PENINGKATAN VOLUME OKSIGEN MAKSIMAL DAN PERFORMA RENANG JARAK JAUH MELALUI *STRENGTH AND CONDITIONING TRAINING*

DISERTASI

Diajukan untuk Memenuhi Sebagian Syarat untuk Memperoleh Gelar Doktor Pendidikan Olahraga

Oleh:
Z. Arifin
2106677

PROGRAM STUDI PENDIDIKAN OLAHRAGA
SEKOLAH PASCASARJANA
UNIVERSITAS PENDIDIKAN INDONESIA
TAHUN 2025

LEMBAR HAK CIPTA

PENINGKATAN VOLUME OKSIGEN MAKSIMAL DAN PERFORMA RENANG JARAK JAUH MELALUI *STRENGTH AND CONDITIONING TRAINING*

Oleh
Z. Arifin

S.Si., Universitas Pendidikan Indonesia, 2011
M.Pd. Universitas Pendidikan Indonesia, 2015

Sebuah Disertasi yang diajukan untuk memenuhi salah satu syarat memperoleh gelar Doktor Pendidikan (Dr) pada Sekolah Pascasarjana
Program Studi Pendidikan Olahraga

LEMBAR PENGESAHAN

Z. ARIFIN

2106677

PENINGKATAN VOLUME OKSIGEN MAKSIMAL DAN PERFORMA RENANG JARAK JAUH MELALUI *STRENGTH AND CONDITIONING TRAINING*

disetujui dan ditandatangani oleh semua pembimbing/penguji ujian tahap 1:

Promotor	Ko-Promotor
Prof. Dr. H. R. Boyke Mulyana, M.Pd.	**Prof. Dr. Hj. Nina Sutresna, M. Pd.**
NIP. 196210231989031001	**NIP. 196412151989012001**

Anggota Promotor

Prof. Dr. Herman Subarjah, M.Si.
NIP. 196009181986031003

Penguji Dalam	Penguji Luar
Dr. H. Dede Rohmat Nurjaya, M.Pd.	**Prof. Dr. Moch Asmawi, M.Pd.**
NIP. 196312091988031001	**NIP. 196212101990031007**

Mengetahui,
Ketua Program Studi Pendidikan Olahraga

Prof. Dr. H. Sucipto, M.Kes. AIFO.
NIP.196106121987031002

LEMBAR PERNYATAAN

Dengan ini saya menyatakan bahwa disertasi yang berjudul "Peningkatan Volume Oksigen Maksimal dan Performa Renang Jarak Jauh Melalui *Strength and Conditioning Training*" ini beserta seluruhnya 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 tersebut, saya siap menanggung resiko/sanksi apabila di kemudian hari ditemukan adanya pelanggaran etika keilmuanatau ada klaim dari pihak lain terhadap keaslian karya saya ini.

Bandung, April 2025
Yang membuat pernyataan,

Z. Arifin
1200897

PENINGKATAN VOLUME OKSIGEN MAKSIMAL DAN PERFORMA RENANG JARAK JAUH MELALUI *STRENGTH AND CONDITIONING TRAINING*

Z. Arifin, Rd. Boyke Mulyana, Nina Sutresna, Herman Subarjah
Pendidikan Olahraga, Sekolah Pascasarjana
Universitas Pendidikan Indonesia

Abstrak

Tujuan penelitian untuk mengetahui bagaimana pengaruh *strength and conditioning training* terhadap peningkatan volume oksigen maksimal dan performa renang jarak jauh. Desain penelitian menggunakan *pretest-posttest control group design*. Penelitian ini melibatkan 20 perenang jarak jauh. Teknik pengambilan sampel menggunakan *total sampling*. Sampel dibagi secara acak menjadi dua kelompok, yang masing-masing berjumlah 10 orang. Instrumen yang digunakan *swum in 12 minutes test*, satu unit *camcorder handycamp*, dan dua kamera GoPro. Kelompok eksperimen mengikuti program latihan selama 12 minggu dengan 7 sesi per minggu yang fokus pada kekuatan, daya tahan kekuatan dan daya tahan. Sementara itu, kelompok kontrol melaksanakan program latihan biasa tanpa penekanan khusus pada *strength and conditioning training*. Teknik analisis data menggunakan *paired sample t-test* and *independent sample t-test*. Hasil penelitian menunjukkan bahwa *strength and conditioning training* berpengaruh signifikan terhadap peningkatan volume oksigen maksimal. *Strength and conditioning training* berpengaruh signifikan terhadap parameter *performance* dan *stroke frequency*, serta parameter *total turn*, 5 *m-in*, dan 15 *m-out*. namun, tidak ada perubahan signifikan pada parameter *clean swim*, *stroke length*, dan *stroke index*, serta parameter *water break t* dan *water break d*. Perbandingan antara kelompok eksperimen dan kontrol menunjukkan perbedaan signifikan pada peningkatan volume oksigen maksimal. Begitupun dengan parameter *performance* dan *stroke frequency*, serta parameter *total turn,* 5 *m-in*, dan 15 *m-out*. tetapi, tidak signifikan pada parameter *clean swim, stroke length*, dan *stroke index,* serta parameter *water break t* dan *water break d.* Studi lanjutan dengan sampel lebih besar, pendekatan terfokus, dan instrumen modern dapat memperjelas manfaat serta meningkatkan validitas dan akurasi hasil penelitian.

