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# REAKTIVKRAFTTRAINING IM NACHWUCHSLEISTUNGSSPORT

## Trainingspraktische Empfehlungen für den langfristigen Leistungsaufbau im Handball

### Literatur

- American College of Sports Medicine. (2016). Plyometric training for children and adolescents. Zugriff unter <https://www.acsm.org/docs/current-comments/plyometrictraining.pdf>.
- Asadi, A., Arazi, H., Young, W. B. & Sáez de Villarreal, E. (2016). The effects of plyometric training on change-of-direction ability: a meta-analysis. *International Journal of Sports Physiology and Performance*, 11, 563-573 (doi:10.1123/ijspp.2015-0694).
- Bedoya, A. A., Miltenberger, M. R. & Lopez, R. M. (2015). Plyometric training effects on athletic performance in youth soccer athletes: A systematic review. *Journal of Strength and Conditioning Research*, 29 (8), 2351-2360 (doi:10.1519/JSC.0000000000000877).
- Behm, D. G. & Anderson, K. G. (2006). The role of instability with resistance training. *Journal of Strength and Conditioning Research*, 20 (3), 716-722.
- Behm, D. G. & Colado Sanchez, J. C. (2013). Instability resistance training across the exercise continuum. *Sports Health: A Multidisciplinary Approach*, 5 (6), 500-503 (doi:10.1177/1941738113477815).
- Behm, D. G., Drinkwater, E. J., Willardson, J. M. & Cowley, P. M. (2010). The use of instability to train the core musculature. *Applied Physiology, Nutrition and Metabolism*, 35, 91-108.
- Behm, D. G., Faigenbaum, A. D., Falk, B. & Klentrou, P. (2008). Canadian Society for Exercise Physiology position paper: resistance training in children and adolescents. *Applied Physiology, Nutrition and Metabolism*, 33, 547-561.
- Behrens, M., Mau-Moeller, A., Mueller, K., Heise, S., Gube, M. et al. (2016). Plyometric training improves voluntary activation and strength during isometric, concentric and eccentric contractions. *Journal of Science and Medicine in Sport*, 19 (2), 170-176 (doi:http://dx.doi.org/10.1016/j.jsams.2015.01.011).
- Bompa, T. O. & Buzzichelli, C. A. (2015). *Periodization: Training for Sports* (3rd ed.). Champaign: Human Kinetics.
- Bompa, T. O. & Carrera, M. (2015). *Conditioning Young Athletes*. Champaign: Human Kinetics.
- Booth, M. A. & Orr, R. (2016). Effects of plyometric training on sports performance. *Strength and Conditioning Journal*, 38 (1), 30-37 (doi:10.1519/SSC.000000000000183).
- Bruhn, S., Kullmann, N. & Gollhofer, A. (2004). The effects of a sensorimotor training and a strength training on postural stabilisation, maximum isometric contraction and jump performance. *International Journal of Sports Medicine*, 25, 56-60.
- Bruhn, S., Kullmann, N. & Gollhofer, A. (2006). Combinatory effects of high-intensity-strength training and sensorimotor training on muscle strength. *International Journal of Sports Medicine*, 27, 401-406.
- Büsch, D., Marschall, F. & Granacher, U. (2016). Intensitätsorientiertes Reaktivkrafttraining im Nachwuchsbereich (in Vorbereitung). *Handballtraining*.
- Büsch, D., Pabst, J., Muehlbauer, T., Ehrhardt, P. & Granacher, U. (2015). Effekte plyometrischen Trainings unter Verwendung instabiler Untergründe auf sportmotorische Sprung- und Schnelligkeitsleistungen von Nachwuchsleistungshandballern. *Sports Orthopaedics and Traumatology*, 31, 299-308 (doi:10.1016/j.orthtr.2015.07.007).
- Carter, A. B., Kaminski, T. W., Douex Jr., A. T., Knight, C. A. & Richards, J. G. (2007). Effects of high volume upper extremity plyometric training on throwing velocity and functional strength ratios of the shoulder rotators in collegiate baseball players. *Journal of Strength and Conditioning Research*, 21 (1), 208-215.
- Chaouachi, A., Hammami, R., Kaabi, S., Chamari, K., Drinkwater, E. J. & Behm, D. G. (2014). Olympic weightlifting and plyometric training with children provides similar or greater performance improvements than traditional resistance training. *Journal of Strength and Conditioning Research*, 28 (6), 1483-1496 (doi:10.1519/JSC.0000000000000305).
