorowicz, M., Wieczorek, A., & Jadczał, Ł. (2021). Are There Differences in Concentric Isokinetic Strength Performance Profiles between International and Non-International Elite Soccer Players? *International Journal of Environmental Research and Public Health*, 18(1), 35.
- Smith, D. A. (2018). *The sliding-filament theory of muscle contraction*. Springer.
- Solomon, E. P. (2015). *Introduction to human anatomy and physiology*. Elsevier Health Sciences.
- Song, J., Kim, K., Lee, S., Lee, J., & Park, J. (2020). History-Dependence of Muscle Excitation and Oxygenation During Isometric Knee Extension Force Production. *운동과학*, 29(4), 385-393.
- SportHealth. (2020). <https://www.sports-health.com/sports-injuries/knee-injuries/guide-knee-joint-anatomy>. Erişim Tarihi: 27.01.2021
- Struzik, A., & Pietraszewski, B. (2015). Lower limb torque asymmetry in judo competitors evaluated in isokinetic conditions. *Med. Sport*, 68(4), 639-650.
- Sweeney, H. L., & Hammers, D. W. (2018). Muscle contraction. *Cold Spring Harbor perspectives in biology*, 10(2), a023200.

- Şahin, Ö. (2010). Rehabilitasyonda izokinetik değerlendirmeler. *Cumhuriyet Medical Journal*, 32(4), 386-396.
- Tang, S. F.-T., Wu, C.-K., Chen, C.-H., Chen, J. T.-N., Tang, A. C.-W., & Wu, S.-H. (2015). Muscle activation features of the osteoarthritic knee with patello-lateral subluxation. *Clinical neurology and neurosurgery*, 129, S30-S35.
- TeachMeAnatomy. (2021). <https://teachmeanatomy.info/lower-limb/joints/knee-joint/>. Erişim Tarihi: 10.01.2021
- Teixeira, J., Carvalho, P., Moreira, C., & Santos, R. (2014). Isokinetic assessment of muscle imbalances and bilateral differences between knee extensores and flexores' strength in basketball, footbal, handball and volleyball athletes. *Int J Sports Sci*, 4(1), 1-6.
- Tew, G. A., Ruddock, A. D., & Saxton, J. M. (2010). Skin blood flow differentially affects near-infrared spectroscopy-derived measures of muscle oxygen saturation and blood volume at rest and during dynamic leg exercise. *European journal of applied physiology*, 110(5), 1083-1089.
- Thompson, B. J., Ryan, E. D., Herda, T. J., Costa, P. B., Herda, A. A., & Cramer, J. T. (2014). Age-related changes in the rate of muscle activation and rapid force characteristics. *Age*, 36(2), 839-849.
- Thorne, B. M. (2010). All-or-None Law. *The Corsini Encyclopedia of Psychology*, 1-1.
- Timón, R., Ponce-González, J. G., González-Montesinos, J. L., Olcina, G., Pérez-Pérez, A., & Castro-Piñero, J. (2017). Inertial flywheel resistance training and muscle oxygen saturation. *The Journal of sports medicine and physical fitness*, 58(11), 1618-1624.
- Tortora, G. J., & Derrickson, B. H. (2018). *Principles of anatomy and physiology*. John Wiley & Sons.
- Tsai, A.-C., Hsieh, T.-H., Luh, J.-J., & Lin, T.-T. (2014). A comparison of upper-limb motion pattern recognition using EMG signals during dynamic and isometric muscle contractions. *Biomedical Signal Processing and Control*, 11, 17-26.
- Tsiokanos, A., Paschalis, V., & Valasotiris, K. (2016). Knee extension strength profile of elite Greek soccer players. *Isokinetics and Exercise Science*, 24(1), 79-82.
- Tsuchiya, Y., Kikuchi, N., Shirato, M., & Ochi, E. (2015). Differences of activation pattern and damage in elbow flexor muscle after isokinetic eccentric contractions. *Isokinetics and Exercise Science*, 23(3), 169-175.
- Tupling, A. R., Bombardier, E., Gupta, S. C., Hussain, D., Vigna, C., Bloomberg, D., Quadrilatero, J., Trivieri, M. G., Babu, G. J., & Backx, P. H. (2011). Enhanced Ca²⁺ transport and muscle relaxation in skeletal muscle from sarcoplasmic-null mice. *American Journal of Physiology-Cell Physiology*, 301(4), C841-C849.
- Türker, H., & Sözen, H. (2013). Surface electromyography in sports and exercise. *Electrodiagnosis in new frontiers of clinical research*, 175-194.
- Van Dyk, N., Bahr, R., Whiteley, R., Tol, J. L., Kumar, B. D., Hamilton, B., Farooq, A., & Witvrouw, E. (2016). Hamstring and quadriceps isokinetic