Kata Kunci: *strength and conditioning training*, volume oksigen maksimal, performa renang jarak jauh

IMPROVEMENT OF MAXIMUM OXYGEN UPTAKE AND LONG-DISTANCE SWIMMING PERFORMANCE THROUGH STRENGTH AND CONDITIONING TRAINING

Z. Arifin, Rd. Boyke Mulyana, Nina Sutresna, Herman Subarja
Pendidikan Olahraga, Sekolah Pascasarjana
Universitas Pendidikan Indonesia

Abstract

The purpose of this study is to determine the effect of strength and conditioning training on the improvement of maximal oxygen uptake and long-distance swimming performance. The research design used is a pretest-posttest control group design. This study involved 20 long-distance swimmers. The sampling technique applied was total sampling. The sample was randomly divided into two groups, each consisting of 10 individuals. The instruments used included the 12-minute swim test, one camcorder handycam, and two GoPro cameras. The experimental group participated in a 12-week training program with seven sessions per week, focusing on strength, muscular endurance, and overall endurance. Meanwhile, the control group followed a conventional training program without specific emphasis on strength and conditioning training. Data analysis techniques included the paired sample t-test and independent sample t-test. The results of the study showed that strength and conditioning training had a significant effect on increasing maximal oxygen uptake. It also significantly influenced performance parameters and stroke frequency, as well as total turn, 5m-in, and 15m-out parameters. However, no significant changes were observed in the clean swim, stroke length, stroke index, or the water break time and water break distance parameters. Comparison between the experimental and control groups showed significant differences in the improvement of maximal oxygen uptake. Significant effects were also found in performance and stroke frequency, as well as total turn, 5m-in, and 15m-out parameters. However, no significant differences were found in clean swim, stroke length, stroke index, or water break time and water break distance parameters. Further studies with a larger sample size, a more focused approach, and modern instruments can clarify the benefits and enhance the validity and accuracy of the research findings.

Keywords: *strength and conditioning training, maximum oxygen uptake, long-distance swimming performance*

KATA PENGANTAR

Puji dan syukur kehadirat Allah SWT., yang dengan rahmat dan petunjuk-Nya sehingga penulis dapat menyelesaikan disertasi yang berjudul "Peningkatan Volume Oksigen Maksimal dan Performa Renang Jarak Jauh Melalui *Strength and Conditioning Training*". Tidak lupa pula dukungan moral dan materil yang diberikan kepada penulis dalam penyusunan disertasi ini. Oleh karena itu, penulis mengucapkan rasa terima kasih kepada:

1. **Prof. Dr. M. Solehudin, M.Pd., MA.,** selaku Rektor Universitas Pendidikan Indonesia dan para wakil rektor yang memberikan kesempatan kepada penulis untuk belajar di Sekolah Pascasarjana Universitas Pendidikan Indonesia;
2. **Prof. Dr. Juntika Nurihsan, M.Pd.,** selaku Direktur dan para wakil Direktur di Sekolah Pascasarjana Universitas Pendidikan Indonesia, yang telah memfasilitasi berkaitan pada Bidang Akademik dan Kemahasiswaan, serta Bidang Sumber Daya, Keuangan dan Umum;
3. **Prof. Dr. H. Sucipto, M.Kes. AIFO.,** selaku Ketua Program Studi Pendidikan Olahraga yang telah memberikan saran/masukan dan motivasi untuk segera menyelesaikan studi;
4. **Prof. Dr. H. R. Boyke Mulyana, M.Pd.,** selaku Promotor yang meluangkan waktu, perhatian dan pikiran untuk memberikan bimbingan dan arahan selama menyelesaikan studi;
5. **Prof. Dr. Hj. Nina Sutresna, M. Pd.,** selaku Ko-Promotor yang telah meluangkan waktu, tenaga, pikiran, memberikan dukungan, serta senantiasa sabar dalam memberikan bimbingan dan arahan kepada penulis selama penyelesaian studi ;
6. **Prof. Dr. Herman Subarjah, M.Si.,** selaku anggota promotor yang telah meluangkan waktu untuk bimbingan dan motivasi untuk dapat menyelesaikan studi dengan tepat waktu;

7. **Prof. Dr. Moch. Asmawi, M. Pd.,** selaku Penguji Luar dan **Dr. Dede Rohmat Nurjaya, M.Pd.,** selaku penguji dalam yang telah meluangkan waktu dan berkenan memberikan masukan serta saran yang sangat berharga;
8. **Lena, S.Pd.,** selaku Staff Program Studi Pendidikan Olahraga Pascasarjana Universitas Pendidikan Indonesia, yang telah membantu memenuhi kebutuhan administrasi selama studi;
9. Ibunda **Aisah** dan Ayahanda **Suhandi** yang tiada henti-hentinya mendoakan dan memberikan motivasi, serta mengingatkan untuk tidak lalai dalam beribadah kepada Allah SWT;
10. Ibu mertua **dr. D. Yuli Nugrawati**, **MMRS**., dan ayah mertua **Asep Mulyana, S.Sos.,** yang senantiasa mendoakan dan membantu berupa moril dan materil selama studi;
11. Istriku tercinta **Sheila Nur Annisa, A.M.Keb.,** dan anaku tersayang **Arina Shalilah Arifin** yang senantiasa sabar dan mengerti hingga selesai studi;
12. Sahabat-sahabatku seperjuangan di **Program Studi Pendidikan Olahraga Angkatan 2021/2022 (S3**) yang telah menjadi sosok *support system* yang baik; dan
13. Semua pihak yang terlibat dalam penelitian yang tidak dapat penulis sebutkan satu persatu atas bantuan dan kerjasamanya.