- Chaouachi, A., Othman, A. B., Hammami, R., Drinkwater, E. & Behm, D. G. (2014). The combination of plyometric and balance training improves sprint and shuttle run performances more often than plyometric-only training with children. *Journal of Strength and Conditioning Research*, 28 (2), 401-412 (doi:10.1519/JSC.0b013e3182987059).
- Chelly, M. S., Hermassi, S., Aouadi, R. & Shephard, R. J. (2014). Effects of 8-week in-season plyometric training on upper and lower limb performance of elite adolescent handball players. *Journal of Strength and Conditioning Research*, 28 (5), 1401-1410 (doi:10.1519/JSC.0000000000000279).
- Chmielewski, T. L., Myer, G. D., Kauffman, D. & Tillman, S. M. (2006). Plyometric exercise in the rehabilitation of athletes: physiological responses and clinical application. *Journal of Orthopaedic & Sports Physical Therapy*, 36 (5), 308-319.
- Fort-Vanmeerhaeghe, A., Romero-Rodriguez, D., Lloyd, R. S., Kushner, A. & Myer, G. D. (2016). Integrative neuromuscular training in youth athletes. Part II: strategies to prevent injuries and improve performance. *Strength & Conditioning Journal*, 38 (4), 9-27.
- Freiwald, J., Baumgart, C., Hoppe, M. W., Slomka, M., Brexendorf, B., Partenheimer, A. & Blume, R. (2013). Return to Sport nach Verletzungen im Hochleistungsfußball – was ist dazu notwendig? *Sport-Orthopädie – Sport-Traumatologie – Sports Orthopaedics and Traumatology*, 29 (1), 4-12 (doi:http://dx.doi.org/10.1016/j.orthtr.2013.02.039).
- Gollhofer, A. & Bruhn, S. (2003). The biomechanics of jumping. In J. C. Reeser & R. Bahr (Eds.), *Handbook of Sports Medicine and Science – Volleyball* (pp. 18-28). Malden (MA): Blackwell Science.
- Granacher, U. (2015). Gesundheit und Leistung. Die Bedeutung von Kraft und Gleichgewicht. In A. Arampatzis, S. Bohm, R. Marzilger & F. Mersmann (Hrsg.), *Active Health: Bewegung ist gesund: Jahrestagung der dvs-Sektion Biomechanik vom 26.-28. März 2015 in Berlin* (S. 18-29). Hamburg: Feldhaus Verlag.
- Granacher, U., Lesinski, M., Büsch, D., Muehlbauer, T., Prieske, O. et al. (2016). Effects of resistance training in youth athletes on muscular fitness and athletic performance: A conceptual model for long-term athlete development. *Frontiers in Physiology*, 7, 164 (doi:10.3389/fphys.2016.00164).
- Granacher, U., Prieske, O., Majewski, M., Büsch, D. & Muehlbauer, T. (2015). The role of instability with plyometric training in sub-elite adolescent soccer players. *International Journal of Sports Medicine*, 36 (5), 386-394 (doi:10.1055/s-0034-1395519).
- Güllich, A. & Schmidtbleicher, D. (1999). Struktur der Kraftfähigkeiten und ihrer Trainingsmethoden [Structure of strength abilities and appropriate training programmes]. *Deutsche Zeitschrift für Sportmedizin*, 50 (7/8), 223-234.
- Hammami, R., Granacher, U., Makhlof, I., Behm, D. G. & Chaouachi, A. (2016). Sequencing effects of balance and plyometric training on physical performance in youth soccer athletes. *Journal of Strength and Conditioning Research* (online first; doi:10.1519/JSC.0000000000001425).
- Horn, A., Behringer, M., Beneke, R., Förster, H., Gruber, W. et al. (2012). Wissenschaftliche Standortbestimmung zum Krafttraining im Nachwuchsleistungssport. *Deutsche Zeitschrift für Sportmedizin*, 63 (2), 1-10.
- Hübscher, M., Zech, A., Pfeifer, K., Hänsel, F., Vogt, L. & Banzer, W. (2010). Neuromuscular training for sports injury prevention: a systematic review. *Medicine & Science in Sports & Exercise*, 42 (3), 413-421.
