USATF

TRACK COACH

2018 / ISSUE 222

2017 USATF NIKE COACH OF THE YEAR

JERRY SCHUMACHER

TRACK COACH

Winter 2018 I 222

The official technical publication of USA Track & Field

USATF

TRACK
COACH
FORMERLY TRACK TECHNIQUE

222 I WINTER 2018

The official technical publication of USA Track & Field

USATF

ED FOX....................................PUBLISHER
RUSS EBBETS.................................EDITOR
TERESA TAM.........PRODUCTION & DESIGN
FRED WILT......................FOUNDING EDITOR

PUBLICATION

Track Coach is published quarterly by Track & Field News, 2570 W. El Camino Real, #220, Mountain View, CA 94040 USA.

The Spring 2018 issue (No. 223) of Track Coach will be e-mailed to subscribers in April 2018.

SUBSCRIPTIONS

$20.00 per year, U.S. or foreign. Track Coach became a digital-only publication in 2015.

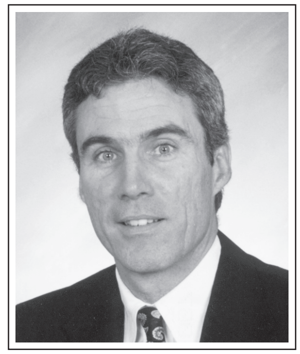
BACK ISSUES OF TRACK COACH

Many back issues of Track Technique/ Track Coach, #92-208, are available singly at $5.50 (U.S. delivery)/ $9.50 (foreign delivery) each post-paid. No issues previous to #111 are available.

To order, send your check to

Track Coach
2570 W El Camino Real,
Suite 220,
Mountain View, CA 94040

FROM THE EDITOR
RUSS EBBETS



SOFT TISSUE

If you have ever taken an anatomy or physiology course you were no doubt taught about the body's "systems": the circulatory system, nervous system, musculo-skeletal system, etc. Not surprisingly this method of teaching is called a "systems" approach.

While the systems approach is a tried and true method to learn how the body works it is also a disjointed one. The fact is the body "works" as a whole system often simultaneously or at least sequentially. In a healthy state all the systems compliment and harmoniously interact with each other.

In spite of this generally recognized holistic view of the body, teaching via the systems approach persists. The main reasons are quite legitimate. For one, it makes the incredibly complex subject manageable, or at least more manageable. It allows one to get a toe hold, divide and conquer or employ whatever segmental analogy you prefer. A second reason would be that it offers a chance to focus in on an area, especially if there is a problem.

The muscular system is divided up into parts. There are the upper and lower arms, the upper and lower legs and the front and back of the body. While this gives us the building blocks of the body sooner or later one begins to question how all this works together. After all, one of the basic tenets of coaching is to train movements, not individual muscles. Refined movements become the techniques that optimize the muscles' contractile forces and initiate stretch reflexes to produce performance-directed movement.

Technical movement, after all, is the sequential and coordinated movement of muscles and bones, joints and levers that creates the nuances of movement. To me this is what the technical aspect of coaching is all about, particularly in the speed and power events.

Okay, no great news flash here. We know that muscles cross joints and usually attach to a bone via a tendon. Ligaments are the soft tissue that attach bones together. Joint capsules are another form of ligament that encapsulates a joint offering protection and stability. A fifth type of soft tissue is the fascia.

The what?

If you have ever prepared a raw chicken breast and pinched the meat you can usually raise a translucent, grayish tissue that exhibits almost a cellophane wrap-like appearance; that is the fascia.

CONTINUED ON PAGE 7085

PLAUSIBLE ERGOGENIC EFFECTS OF VITAMIN D ON ATHLETIC PERFORMANCE AND RECOVERY

Track Coach editor Russ Ebbets offers a comprehensive account of the important review of the research on Vitamin D and its effect on athletic performance by Dylan Dahlquist, Brad Dieter and Michael Koehle. That original article, by Dahlquist, et al, appeared in the *Journal of the International Society of Sports Nutrition*, 2015.

BY RUSS EBBETS, EDITOR, TRACK COACH

INTRODUCTION

Vitamin D is one of the four essential fat soluble vitamins along with vitamins A, E and K. Utilized by the body in over 900 gene variants Vitamin D has the unique ability to be produced by the body (Wang, 2005).

Vitamin D is widely used by the body for a multitude of conditions. Studies have shown that Vitamin D can play a role in tumor suppression, neurologic function and cardio-vascular health. Other areas where vitamin D makes an important contribution are with bone health, glucose metabolism and the impacts of exercise induced inflammation (Smith, 2012; Alvarez-Diaz, 2009; Dhesi, 2004; Reddy, 2010; Sukuman, 2015; Schoenmakers, 2013; Close, 2013).

