

Should Female Gymnasts Lift Weights?

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Gymnastics coaches and administrators in the US are reluctant to include weight training with female gymnasts because they believe it produces detrimental increases in muscle mass. However, weight training based on high-intensity low-repetition sets is likely to improve the performance of most gymnasts by increasing strength with minimal muscle hypertrophy.

KEYWORDS: gymnastics, weight training, hypertrophy, body size, strength

Gymnasts must remain on the lean side of lean to be effective competitors at the highest level (Nelson et al., 1983; Sands et al., 1992, 1995). Not surprisingly, concern about excess body weight is common in gymnastics (Anorexia/Bulimia Association, 1994; American College of Sports Medicine, 1997; Leglise, 1998; Nattiv & Lynch, 1994). Female gymnasts and their coaches in the US are therefore reluctant to use weight training, in spite of abundant evidence of the benefits of weight training for sports requiring strength. Their concern is that the gymnast will develop excessive body and muscle mass ("bulk up") and thus become too heavy to perform effectively.

Gymnasts and other athletes who must move their body weight as the primary resistance need to train for strength relative to body mass rather than absolute strength (Poliquin, 1991; Sands, Mikesky, & Edwards, 1991). As the gymnast matures, she is likely to gain absolute strength but lose relative strength as her body mass increases (Sands et al., 1991; Irvin et al., 1992; Zatsiorsky, 1995). Female gymnasts can increase reliance on motor skills to compensate for a decline in relative strength (Poliquin, 1991; Zatsiorsky, 1995), but strength training aimed at increasing relative strength is another important approach.

While some gymnastics coaches are reluctant to prescribe weight training, most include strength training in the form of repetitions of strength-oriented gymnastics skills (Howard & Evans, 1990; Hullner, 1989; Menkhin, 1978; Sands, 1990; Sands et al., 1995; Sands & McNeal, 1997; Singh et al., 1987). Many gymnastics skills have a large strength component, so separating the skill performance from strength training is somewhat arbitrary (Chu, 1994; George, 1980; Hullner, 1989). All gymnastics coaches would agree that development of strength through repetition of gymnastics skills is appropriate. However, skills at the elite level are becoming ever more difficult, and extra time for training is at a premium. Weight training would be orthopedically less demanding than extra skill repetitions and require less time for these gymnasts. In this article we will describe weight training that can develop

strength with minimal hypertrophy, and we will address coaches' concerns about the effects of weight training on muscle size and body build.

Training for Maximal and Minimal Hypertrophy

Training prescribed to encourage muscle hypertrophy usually involves large numbers of sets of repetitions with light to medium loads, movement speeds from rapid to slow, repetitions to maximum effort, and short rest periods (e.g., Bloomer & Ives, 2000; Hatfield, 1984; Poliquin, 1991; Schmidtbleicher, 1992). In contrast, prescriptions for maximizing strength and minimizing hypertrophy usually involve heavier loads, smaller numbers of repetitions, and longer periods of rest. Table 1 shows Poliquin's guidelines for the two extremes of training.

	Maximal hypertrophy	Minimal hypertrophy
Intensity (% 1-RM)	60-80	85-100
Repetitions	6-20	1-5
Sets	3-6	5-12
Rest between sets (min)	2-4	4-5
Concentric tempo (seconds per rep)	1-10	1-4
Eccentric tempo (seconds per rep)	4-10	3-5
Total set duration (seconds)	40-70	<20
Exercises per workout	6-12	1-4

The guidelines in Table 1 are not a guarantee for developing or avoiding hypertrophy. Individual responses in the degree of hypertrophy appear to be related to an individual's sex, maturity, distribution of fiber types, somatotype, initial training status, duration of training, and intensity of training (Beunen & Malina, 1996; Blinkie & Bar-Or, 1996; Blimki & Sale, 1998; Goldspink, 1992; Hakkinen & Pakarinen, 1995; MacDougall, 1992; Moritani, 1992; Tittel & Wutscherk, 1992; Zauner et al., 1989). Periodization (the timing and sequencing of training) may also be an important determinant of the development of strength and hypertrophy. There are numerous types of periodization (e.g., Baker et al., 1994; Bompa, 1993; Fleck & Kraemer, 1987; Koch, 1994), but little research has been performed to determine their influence on hypertrophy. Not all gymnastics coaches use periodization, and there is no agreement on the kind of periodization that results in maximal strength and minimal hypertrophy.