- Ignjatovic, A. M., Markovic, Z. M. & Radovanovic, D. S. (2012). Effects of 12-week medicine ball training on muscle strength and power in young female handball players. *Journal of Strength & Conditioning Research*, 26 (8), 2166-2173 (doi:10.1519/JSC.0b013e31823c477e).
- Ismail, M. M., Ibrahim, M. M., Youssef, E. F. & El Shorbagy, K. M. (2010). Plyometric training versus resistive exercises after acute lateral ankle sprain. *Foot & Ankle International*, 3 (6), 523-530 (doi:10.3113/FAI.2010.0523).
- Johnson, B. A., Salzberg, C. L. & Stevenson, D. A. (2011). A systematic review of plyometric training programs for young children. *Journal of Strength and Conditioning Research*, 25 (9), 2623-2633 (doi:10.1519/JSC.0b013e318204caa0).
- Khlifa, R., Aouadi, R., Hermassi, S., Chelly, M. S., Jlid, M. C. et al. (2010). Effects of a plyometric training program with and without added load on jumping ability in basketball players. *Journal of Strength and Conditioning Research*, 24 (11), 2955-2961.

- Komi, P. V. (2003). Stretch-shortening cycle. In P. V. Komi (Ed.), *Strength and Power in Sport* (2nd ed., pp. 184-202). Oxford: Blackwell Science.
- Kyröläinen, H., Avela, J., McBride, J. M., Koskinen, S., Andersen, J. L. et al. (2004). Effects of power training on mechanical efficiency in jumping. *European Journal of Applied Physiology*, 91, 155-159.
- Kyröläinen, H., Avela, J., McBride, J. M., Koskinen, S., Andersen, J. L. et al. (2005). Effects of power training on muscle structure and neuromuscular performance. *Scandinavian Journal of Medicine & Science in Sports*, 15 (1), 58-64 (doi:10.1111/j.1600-0838.2004.00390.x).
- Lephart, S. M., Abt, J. P., Ferris, C. M., Sell, T. C., Nagai, T. et al. (2005). Neuromuscular and biomechanical characteristic changes in high school athletes: a plyometric versus basic resistance program. *British Journal of Sports Medicine*, 39 (12), 932-938 (doi:10.1136/bjism.2005.019083).
- Lesinski, M., Prieske, O., Beurskens, R., Behm, D. G. & Granacher, U. (2016). Effects of drop height and surface instability on neuromuscular activation during drop jumps. *Scandinavian Journal of Medicine and Science in Sports* (online first; doi: 10.1111/sms.12732).
- Lesinski, M., Prieske, O. & Granacher, U. (2016). Effects and dose-response relationships of resistance training on physical performance in youth athletes: A systematic review and meta-analysis. *British Journal of Sports Medicine*, 50 (13), 781-795 (doi:10.1136/bjssports-2015-095497).
- Lloyd, R. S., Cronin, J. B., Faigenbaum, A. D., Haff, G. G., Ard, R. H. et al. (2016). National Strength And Conditioning Association position statement on long-term athletic development. *Journal of Strength and Conditioning Research*, 30 (6), 1491-1509 (doi:10.1519/JSC.0000000000001387).
- Lloyd, R. S. & Meyers, R. W. (2011). The natural development and trainability of plyometric ability during childhood. *Strength and Conditioning Journal*, 33 (2), 23-32.
- Lloyd, R. S., Oliver, J. L. & Meyers, R. W. (2011). The natural development and trainability of plyometric ability during childhood. *Strength & Conditioning Journal*, 33 (2), 23-32.
- Lloyd, R. S., Radnor, J. M., De Ste Croix, M. B. A., Cronin, J. B. & Oliver, J. L. (2016). Changes in sprint and jump performances after traditional, plyometric, and combined resistance training in male youth pre- and post-peak height velocity. *Journal of Strength & Conditioning Research*, 30 (5), 1239-1247 (doi:10.1519/jsc.0000000000001216).
- Makaruk, H., Winchester, J. B., Sadowski, J., Czaplicki, A. & Sacewicz, T. (2011). Effects of unilateral and bilateral plyometric training on power and jumping ability in women. *Journal of Strength and Conditioning Research*, 25 (12), 3311-3318 (doi:10.1519/JSC.0b013e318215fa33).