Penulis menyadari bahwa masih terdapat kekurangan, baik dari segi penyajian data maupun aspek teknis lainnya. Oleh karena itu, kami dengan tulus menerima setiap saran dan kritik yang bersifat membangun dari pembaca, sebagai bahan perbaikan di masa mendatang. Akhir kata, penulis berharap semoga disertasi ini berguna bagi para pembaca dan pihak-pihak lain yang berkepentingan.

Bandung, April 2025

Penulis

Z Arifin

DAFTAR ISI

DAFTAR TABEL

DAFTAR GAMBAR

DAFTAR LAMPIRAN

DAFTAR PUSTAKA

Abbiss, C. R., and P. .. Laursen. 2008. "Describing and Understanding Pacing Strategies." *Sports Medicine* 38(3):239–52.

Abigail Ellsworth. 2011. *Core Training Anatomy*. San Diego, California: Thunder Bay Press.

Amara, Sofiene et al. 2021. "What Is the Optimal Strength Training Load to Improve Swimming Performance? A Randomized Trial of Male Competitive Swimmers." *International Journal of Environmental Research and Public Health* 18(22):11770. doi: 10.3390/ijerph182211770.

Amaro, N. M. et al. 2019. "A Systematic Review on Dry-Land Strength and Conditioning Training on Swimming Performance." *Science and Sports* 34(1):e1–14. doi: 10.1016/j.scispo.2018.07.003.

Amaro, Nuno M. et al. 2017. "Effects of Dry-Land Strength and Conditioning Programs in Age Group Swimmers." *Journal of Strength and Conditioning Research* 31(9):2447–54. doi: 10.1519/JSC.0000000000001709.

Aspenes, Stian et al. 2009. "Combined Strength and Endurance Training in Competitive Swimmers." *Journal of Sports Science & Medicine* 8(3):357–65.

Aspenes, Stian Thoresen, and Trine Karlsen. 2012. "Exercise-Training Intervention Studies in Competitive Swimming." *Sports Medicine (Auckland, N.Z.)* 42(6):527–43. doi: 10.2165/11630760-000000000-00000.

Baar, K. 2002. "Adaptations of Skeletal Muscle to Exercise: Rapid Increase in the Transcriptional Coactivator PGC-1." *FASEB Journal* 16(14):1879–86. doi: 10.1096/fj.02-0367com.

Baechle, T. R. 2004. *NSCA's Essentials of Personal Training*. Champaign, IL: Human Kinetics.

Barbosa, Tiago M. et al. 2010. "Energetics and Biomechanics as Determining Factors of Swimming Performance: Updating the State of the Art." *Journal of Science and Medicine in Sport* 13(2):262–69. doi: 10.1016/j.jsams.2009.01.003.

Bay, Scott. 2016. *Swimming: Steps to Success (3rd Ed.)*. Vol. 1. Human Kinetics.

Bazyler, Caleb D. et al. 2015. "Strength Training for Endurance Athletes: Theory to Practice." *Strength and Conditioning Journal* 37(2):1–12. doi: 10.1519/SSC.0000000000000131.

Beattie, Kris et al. 2014. "The Effect of Strength Training on Performance in Endurance Athletes." *Springer International Publishing Switzerland*. doi: 10.1007/s40279-014-0157-y.

Bíró, M., Révész, L., & Hidvégi, P. 2015. *History Technique Teaching*. Hungaria: EKC Líceum Press.

Bompa, O, Tudor & Buzzichelli, Carlo. 2015. *Periodization Training for Sports Third Edition*. Champaign, IL: Human Kinetics.

Bompa, T. O., and Carlo A. Buzzichelli. 2019. *Peridization: Theory and Methodology of Training*. Champaign, IL: Human Kinetics.

Bompa Tudor, O., & Haff, G. G. 2009. *Periodization: Theory and Methodology of Training, 6th Edition*. Champaign, IL: Human Kinetics.

Borba, Francisco da Silva Coelho de. 2013. "Teste de Avaliação Da Performance Em Luta." Universidade Técnica de Lisboa.

Campo, Silvia Sedano et al. 2009. "Effects of Lower-Limb Plyometric Training on Body Composition, Explosive Strength, and Kicking Speed in Female Soccer Players." *Journal of Strength and Conditioning Research* 23(6):1714–22. doi: 10.1519/JSC.0b013e3181b3f537.

Caputo, Fabrizio et al. 2006. "Fatores Intrínsecos Do Custo Energético Da Locomoção Durante a Natação." *Revista Brasileira de Medicina Do Esporte* 12(6):399–404. doi: 10.1590/S1517-86922006000600019.

Del Castillo, Jose A. et al. 2022. "The Importance of Previous Season Performance on World-Class 200- And 400-m Individual Medley Swimming." *Biology of Sport* 39(1):45–51. doi: 10.5114/BIOLSPORT.2022.103573.

Chakravorti, N. et al. 2012. "Swimming Turn Technique Optimisation by Real-Time Measurement of Foot Pressure and Position." *Procedia Engineering* 34(December):586–91. doi: 10.1016/j.proeng.2012.04.100.

Chmielewski, Terese L. et al. 2006. "Plyometric Exercise in the Rehabilitation of Athletes: Physiological Responses and Clinical Application." *Journal of Orthopaedic and Sports Physical Therapy* 36(5):308–19. doi: 10.2519/jospt.2006.2013.

Chu, D. A., & Meyer, G. C. 2013. *Plyometrics*. Champaign, IL: Human Kinetics.

Clayton, Nick, et al. 2015. *Foundations of Fitness Programming*. Colorado Springs, CO: National Strength and Conditioning Association.

Comyns, Tom. 2015. *Circuit Training Development of Strength & Conditioning*. Ireland: Lucozade Sport.