- strength deficits are weak risk factors for hamstring strain injuries: a 4-year cohort study. *The American journal of sports medicine*, 44(7), 1789-1795.
- Vandenboom, R. (2011). Modulation of skeletal muscle contraction by myosin phosphorylation. *Comprehensive Physiology*, 7(1), 171-212.
- Vieira, A., Alex, S., Martorelli, A., Brown, L. E., Moreira, R., & Bottaro, M. (2017). Lower-extremity isokinetic strength ratios of elite springboard and platform diving athletes. *The Physician and sportsmedicine*, 45(2), 87-91.
- Vieira, L. H. P., de Souza Serenza, F., de Andrade, V. L., de Paula Oliveira, L., Mariano, F. P., Santana, J. E., & Santiago, P. R. P. (2016). Kicking performance and muscular strength parameters with dominant and nondominant lower limbs in Brazilian elite professional futsal players. *Journal of applied biomechanics*, 32(6), 578-585.
- VisibleBody. (2021). <https://www.visiblebody.com/blog/learn-muscle-anatomy-knee-joint-group>. Erişim Tarihi: 15.01.2021
- Waugh, C. M., Korff, T., Fath, F., & Blazevich, A. J. (2013). Rapid force production in children and adults: mechanical and neural contributions. *Med Sci Sports Exerc*, 45(4), 762-771.
- Wei, Z., Wang, X.-X., & Wang, L. (2020). Effect of short-term Kinesiology taping on knee proprioception and quadriceps performance in healthy individuals. *Frontiers in physiology*, 11, 1501.
- Westerblad, H., Bruton, J. D., & Katz, A. (2010). Skeletal muscle: energy metabolism, fiber types, fatigue and adaptability. *Experimental cell research*, 316(18), 3093-3099.
- Wilkosz, P., Kabacinski, J., Mackala, K., Murawa, M., Ostarello, J., Rzepnicka, A., Szczesny, L., Fryzowicz, A., Maczynski, J., & Dworak, L. B. (2021). Isokinetic and Isometric Assessment of the Knee Joint Extensors and Flexors of Professional Volleyball Players. *International Journal of Environmental Research and Public Health*, 18(13), 6780.
- Wilson, J. M., Loenneke, J. P., Jo, E., Wilson, G. J., Zourdos, M. C., & Kim, J.-S. (2012). The effects of endurance, strength, and power training on muscle fiber type shifting. *The Journal of Strength & Conditioning Research*, 26(6), 1724-1729.
- Wong, D. P., & Wong, S. H. (2009). Physiological profile of Asian elite youth soccer players. *The Journal of Strength & Conditioning Research*, 23(5), 1383-1390.
- Wray, S., & Burdyga, T. (2010). Sarcoplasmic reticulum function in smooth muscle. *Physiological reviews*, 90(1), 113-178.
- Xaverova, Z., Dirnberger, J., Lehnert, M., Belka, J., Wagner, H., & Orechovska, K. (2015). Isokinetic strength profile of elite female handball players. *Journal of human kinetics*, 49, 257.

- Yapıcı, A. (2016). Factors effecting hamstrings to quadriceps peak torque ratio in volleyball players. *Journal of Human Sciences*, 13(3), 5282-5289.
- Yapıcı, A., Findikoglu, G., & Dundar, U. (2014). Do isokinetic angular velocity and contraction types affect the predictors of different anaerobic power tests? *The Journal of sports medicine and physical fitness*, 56(4), 383-391.
- Yilmaz, A. (2019). *Diz Kuvvetinin Belirlenmesinde Kullanılan İzokinetic Ve Alan Testlerinin Fleksiyon Ve Ekstansiyon Fazlarında Elektromiyografik Analizi*. Ondokuz Mayıs Üniversitesi]. Samsun.
- Yilmaz, A., Kabadayı, M., Bostancı, Ö., Özdal, M., & Mayda, M. (2019). Analysis of isokinetic knee strength in soccer players in terms of selected parameters. *Physical education of students*, 23(4), 209-216.
- Yilmaz, A. K., Ermiş, E., Kabadayı, M., & Bostancı, Ö. (2020). Correlation of Upper and Lower Extremities Isokinetic Strength in Elite Male Judokas. *Journal of Men's Health*, 16(4), e141-e152.
- Yilmaz, A. K., & Kabadayı, M. (2020). Electromyographic responses of knee isokinetic and single-leg hop tests in athletes: dominant vs. non-dominant sides. *Research in Sports Medicine*, 1-15.
- Zange, J., Molitor, S., Illbruck, A., Müller, K., Schönau, E., Kohl-Bareis, M., & Rittweger, J. (2014). In the unloaded lower leg, vibration extrudes venous blood out of the calf muscles probably by direct acceleration and without arterial vasodilation. *European journal of applied physiology*, 114(5), 1005-1012.
- Zatsiorsky, V. M., & Prilutsky, B. I. (2012). *Biomechanics of skeletal muscles*. Human Kinetics.
- Zhang, L., Liu, G., Han, B., Wang, Z., Yan, Y., Ma, J., & Wei, P. (2020). Knee joint biomechanics in physiological conditions and how pathologies can affect it: a systematic review. *Applied bionics and biomechanics*, 2020.
- Zoladz, J. A. (2018). *Muscle and exercise physiology*. Academic press.
- Zot, H. G., & Hasbun, J. E. (2016). Modeling Ca²⁺-bound troponin in excitation contraction coupling. *Frontiers in physiology*, 7, 406.
- Zouita, A. B. M., Salah, F. Z. B., Dziri, C., & Beardsley, C. (2018). Comparison of isokinetic trunk flexion and extension torques and powers between athletes and nonathletes. *Journal of exercise rehabilitation*, 14(1), 72.
- Zubac, D., & Šimunic, B. (2017). Skeletal muscle contraction time and tone decrease after 8 weeks of plyometric training. *The Journal of Strength & Conditioning Research*, 31(6), 1610-1619.
- Zuzana, H., Cacek, J., Tomáš, K., Bokůvka, D., & Tereza, H. (2017). Relationship Between The Isokinetic Strength Of The Knee Flexors, Knee Extensors, And Sprint Running Performance In Elite Football Players. 11th International Conference On Kinanthropology, Brno.