Strength Training for Gymnasts

In our long experience of gymnastics, gymnasts do not and cannot follow the guidelines for minimizing hypertrophy in Table 1 by using body weight as the only resistance. The typical elite female gymnast can perform far more than 1-5 repetitions of gymnastic-specific skills. For example, in physical-ability field tests prior to the Sydney Olympics, the US senior national team produced the following maximum numbers of repetitions: handstand push ups, 13 ± 8 (mean \pm standard deviation); press handstands, 7 ± 4 ; and cast handstands, 10 ± 5 (unpublished data, WA Sands, 2000). Paradoxically, these results show that typical gymnastics strength training consisting of repetitions of skills is more likely to maximize hypertrophy than relative strength.

Training with added weights is the only practical way to bring the repetitions-maximum into the range for minimizing hypertrophy. Zatsiorsky recommended "training with the greatest weights possible, with a small number of repetitions and large intervals of rest between sets" (quoted by Trifonov & Yessis, 1986, p 44).

Zatsiorsky's ideas are entirely consistent with Poliquin's guidelines for minimizing hypertrophy.

An increase in maximal strength "is always connected with an improvement of relative strength and therefore with improvement of power abilities" (Schmidtbleicher, 1992, p 384). Strength gained by any means should therefore be beneficial, as long as the strength conforms to gymnastic-specific movements. However, strength training of irrelevant muscles and movements may add size and weight to a gymnast without benefiting performance. Unfortunately, gymnastics weight training programs have often reflected a body-building approach, by incorporating too many exercises involving muscles and movements that are scarcely involved in gymnastics skills (Pearl, 1986). Gymnastics-relevant lifts and exercises may be reduced to only four: squats, presses, pull downs, and deadlifts. Two common exercise variations that can be included are a front raise and straight-arm pull down. Weight-training programs that follow the guidelines of Poliquin for maximizing relative strength are available for gymnasts (Plotkin et al., 1989; Sands & McNeal, 1997).

Effects of Weight Training on Body Build

The literature on weight training and gymnastics includes conditioning programs and case studies (Chu, 1994; James, 1987; Colombo, 1999; Marina and Rodriguez, 1999; Pearl, 1986; Plotkin et al., 1989; Sands et al., 1997; Trifonov & Yessis, 1986), but there are no reports on the effects of weight training on body build. Anthropometry on gymnasts during preparation camps prior to the Sydney Olympics indicates that weight training does not cause gymnasts to bulk up (unpublished data, WA Sands, 2000). The gymnasts were 33 US national team members, 14 of whom weight trained for two or more sessions per week. In spite of being older (18.1 ± 2.0 vs 16.5 ± 1.0 y), these gymnasts were lighter (48.0 ± 5.4 vs 52.1 ± 5.9 kg), had a lower body mass index (20.3 ± 1.9 vs 21.7 ± 1.9), and were slightly shorter (153.5 ± 4.0 vs 154.9 ± 4.3 cm) than the members of the team who did not weight train. More detailed anthropometry on these gymnasts was not permitted, owing to concerns about body fat and the potential for triggering eating disorders (Nattiv et al., 1994; Nattiv & Mandelbaum, 1993; Noden, 1994; Rosen & Hough, 1988; Wilmore, 1996).

Effects of Weight Training on Adolescent Growth

A major concern of gymnastics coaches is that weight training will magnify the increases in muscle and body mass that occur during the adolescent growth spurt. Unfortunately research has not provided clear answers to the link between growth and training-related size increases (Blimkie & Sale, 1998), and coaches can rarely determine if an increase in rate of change of size, mass, or shape is due to training or maturation. Attribution of normal growth to the effects of weight training may have led to the concerns about the effects of weight training on body build.

Conclusion

Coaching folklore condemning weight training for gymnasts is probably misguided. Weight-training workouts that develop strength with minimal muscle hypertrophy are likely to enhance the performance of female gymnasts. The current skill-repetition approach to developing strength in female gymnasts may cause more hypertrophy than a well-designed program of weight training in the short term, but the relative effect of these forms of training on muscle growth during maturation is unknown.

References

American College of Sports Medicine (1997). The female athlete triad. *Medicine and Science in Sports and Exercise* 29(5), i-ix