Deficiencies in vitamin D have been linked to psychological problems as diverse as depression (Grudet, 2014), suicidal ideation (Polek, 2014) and cognitive decline (Chei, 2014). Physiologic problems in the body have also been linked to low vitamin D levels. Researchers have seen an increased risk of cancer (Holick, 2006), the long bone softening disease of rickets (McCollum, 1922; Welsh, 2000) and spinal spondyloarthritis (Guillot, 2014). In that vitamin D is intimately linked to bone health it is not surprising that low levels are seen with an increased risk of fractures (Bikle, 2014; Ogan, 2013). Finally, low levels can cause a catabolic effect on muscle tissue that has been linked to decreased strength and subsequently decreased performance (Sato, 2005).

Of particular focus in Dahlquist's review (2015) are the influences vitamin D can have on athletic participation. It bears repeating that anything that decreases the ability of the muscular system to exhibit strength, metabolize glucose or effects cardio-vascular health would logically have an impact on athletic performance. Numerous studies have researched the role vitamin D may have in athletic performance with both promising and confounding results.

DISCUSSION

The cause of the endogenous production of vitamin D is exposure to sunlight (Heaney, 2008). It seems almost beyond belief that in spite of this Bendik (2014) found that 88.1% of the world's population is deficient in vitamin D. This is startling as it was theorized that as little as 20 minutes per day sun exposure to 5% of the body will produce upwards of 10,000-20,000IU per day, an amount well exceeding the daily dosages recommended below (Webb, 2006).

Farrokhyar's (2014) meta-analysis further confirmed this rampant deficiency with an extensive study of over 2300 athletes in 23 studies and found that 56% of those athletes surveyed were low in vitamin D. One would think that athletic populations would have better access to foodstuffs and play closer attention to their diets. These 81% and 56% deficient statistics are particularly surprising especially with vitamin D produced endogenously.

Vitamin D was specifically reviewed in three areas regarding athletic performance: maximum O_2 uptake, recovery and force and power production. There are vitamin D receptors in the heart and vascular network of the body. Both these locations hint that healthy "receptors" bathed in vitamin D's pre-hormone 25-hydroxyvitamin D (25(OH)D) would be able to utilize oxygen at a greater rate than deficient ones (Reddy, 2010). Several studies (Gregory, 2013; Mowry, 2009; Ardestani, 2011) found a positive correlation between VO_2 max and serum 25(OH)D concentrations. One of Dahlquist's criticisms of these studies is that "confounding influences were not addressed" referring to the fact that the potential influence of other supplements or the ingestion of a multi-vitamin were not controlled for and may potentially have skewed the results.

VITAMIN D WAS SPECIFICALLY REVIEWED IN THREE AREAS REGARDING ATHLETIC PERFORMANCE: MAXIMUM O_2 UPTAKE, RECOVERY AND FORCE AND POWER PRODUCTION.

Maximum O_2 Uptake

Some of the studies on athletics have been promising. Fitzgerald (2014) found that higher 25(OH)D serum concentration levels helped maximum O_2 uptake in males but not females. Jastrzebski (2014) found that vitamin D supplementation helped improve rower's maximum O_2 uptake slightly (12.8% v 10.3) but the question was raised as to whether this finding would transfer to other sports? Koundourakis (2014) found a positive correlation between vitamin D ingestion and soccer players' abilities to perform squat jumps, counter movement jumps and noted improved sprint times over 10m and 20m distances.

Recovery

Recovery is another critical area of concern in competitive sport. Increased levels of vitamin D have been linked to an increased myogenic differentiation and proliferation. This differentiation and proliferation aids muscle protein synthesis (MPS) and decreases the myostatin response that inhibits MPS (Garcia, 2013; Garcia, 2011). A muscle crush study was noted where Wistar rats were given high dose versus low dose (332,000IU/kg v. 33,200IU/kg) amounts of vitamin D. The results showed a significant influence with vitamin D supplementation.

The amounts of vitamin D per kilogram of body weight ingested by the Wistar rats was well above human daily recommendations bringing into question the "transferability" of the study. The high dose group evidenced significantly more phagocytic activity, evidenced improved recovery time, increased tetanic force production and increased twitch force. While it was emphasized that the dosage levels do not relate to humans, in principle the results of a "high" vitamin D dosage for injury recovery seems to be supported (Stratos, 2013).