Conti, A. A. 2015. "Swimming, Physical Activity and Health: A Historical Perspective." *La Clinica Terapeutica* 166(4):179–82. doi: 10.7417/CT.2015.1867.

Cooper, K. H. 2013. *Aerobics Program for Total Well-Being: Exercise, Diet, and Emotional Balance*. New York: Bantam books.

Costill, D. L. 1985. "Energy Expenditure during Front Crawl Swimming: Predicting Success in Middle-Distance Events." *International Journal of Sports Medicine* 6(5):266–70. doi: 10.1055/s-2008-1025849.

Dail, Teresa, and Caroline Smith. 2016. "Swimming and Children with Attention-Deficit Hyperactive Disorder: A Winning Combination." *Journal of Physical Education, Recreation & Dance* 87(8):16–20. doi: 10.1080/07303084.2016.1216486.

Davies, George et al. 2015. "Current Concepts of Plyometric Exercise." *International Journal of Sports Physical Therapy* 10(6):760–86.

Deschenes, Michael R. & McCoy, Raymond W. McCoy. 2017. "Skeletal Muscle Anatomy and Biomechanics." Pp. 26–45 in *NSCA ' s Essentials of Tactical Strength and Conditioning*, edited by B. A. Alvar and D. Rscc. United States of America: Human Kinetics.

Dhuha, Ahad Agafian et al. 2020. "The Effect of Endurance and Leg Muscle Strength Training Method on the Increase of VO2Max Article Info." *Journal of Physical Education and Sports* 9(3):275–80. doi:

https://doi.org/10.15294/jpes.v9i3.36073.

Dopsaj, Milivoj et al. 2020. "Body Composition in International Sprint Swimmers: Are There Any Relations with Performance?" *International Journal of Environmental Research and Public Health* 17(24):9464. doi: 10.3390/ijerph17249464.

Eskiyecek, Canan Gülbin. 2020. "The Effect of 8-Week Core Exercises Applied to 10-12 Age Male Swimmers on Swimming Performance." *International Journal of Applied Exercise Physiology* 9(3):10–17. doi: 10.26655/IJAEP.2020.3.22.

Fone, Line, and Roland van den Tillaar. 2022. "Effect of Different Types of Strength Training on Swimming Performance in Competitive Swimmers: A Systematic Review." *Sports Medicine - Open* 8(1). doi: 10.1186/s40798-022-00410-5.

Gainsford, Janine. 2013. *Swimming in Christchurch : How the Industry Was Affected by the Earthquakes*. New Zealand: Lincoln University.

Gallagher, Sean, et al. 2000. *Physical Strength Assessment in Ergonomics*. Fairfax, Virginia: American Industrial Hygiene Association.

Gary R. Hunter and Robert T. Harris. 2008. "Structure and Function of the Muscular, Neuromuscular, Cardiovascular, and Respiratory Systems." in *Essentials of strength training and Conditioning*, edited by R. W. (Eds. . Baechle, T. R., & Earle. Champaign, IL: Human Kinetics.

Ginting, Andarias et al. 2021. "The Effectiveness of Learning Freestyle Swimming Using the Islamt2e Based on Static Swimming Tools." *International Journal of Human Movement and Sports Sciences* 9(5):863–75. doi: 10.13189/saj.2021.090506.

Girold, S., et al. 2012. "Dry-Land Strength Training vs. Electrical Stimulation in Sprint Swimming Performance." *The Journal of Strength & Conditioning Research* 26(2):497–505.

Girold, Sebastien et al. 2007. "Effects of Dry-Land vs. Resisted-and Assisted-Sprint Exercises on Swimming Sprint Performances." *Journal of Strength and Conditioning Research* 21(2):599–605. doi: 10.1519/00124278-200705000-00054.

Gonjo, Tomohiro, and Bjørn Harald Olstad. 2020. "Race Analysis in Competitive Swimming: A Narrative Review." *International Journal of Environmental Research and Public Health* 18(1):69. doi: 10.3390/ijerph18010069.

Gourgoulis, Vassilios et al. 2019. "Effect of an 11-Week In-Water Training Program with Increased Resistance on the Swimming Performance and the Basic Kinematic Characteristics of the Front Crawl Stroke." *Journal of Strength and Conditioning Research* 33(1):95–103. doi: 10.1519/JSC.0000000000001879.

Gregory Whyte. 2006. *The Physiology of Training: Advances in Sport and Exercise Science Series*. Buckinghamshire, UK: Churchill Livingston Elsevier.

Guzman, Ruben J. 2017. *The Swimming Drill Book*. Champaign, IL: Human Kinetics.

Hargreaves, Mark, and Lawrence L. Spriet. 2020. "Skeletal Muscle Energy Metabolism during Exercise." *Nature Metabolism* 2(9):817–28. doi: 10.1038/s42255-020-0251-4.

Heinlein, Scott A., and Andrew J. Cosgarea. 2010a. "Biomechanical Considerations in the Competitive Swimmer's Shoulder." *Sports Health* 2(6):519–25. doi: 10.1177/1941738110377611.

Heinlein, Scott A., and Andrew J. Cosgarea. 2010b. "Biomechanical Considerations in the Competitive Swimmer's Shoulder." *Sports Health: A Multidisciplinary Approach* 2(6):519–25. doi: 10.1177/1941738110377611.

Hellsten, Ylva, and Michael Nyberg. 2015. "Cardiovascular Adaptations to Exercise Training." Pp. 1–32 in *Comprehensive Physiology*. Vol. 6. Wiley.