- Malisoux, L., Francaux, M., Nielens, H. & Theisen, D. (2006). Stretch-shortening cycle exercises: an effective training paradigm to enhance power output of human single muscle fibers. *Journal of Applied Physiology*, 100 (3), 771-779 (doi:10.1152/jappphysiol.01027.2005).
- Markovic, G. (2007). Does plyometric training improve vertical jump height? A meta-analytical review. *British Journal of Sports Medicine*, 41, 349-355.
- Markovic, G. & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. *Sports Medicine*, 40 (10), 859-895.
- Matavulj, D., Kukolj, M., Ugarkovic, D., Tihanyi, J. & Jaric, S. (2001). Effects of plyometric training on jumping performance in junior basketball players. *Journal of Sports Medicine and Physical Fitness*, 41 (2), 159-164.
- Olivier, N., Marschall, F. & Büsch, D. (2008). *Grundlagen der Trainingswissenschaft und -lehre*. Schorndorf: Hofmann-Verlag.
- Park, G. D., Lee, J. C. & Lee, J. (2014). The effect of low extremity plyometric training on back muscle power of high school throwing event athletes. *Journal of Physical Therapy Science*, 26 (1), 161-164 (doi:10.1589/jpts.26.161).
- Pezzullo, D. J., Karas, S. & Irrgang, J. J. (1995). Functional plyometric exercises for the throwing athlete. *Journal of Athletic Training*, 30 (1), 22-26.
- Roberts, T. J. (2016). Contribution of elastic tissues to the mechanics and energetics of muscle function during movement. *Journal of Experimental Biology*, 219 (2), 266-275 (doi:10.1242/jeb.124446).
- Sáez de Villarreal, E., Kellis, E., Kraemer, W. J. & Izquierdo, M. (2009). Determining variables of plyometric training for improving vertical jump height performance: a meta-analysis. *Journal of Strength and Conditioning Research*, 23 (2), 495-506 (doi:10.1519/JSC.0b013e318196b7c6).
- Sáez de Villarreal, E., Requena, B. & Newton, R. U. (2010). Does plyometric training improve strength performance? A meta-analysis. *Journal of Science and Medicine in Sport*, 13 (5), 513-522 (doi:10.1016/j.jsams.2009.08.005).
- Schmidtbleicher, D. (1992). Training for Power Events. In P. V. Komi (Ed.), *Strength and Power in Sport* (pp. 381-395). Oxford: Blackwell Scientific Publications.
- Schulte-Edelmann, J. A., Davies, G. J., Kernozek, T. W. & Gerberding, E. D. (2005). The effects of plyometric training of the posterior shoulder and elbow. *Journal of Strength & Conditioning Research*, 19 (1), 129-134.
- Seil, R., Nürnberger, C., Lion, A., Gerich, T., Hoffmann, A. & Pape, D. (2016). Knieverletzungen im Handball. *Sport-Orthopädie - Sport-Traumatologie - Sports Orthopaedics and Traumatology*, 32 (2), 154-164 (doi:10.1016/j.orthtr.2016.03.001).
- Sheppard, J. M. & Young, W. B. (2006). Agility literature review: Classifications, training and testing. *Journal of Sports Sciences*, 24 (9), 919-932.
- Sperlich, P. F., Behringer, M. & Mester, J. (2015). The effects of resistance training interventions on vertical jump performance in basketball players: a meta-analysis. *Journal of Sports Medicine and Physical Fitness* (online first).
- van den Tillaar, R., Waade, L. & Roaas, T. (2015). Comparison of the effects of 6 weeks of squat training with a plyometric training programme upon different physical performance tests in adolescent team handball players. *Acta Kinesiologiae Universitatis Tartuensis*, 21, 75-88 (doi:10.12697/akut.2015.21.07).
- Van Lieshout, K. G., Anderson, J. G., Shelburne, K. B. & Davidson, B. S. (2014). Intensity rankings of plyometric exercises using joint power absorption. *Clinical Biomechanics*, 29 (8), 918-922 (doi:http://dx.doi.org/10.1016/j.clinbiomech.2014.06.015).
- Vossen, J. F., Kramer, J. F., Burke, D. G. & Vossen, D. P. (2000). Comparison of dynamic push-up training and plyometric push-up training on upper-body power and strength. *Journal of Strength and Conditioning Research*, 14 (3), 248-253.

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