- Antonio J (2000). Nonuniform response of skeletal muscle to heavy resistance training: can bodybuilders induce regional muscle hypertrophy? *Journal of Strength and Conditioning Research* 14, 102-113
- Baker D, Wilson G, Carlyon R (1994). Periodization: The effect on strength of manipulating volume and intensity. *Journal of Strength and Conditioning Research* 8, 235-242
- Beunen G, Malina R M (1996). Growth and biological maturation: Relevance to athletic performance. In O Bar-Or (Ed), *The child and adolescent athlete* (pp 3-24). Oxford, England: Blackwell
- Blimkie, CJR, Bar-Or, O (1996). Trainability of muscle strength, power and endurance during childhood. In O Bar-Or (Ed), *The child and adolescent athlete* (pp 113-129). Oxford, England: Blackwell
- Blimkie CJR, Sale DG (1998). Strength development and trainability during childhood. In E Van Praagh (Ed), *Pediatric anaerobic performance* (pp 193-224). Champaign, IL: Human Kinetics
- Bloomer RJ, Ives JC (2000). Varying neural and hypertrophic influences in a strength program. *Strength and Conditioning Journal* 22(2), 30-35
- Bompa TO (1993). *Periodization of Strength*. Toronto, Ontario, Canada: Veritas Publishing
- Chu DA (1994). Strength exercises specific to gymnastics: a case study. *Journal of Strength and Conditioning Research* 8, 95-102
- Claessens AL, Lefevre J, Beunen G, Malina RM (1999). The contribution of anthropometric characteristics to performance scores in elite female gymnasts. *Journal of Sports Medicine and Physical Fitness* 39, 355-360
- Colombo C (1999). Entraînement de la force chez l'enfant et l'adolescent. *Gym' Technic* 26, 8-10
- Edgerton VR (1976). Neuromuscular adaptation to power and endurance work. *Canadian Journal of Applied Sport Sciences* 1, 49-58
- Edgerton VR, Roy RR (1991). Regulation of skeletal muscle fiber size, shape and function. *Journal of Biomechanics* 24 (Suppl 1), 123-133
- Fleck SJ, Kraemer WJ (1987). *Designing resistance training programs*. Champaign, IL: Human Kinetics
- George GS (1980). *Biomechanics of women's gymnastics* (1st Ed). Englewood Cliffs, NJ: Prentice-Hall
- Goldspink G (1992). Cellular and molecular aspects of adaptation in skeletal muscle. In PV Komi (Ed), *Strength and power in sport* (pp 211-229). Oxford, England: Blackwell
- Hakkinen K, Alen M, Komi PV (1984). Neuromuscular, anaerobic, and aerobic performance characteristics of elite power athletes. *European Journal of Applied Physiology* 53, 97-105
- Hakkinen K, Pakarinen A (1995). Acute hormonal responses to heavy resistance exercise in men and women at different ages. *International Journal of Sports Medicine* 16, 507-513
- Hatfield FC (1984). *Body building a scientific approach*. Chicago, IL: Contemporary
- Hedrick A (1995). Training for hypertrophy. *National Strength and Conditioning Association Journal* 17(3), 22-29
- Higbie EJ, Cureton KJ, Warren GL, Prior BM (1996). Effects of concentric and eccentric training on muscle strength, cross-sectional area, and neural activation. *Journal of Applied Physiology* 81, 2173-2181

- Howard J, Evans S (1990). The Stalder press: a kinesiological study with recommended performance enhancement techniques. *National Strength and Conditioning Association Journal* 12(4), 6-12
- Hullner P (1989). Development of the conditioning factors in elite gymnastics. Indianapolis, IN: USGF Publications
- Irvin R, Major J, Sands WA (1992). Lower body and torso strength norms for elite female gymnasts. In JL McNitt-Gray, R Girandola, J Callaghan (Ed), 1992 USGF Sport Science Congress Proceedings (pp 5-12). Indianapolis, IN: USGF Publications
- James S (1987). Periodization of weight training for women's gymnastics. *National Strength and Conditioning Association Journal* 9(1), 28-31
- Koch F (1994). Strength training for sports. Oxnard, CA: Applied Futuristics
- Komi PV (1986). Training of muscle strength and power: Interaction of neuromotoric, hypertrophic, and mechanical factors. *International Journal of Sports Medicine* 7 (Suppl), 10-15
- Leglise M (1998). Limits on young gymnasts. *Technique* 18(4), 8-14
- MacDougall DJ (1992). Hypertrophy or hyperplasia. In PV Komi (Ed), *Strength and power in sport* (pp 230-238). Oxford, England: Blackwell
- Marina M, Rodriguez FA (1999). Effect of specific training on the muscular strength and power of elite female competitive gymnasts: A two-year longitudinal study. In P Parisi, F Pigozzi, G Prinzi (Ed), *Sport Science '99 in Europe* (p 167). Rome, Italy: Rome University Institute of Motor Sciences
- Menkhin UV (1978). The main principle of special physical training of gymnasts. *Yessis Review of Soviet Physical Education and Sports* 13, 29-35
- Moritani T (1992). Time course of adaptations during strength and power training. In PV Komi (Ed), *Strength and power in sport* (pp 266-278). Oxford, England: Blackwell
- Moritani T, DeVries HA (1979). Neural factors versus hypertrophy in the time course of muscle strength gain. *American Journal of Physical Medicine* 58, 115-130
- Nattiv A, Agostini R, Drinkwater B, Yeager KK (1994). The female athlete triad. *Clinics in Sports Medicine* 13, 405-418
- Nattiv A, Lynch L (1994). The female athlete triad. *Physician and Sportsmedicine* 22(1), 60-68
- Nattiv A, Mandelbaum BR (1993). Injuries and special concerns in female gymnasts. *Physician and Sportsmedicine* 21(7), 66-84
- Nelson JK, Johnson BL, Con Smith G (1983). Physical characteristics, hip flexibility and arm strength of female gymnasts classified by intensity of training across age. *Journal of Sports Medicine and Physical Fitness* 23, 95-101
- Noden M (1994, August 8). Dying to win. *Sports Illustrated* 81(6), 52-60
- Pearl B (1986). *Getting Stronger*. Bolinas, CA: Shelter Publications
- Plotkin AB, Rubin VS, Arkaev LY (1989). Exercises with weights in specialized physical preparation of high level gymnasts. *Soviet Sports Review* 24, 66-70
- Poliquin C (1991). Training for improving relative strength. *Science Periodical on Research and Technology in Sport* 11, 1-9
- Rosen LW, Hough DO (1988). Pathogenic weight-control behaviors of female college gymnasts. *Physician and Sportsmedicine* 16(9), 140-144
- Sakuma K, Yamaguchi A, Katsuta S (1995). Are region-specific changes in fibre types attributable to nonuniform muscle hypertrophy by overloading? *European Journal of Applied Physiology and Occupational Physiology* 71, 499-504
- Sale DG (1992). Neural adaptation to strength training. In PV Komi (Ed), *Strength and power in sport* (pp 249-265). Oxford, England: Blackwell