Herda, Trent J. and Cramer, Joel T. 2015. "Bioenergetics of Exercise and Training." in *Essentials of strength training and conditioning*, edited by N. T. (Eds. . Haff, G. G., & Triplett. Champaign, IL: Human Kinetics.

Hermosilla, Francisco et al. 2021. "Effects of Dry-Land Training Programs on Swimming Turn Performance: A Systematic Review." *International Journal of Environmental Research and Public Health* 18(17):9340. doi: 10.3390/ijerph18179340.

Howells, Kristy, and Deborah Jarman. 2016. "Benefits of Swimming for Young

Children." *Physical Education Matters* 11(3):20–21.

Ilakia S et al. 2024. "Effect of Sport Specific Strength and Conditioning Training on Strength and Power among Mixed Martial Arts Athletes." *Indian Journal of Physiotherapy & Occupational Therapy - An International Journal* 18:226–31. doi: 10.37506/40pj0e98.

Indrayana, Boy, and Ely Yuliawan. 2019. "Penyuluhan Pentingnya Peningkatan Vo2Max Guna Meningkatkan Kondisi Fisik Pemain Sepakbola Fortuna Fc Kecamatan Rantau Rasau." *Jurnal Ilmiah Sport Coaching and Education* 3(1):41–50. doi: 10.21009/jsce.03105.

Jared W. Coburn and Moh H. Malek. 2011. "Structure and Function of the Muscular, Nervous, and Skeletal Systems." Pp. 89–103 in *NSCA's Essentials of Personal Training [2 ed.]*, edited by Jared W. Coburn and Moh H. Malek. Human Kinetics.

Jason C. Casey and Chris A. Bailey. 2021. "Plyometric and Speed Training Program Design Technique." in *NSCA'S Essentials of Personal Training*, edited by R. L. (Eds. . Schoenfeld, B. J., & Snarr. Champaign, IL: Human Kinetics.

Jay R. Hoffman. 2008. "The Cardiorespiratory System." in *Conditioning for Strength and Human Performance*, edited by L. E. Chandler, T. J., & Brown. Philadelphia: Lippincott Williams & Wilkins.

Jesus, S. et al. 2011. "13th FINA World Championship Finals: Stroke Kinematical and Race Times According to Performance, Gender and Event." *Portuguese Journal of Sport Sciences* 11:275–78.

Ji, Mu Yeop et al. 2021. "Effect of Dry-Land Core Training on Physical Fitness and Swimming Performance in Adolescent Elite Swimmers." *Iranian Journal of Public Health* 50(3):540–49. doi: 10.18502/ijph.v50i3.5595.

Jones, Julian V. et al. 2018. "Comparison Between Elite and Subelite Swimmers on Dry Land and Tumble Turn Leg Extensor Force-Time Characteristics." *Journal of Strength and Conditioning Research* 32(6):1762–69. doi: 10.1519/JSC.0000000000002041.

Joyce, D., & Lewindon, D. (Eds. .. 2014. *High-Performance Training for Sports*.

Champaign, IL: Human Kinetics.

Junior, Edvander Bertoleti et al. 2016. "Swimming Performance Evaluation in Athletes Submitted to Different Types of Strength Training." *Journal of Exercise Physiology Online* 19(6):1–9.

Karpiński, Jakub et al. 2020. "The Effects of a 6-Week Core Exercises on Swimming Performance of National Level Swimmers" edited by D. M. Pessôa Filho. *PLOS ONE* 15(8):e0227394. doi: 10.1371/journal.pone.0227394.

Kenney, W. L., Wilmore, J. H., & Costill, D. L. 2021. *Physiology of Sport and Exercise*. Champaign, IL: Human Kinetics.

Khodaee, Morteza et al. 2016. "Medical Care for Swimmers." *Sports Medicine - Open* 2(1):27. doi: 10.1186/s40798-016-0051-2.

Kojima, Kosuke et al. 2018. "In-Water Resisted Swim Training for Age-Group Swimmers: An Evaluation of Training Effects." *Pediatric Exercise Science* 30(1):124–31. doi: 10.1123/pes.2016-0230.

Konstantaki, Maria et al. 2008. "Effects of Arms-Only Swimming Training on Performance, Movement Economy, and Aerobic Power." *International Journal of Sports Physiology and Performance* 3(3):294–304. doi: 10.1123/ijspp.3.3.294.

Konstantaki, Maria, and Edward M. Winter. 2007. "The Effectiveness of a Leg-Kicking Training Program on Performance and Physiological Measures of Competitive Swimmers." *International Journal of Sports Science & Coaching* 2(1):37–48. doi: 10.1260/174795407780367140.

Lang, Melanie, and Richard Light. 2010. "Interpreting and Implementing the Long Term Athlete Development Model: English Swimming Coaches' Views on the (Swimming) LTAD in Practice." *International Journal of Sports Science & Coaching* 5(3):389–402. doi: 10.1260/1747-9541.5.3.389.

Lauer, Jessy et al. 2013. "Phase-Dependence of Elbow Muscle Coactivation in Front Crawl Swimming." *Journal of Electromyography and Kinesiology* 23(4):820–25. doi: 10.1016/j.jelekin.2013.02.004.

Lin, Chun-yi et al. 2018. "Acute Physiological and Psychological Effects of Qigong

Exercise in Older Practitioners." 2018. doi: 10.1155/2018/4960978.

Lloyd, Rhodri S. et al. 2011. "The Natural Development and Trainability of Plyometric Ability During Childhood." *Strength & Conditioning Journal* 33(2):23–32. doi: 10.1519/SSC.0b013e3182093a27.

Lopes, Tiago J. et al. 2021. "The Effects of Dry-Land Strength Training on Competitive Sprinter Swimmers." *Journal of Exercise Science & Fitness* 19(1):32–39. doi: 10.1016/j.jesf.2020.06.005.

Lopes, Tiago J et al. 2021. "The Effects of Dry-Land Strength Training on Competitive Sprinter Swimmers." *Journal of Exercise Science & Fitness* 19(1):32–39. doi: 10.1016/j.jesf.2020.06.005.

Loturco, Irineu. 2023. "Plyometric Training Practices of Brazilian Olympic Sprint and Jump Coaches : Toward a Deeper Understanding of Their Choices and Insights By." 88(July):131–50. doi: 10.5114/jhk/168792.

Margolis, Lee M., and Stefan M. Pasiakos. 2013. "Optimizing Intramuscular Adaptations to Aerobic Exercise: Effects of Carbohydrate Restriction and Protein Supplementation on Mitochondrial Biogenesis." *Advances in Nutrition* 4(6):657–64. doi: 10.3945/an.113.004572.

Marques, Mário C. et al. 2020. "In-Season Strength Training in Elite Junior Swimmers: The Role of the Low-Volume, High-Velocity Training on Swimming Performance." *Journal of Human Kinetics* 74(1):71–84. doi: 10.2478/hukin-2020-0015.

Matthews, Martyn J. et al. 2017. "The Effects of Swimming Fatigue on Shoulder Strength, Range of Motion, Joint Control, and Performance in Swimmers." *Physical Therapy in Sport* 23:118–22. doi: 10.1016/j.ptsp.2016.08.011.

McArdle, William D. et al. 2011. *Essentials of Exercise Physiology*. 4th Editio. Philadelphia: Lippincott Williams & Wilkins.

McDougall, Craig W. et al. 2022. "Freshwater Wild Swimming, Health and Well-Being: Understanding the Importance of Place and Risk." *Sustainability (Switzerland)* 14(10):1–17. doi: 10.3390/su14106364.

McGibbon, Katie E. et al. 2018. "Pacing in Swimming: A Systematic Review."

Sports Medicine 48(7):1621–33. doi: 10.1007/s40279-018-0901-9.

McHenry, Patrick., and Mike. Nitka. 2021. *NSCA's Guide to High School Strength and Conditioning*. Champaign, IL: Human Kinetics.

McLeod, I. A. 2010. *Swimming Anatomy*. Champaign, IL: Human Kinetics.

Miguel-Ortega, Álvaro et al. 2024. "Endurance in Long-Distance Swimming and the Use of Nutritional Aids." *Nutrients* 16(22):3949. doi: 10.3390/nu16223949.

Milhem, Wajdi et al. 2014. "Training Strategies, Theories and Types." *J. Accounting, Bus. Manag.* 21(1):12–26.

Mohamady, Ahmed El, and El Kady. 2012. "Effect of Basic Endurance Training on the Level of Maximum Oxygen Consumption and the Recorded Achievement for Junior Swimmers 400m Freestyle Stroke." *World Journal of Sport Sciences* 6(1):21–25. doi: 10.5829/idosi.wjss.2012.6.1.1105.

Montgomery, J. P., & Chambers, M. A. 2008. *Mastering Swimming*. Champaign, IL: Human Kinetics.

Morais, Jorge E. et al. 2019. "Stability of Pace and Turn Parameters of Elite Long-Distance Swimmers." *Human Movement Science* 63(September 2018):108–19. doi: 10.1016/j.humov.2018.11.013.

Morouço, Pedro G. et al. 2012. "Effects of Dry-Land Strength Training on Swimming Performance: A Brief Review." *Journal of Human Sport and Exercise* 7(2):553–59. doi: 10.4100/jhse.2012.72.18.

Mujika, Iñigo and Crowley, Emmet. 2019. "Strength Training for Swimmers." Pp. 369–82 in *Concurrent Aerobic and Strength Training*, edited by M. Schumann and B. R. Rønnestad. Switzerland: Springer International Publishing.

Mullen, G. John. 2018. *Swimming Science : Optimizing Training and Performance*. Chicago : The University of Chicago Press.

N. Travis Triplett. 2011. "Bioenergetics." Pp. 29–40 in *NSCA's Essentials of Personal Training [2 ed.]*, edited by Jared W. Coburn and Moh H. Malek. Champaign, IL: Human Kinetics.

Naczk, Mariusz et al. 2017. "Influence of Short-Term Inertial Training on Swimming Performance in Young Swimmers." *European Journal of Sport Science*

17(4):369–77. doi: 10.1080/17461391.2016.1241304.

Neuloh, Joshua E. et al. 2020. "Analysis of End-Spurt Behaviour in Elite 800-m and 1500-m Freestyle Swimming." *European Journal of Sport Science* 0(0):0–1. doi: 10.1080/17461391.2020.1851772.

Nicol, Emily et al. 2018. "The Characteristics of an Elite Swimming Turn." *36th Conference of the International Society of Biomechanics in Sports* (October):869–72.

Nicol, Emily et al. 2021. "The Biomechanics of Freestyle and Butterfly Turn Technique in Elite Swimmers." *Sports Biomechanics* 20(4):444–57. doi: 10.1080/14763141.2018.1561930.

Ozmun, J. C., Mikesky, A. E., & Surburg, P. R. 1994. "Neuromuscular Adaptations Following Prepubescent Strength Training." *Medicine & Science in Sports & Exercise* 26(4):510???514. doi: 10.1249/00005768-199404000-00017.