- Sale DG, Martin JE, Moroz DE (1992). Hypertrophy without increased isometric strength after weight training. *European Journal of Applied Physiology and Occupational Physiology* 64, 51-55
- Sands B (1984). *Coaching women's gymnastics*. Champaign, IL: Human Kinetics
- Sands WA (1990). Physical readiness. In GS George (Ed), *USGF gymnastics safety manual* (2nd ed, pp 63-68). Indianapolis, IN: US Gymnastics Federation
- Sands WA, Irvin RC, Major JA (1992). What the sport scientist can really tell about your percent fat and an alternative method for assessing body composition. In JL McNitt-Gray, R Girandola, J Callaghan (Eds), *1992 USGF Sport Science Congress Proceedings* (pp 54-62). Indianapolis, IN: USGF Publications
- Sands WA, Irvin RC, Major JA (1995). Women's gymnastics: The time course of fitness acquisition. A 1-year study. *Journal of Strength and Conditioning Research* 9, 110-115
- Sands WA, McNeal JR (1997). A minimalist approach to conditioning for women's gymnastics. In S Whitlock (Ed), *1997 USA Gymnastics Congress Proceedings Book* (pp 78-80). Indianapolis, IN: USA Gymnastics
- Sands WA, Mikesky AE, Edwards JE (1991, Sep 14). Physical abilities field tests US Gymnastics Federation Women's National Teams. *USGF Sport Science Congress Proceedings* 1, 39-47
- Schmidtbleicher D (1992). Training for power events. In PV Komi (Ed), *Strength and power in sport* (pp 381-395). Oxford, England: Blackwell
- Singh H, Rana RS, Walia SS (1987). Effect of strength and flexibility on performance in men's gymnastics. In B Petiot, JH Salmela, TB Hoshizaki (Ed), *World identification systems for gymnastic talent* (pp 118-121). Montreal, Canada: Sport Psyche Editions
- Steele VA, White JA (1986). Injury prediction in female gymnasts. *British Journal of Sports Medicine* 20, 31-33
- Tittel K, Wutscherk H (1992). Anthropometric factors. In PV Komi (Ed), *Strength and power in sport* (pp 180-196). Oxford, England: Blackwell
- Trifonov AG, Yessis M (1986). Gymnasts also need slow strength. *NSCA Journal* 8(4), 43-45
- Wilmore JH (1996). Eating disorders in the young athlete. In O Bar-Or (Ed), *The child and adolescent athlete* (pp 287-303). Oxford, England: Blackwell
- Young A, Stokes M, Round JM, Edwards RHT (1983). The effect of high-resistance training on the strength and cross-sectional area of the human quadriceps. *European Journal of Clinical Investigation* 13, 411-417
- Young WB, Bilby GE (1993). The effect of voluntary effort to influence speed of contraction on strength, muscular power, and hypertrophy development. *Journal of Strength and Conditioning Research* 7, 172-178
- Zatsiorsky VM (1995). *Science and practice of strength training*. Champaign, IL: Human Kinetics
- Zauner CW, Maksud MG, Melichna J (1989). Physiological considerations in training young athletes. *Sports Medicine* 8, 15-31

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