Palar, C. M., Wongkar, D., & Ticoalu, S. H. 2015. "Manfaat Latihan Olahraga Aerobik Terhadap Kebugaran Fisik Manusia Fakultas Kedokteran Universitas Sam Ratulangi Manado." *Jurnal E-Biomedik (EBm)* 3(1):316–21.

Patel, Namrata N. 2014. "Plyometric Training : A Review Article." *International Journal of Current Research and Review* 6(15):33–37.

Pickett, Craig W. et al. 2018. "Maximal Upper-Body Strength and Oxygen Uptake Are Associated With Performance in High-Level 200-m Sprint Kayakers." *Journal of Strength and Conditioning Research* 32(11):3186–92. doi: 10.1519/JSC.0000000000002398.

Pomatahu, Aisah R. 2019. "The Effect of Hollow Sprint and Sprint Training on Long Jump Skills." *Sport Scientifis And Practical Aspects* 16(2):29–37.

Potach, David H., and Chu, Donald A. 2008. "Plyometric Training." Pp. 413–56 in *Essentials of strength training and conditioning*, edited by R. W. (Eds. . Baechle, T. R., & Earle. Champaign, IL: Human Kinetics.

Potdevin, François J. et al. 2011. "Effects of a 6-Week Plyometric Training Program on Performances in Pubescent Swimmers." *Journal of Strength and Conditioning Research* 25(1):80–86. doi: 10.1519/JSC.0b013e3181fef720.

Potdevin, François J et al. 2011. “Effects of a 6-Week Plyometric Training Program on Performances in Pubescent Swimmers.” *Journal of Strength and Conditioning Research* 25(1):80–86. doi: 10.1519/JSC.0b013e3181fef720.

Powers, Scott K., and Edward T. Howley. 2021. *Exercise Physiology : Theory and Application to Fitness and Performance Exercise Metabolism*. United States of America: McGraw Hill LLC.

Pribadi, Agus, and Bimo Alexander. 2022. “Pengaruh Fartlek Training Pada Peningkatan Daya Tahan Aerobik Dan Anaerobik Atlit Hoki Ruangan Kota Jogja.” 1(1):1–7. doi: 10.31316/ijst.v1i1.4179.

Price, Todd et al. 2024. “Physical Performance Determinants in Competitive Youth Swimmers: A Systematic Review.” *BMC Sports Science, Medicine and Rehabilitation* 16(1):1–19. doi: 10.1186/s13102-023-00767-4.

Pyne, David B., and Rick L. Sharp. 2014. “Physical and Energy Requirements of Competitive Swimming Events.” *International Journal of Sport Nutrition and Exercise Metabolism* 24(4):351–59. doi: 10.1123/ijsnem.2014-0047.

Ramírez, María. 2022. “Effects of Plyometric Training on Lower Body Muscle Architecture , Tendon Structure , Stiffness and Physical Performance : A Systematic Review and Meta - Analysis.” doi: 10.1186/s40798-022-00431-0.

Ratamess, N. 2012. *ACSM’s Foundations of Strength Training and Conditioning*. Michigan: Lippincott Williams & Wilkins.

Reichmuth, Daniela et al. 2021. “Key Performance Indicators Related to Strength, Endurance, Flexibility, Anthropometrics, and Swimming Performance for Competitive Aquatic Lifesaving.” *International Journal of Environmental Research and Public Health* 18(7). doi: 10.3390/ijerph18073454.

Reuter, B. 2012. *Developing Endurance*. Champaign, IL: Human Kinetics.

Richard Blagrove. 2015. *Strength and Conditioning for Endurance Running*. Ramsbury, Marlborough: The Crowood Press.

Richardson, Allen B., and James W. Miller. 1991. “Swimming and the Older Athlete.” *Clinics in Sports Medicine* 10(2):301–18.

Riewald, Scott. 2015. “Strength and Conditioning for Performance Enhancement.”

in *Science of Swimming Faster*, edited by S. Riewald and S. Rodeo. Champaign, IL: Human Kinetics.

Rivera-Brown, Anita M., and Walter R. Frontera. 2012. "Principles of Exercise Physiology: Responses to Acute Exercise and Long-term Adaptations to Training." *PM&R* 4(11):797–804. doi: 10.1016/j.pmrj.2012.10.007.

Rodríguez, Ferran A., and Alois Mader. 2011. "Energy Systems in Swimming." *World Book of Swimming: From Science to Performance* (May):225–40. doi: 10.13140/2.1.3260.5128.

Rodríguez González, L. et al. 2022. "Study of Strength Training on Swimming Performance. A Systematic Review." *Science & Sports* (October). doi: 10.1016/j.scispo.2022.09.002.

Sadowski, Jerzy et al. 2012. "Effectiveness of the Power Dry-Land Training Programmes in Youth Swimmers." *Journal of Human Kinetics* 32(1):77–86. doi: 10.2478/v10078-012-0025-5.

Sammoud, Senda et al. 2021. "The Effects of Plyometric Jump Training on Jump and Sport-Specific Performances in Prepubertal Female Swimmers." *Journal of Exercise Science and Fitness* 19(1):25–31. doi: 10.1016/j.jesf.2020.07.003.

Sanders, Ross H. &. Carla B. McCabe. 2015. "Freestyle Technique." in *Science of Swimming Faster*, edited by S. Riewald and S. Rodeo. Champaign, IL: Human Kinetics.

Sands, W. A., Wurth, J. J., & Hewit, J. K. 2012. *Basics of Strength and Conditioning Manual*. Colorado Springs, CO: National Strength and Conditioning Association.

Sawdon-Bea, Jenna, and Jessica Benson. 2015. "The Effects of a 6-Week Dry Land Exercise Program for High School Swimmers." *Journal of Physical Education and Sports Management* 2(1):1–17. doi: 10.15640/jpesm.v2n1a1.

Schiffer, Jürgen. 2012. "Plyometric Training and the High Jump." *New Studies in Athletics* (3):9–21.

Schoenfeld, Brad Jon et al. 2019. "How Many Times per Week Should a Muscle Be Trained to Maximize Muscle Hypertrophy? A Systematic Review and Meta-

Analysis of Studies Examining the Effects of Resistance Training Frequency." *Journal of Sports Sciences* 37(11):1286–95. doi: 10.1080/02640414.2018.1555906.

Seiler, Stephen. 2010. "What Is Best Practice for Training Intensity and Duration Distribution in Endurance Athletes?" *International Journal of Sports Physiology and Performance* 5(3):276–91. doi: 10.1123/ijspp.5.3.276.

Silva Oliveira, Pedro et al. 2024. "Comparison of Polarized Versus Other Types of Endurance Training Intensity Distribution on Athletes' Endurance Performance: A Systematic Review with Meta-Analysis." *Sports Medicine* 54(8):2071–95. doi: 10.1007/s40279-024-02034-z.

Sin, Tjung Hauw, and Fakhrina Hudayani. 2020. "The Influence of Swimming Learning Method Using Swimming Board towards Students' Interest in Freestyle." *Jurnal Keolahragaan* 8(2):216–21. doi: 10.21831/jk.v8i2.34412.

Slimani, Maamer et al. 2016. "Effects of Plyometric Training on Physical Fitness in Team Sport Athletes: A Systematic Review." *Journal of Human Kinetics* 53(1):231–47. doi: 10.1515/hukin-2016-0026.

Smith, Denise. 2017. "Cardiopulmonary and Endocrine Responses and Adaptations to Exercise." in *NSCA ' s Essentials of Tactical Strength and Conditioning*, edited by B. A. Alvar and D. Rscc. Champaign, IL: Human Kinetics.

Snell, Peter G. et al. 2007. "Maximal Oxygen Uptake as a Parametric Measure of Cardiorespiratory Capacity." *Medicine and Science in Sports and Exercise* 39(1):103–7. doi: 10.1249/01.mss.0000241641.75101.64.

Sole, Christopher J. 2018. "Plyometric Training." in *Advanced strength and conditioning: an evidence-based approach*, edited by P. Turner, A., & Comfort. New York: Routledge.

Stan, Amelia Elena. 2012. "The Benefits of Participation in Aquatic Activities for People with Disabilities." *Sports Medicine Journal / Medicina SportivÃ¢* 8(1):1737–42.

Stone, Michael H. et al. 2022. "Training Specificity for Athletes: Emphasis on Strength-Power Training: A Narrative Review." *Journal of Functional*

Morphology and Kinesiology 7(4):102. doi: 10.3390/jfmk7040102.

Susanti, Rini et al. 2021. "Latihan Pliometrik Dalam Meningkatkan Komponen Fisik : A Systematic Review." 6:156–71.

Sweetenham, Bill, and John Atkinson. 2003. *Championship Swim Training*. Champaign, IL: Human Kinetics.

Taormina, S. 2014. *Wim Speed Strokes for Swimmers and Triathletes: Master Freestyle, Butterfly, Breaststroke and Backstroke for Your Fastest Swimming (Swim Speed Series).* United States of America: VeloPress.

Tovin, B. J. 2006. "The Prevention and Treatment of Swimmer's Shoulder." *North American Journal of Sports Physical Therapy: NAJSPT* 1(4):166–175.

Turner, Anthony, and Paul Comfort. 2022. *Advanced Strength and Conditioning: An Evidence-Based Approach*. New York: Routledge.

Vasile, Luciela. 2014. "Endurance Training in Performance Swimming." *Procedia - Social and Behavioral Sciences* 117:232–37. doi: 10.1016/j.sbspro.2014.02.206.

Vingren, Jakob L. et al. 2010. "Testosterone Physiology in Resistance Exercise and Training." *Sports Medicine* 40(12):1037–53. doi: 10.2165/11536910-000000000-00000.

Wądrzyk, Łukasz et al. 2022. "Evaluating the Usefulness of the Modified Swimming Anaerobic Sprint Test (SAST) Based on the Relationship with the 100- and 200-m Freestyle." *Applied Sciences (Switzerland)* 12(15). doi: 10.3390/app12157566.

Wee, E, H. et al. 2011. "Effects of a 4-Week Plyometric Training on the Jumping Performance of Basketball Players." *Malaysian Journal of Sport Science and Recreation* 7(1):64–82.

Weston, Matthew et al. 2015. "Isolated Core Training Improves Sprint Performance in National-Level Junior Swimmers." *International Journal of Sports Physiology and Performance* 10(2):204–10. doi: 10.1123/ijspp.2013-0488.

White, Gregory. 2006. *The Physiology of Training. Advances in Sport and Exercise Science Series*. Buckinghamshire: Elsevier Limited.

Wirth, Klaus et al. 2022. “Strength Training in Swimming.” *International Journal of Environmental Research and Public Health* 19(9). doi: 10.3390/ijerph19095369.

Wyon, M., & Allard, G. 2022. *Periodization: A Framework for Dance Training*. London: Bloomsbury Academic.

Yang, V. H. et. al. 2012. “Plyometric and Speed Training.” in *NSCA’S Essentials of Personal Training*, edited by M. H. Coburn, J. W., & Malek. Champaign, IL: Human Kinetics.

Zatsiorsky, Vladimir M. 2021. *Science and Practice of Strength Training*. Champaign, IL: Human Kinetics.