A second study by Barker, (2013) looked at 28 healthy, moderately active adult males. Participants were given 4000IU of vitamin D daily for 35 days. Their test exercise was to perform 10 sets of 10 depth jumps. While both the vitamin D group and placebo groups lost power output following the eccentric jumps the vitamin D group lost significantly less than the placebo taking control group (-6% v. -32%).

Force and Power Production

Vitamin D has also been shown to have a positive impact on force and power production (Ogan, 2013). Three authors found an increase in muscle size and an increase in type II muscle fibers (Sato, 2005; Todd, 2015; Ceglia, 2013). The problem with these findings have only been confirmed on studies using 65+ year-old females (Ceglia, 2013).

A second study on force and power looked at the effects of vitamin D supplementation on 10 male soccer players (Close, 2013). Participants were able to increase their vertical jump performance and reduce 10m sprint times. Interestingly one had to have the increased supplementation. Those that were given moderate doses showed no significant benefit. (Close, 2010; Fitzgerald, 2014; Forney, 2014)

Testosterone Studies

Low testosterone levels (aka low T) is a reality for aging males. Low T is seen as causing decreased protein anabolism, decreased strength, decreased fat metabolism and leading to an increase in fat deposition (Mauras, 1998). Wehr (2010) conducted a large study (N = 2299) on males 62 +/- 11 years and found only 11% had adequate vitamin D levels. The participant population also had significantly lower mean levels of vitamin D than the rest of the population.

THE RECOMMENDATIONS FOR SUN EXPOSURE ARE THAT ONE GET 5-20 MINUTES EXPOSURE TO 5% OF THE BODY. THIS SHOULD BE DONE 2-3 TIMES PER WEEK.

A second testosterone study by Pilz (2011) was a 12-month double-blind study with 54 non-diabetic males who consumed 3332IU/day. Results showed that levels of 25(OH)D were raised and that total testosterone, bioactive testosterone and free testosterone were all elevated. It was inferred that the presence of serum 25(OH)D may enhance endogenous testosterone production.

The mechanism of the 25(OH)D on testosterone is seen as inhibiting the gradual decrease of testosterone and the enhancing androgen binding that takes place. Ultimately this increased binding leads to increased concentration of the hormone with the result being increased muscle hypertrophy, strength and power (Kinuta, 2000).

Sources of Vitamin D

Vitamin D comes from two sources–endogenously produced from exposure to the sun and from the diet. The recommendations for sun exposure are that one get 5-20 minutes exposure to 5% of the body. This should be done 2-3 times per week. It was noted that 15 minutes of exposure could endogenously produce 10-20,000IU of D3 (Holick, 2001; Heaney, 2008). Dahlquist's review noted several "complicating" factors that may affect this number including: seasonal variations, altitude, cloudy climates, darker skin, obesity and the use of sunblock.

Attaining vitamin D from the diet can come in two ways, from the foods one eats and from supplementation. D2 is the less desirable way to ingest vitamin D. Vitamin D2 is for the most part plant based and is not as well utilized by the body. D2 is seen as less stable, less bioavailable with age and less well absorbed (Tripkovic, 2012; Houghton, 2006; Logan, 2013). Various "fortified" foods are available (Bikle, 2014; Holick, 2007) that include: milk, cereal, margarine and synthetic analogues.

Vitamin K

Vitamin K, one of the four fat soluble vitamins mentioned above is regulated by vitamin D. Vitamin K plays a key role in healthy bones and works synergistically with vitamin D (Kidd, 2010). Low levels of vitamin K have been linked to increased calcium release from the bones with its deposition in the vascular soft tissues leading to arterial calcification and hypercalcemia (Akiyara, 1994; Masterjohn, 2007; El Asmar, 2014; Hamidi, 2014; Iwamoto, 2014). Vitamin D toxicity is only possible if there is a concomitant vitamin K deficiency (Hamidi, 2014; Iwamoto, 2014).

The recommended daily dose of vitamin K ranges from 50mcg to 1000mcg (Binkley, 2002). There are two forms of vitamin K, K1 and K2. Vitamin K1 is found in vegetables, fruits, oils and beans. Vitamin K1 has been shown to effectively help blood clotting proteins (Fusaro, 2011) and prevent bone loss in female marathoners (Craciun, 1998).

Vitamin K2 is found in fish, offal, meat, dairy, blue cheese and fermented soybeans. Vitamin K2 helps prevent soft tissue calcification (Fusaro, 2011). Mega doses of a vitamin K2 variant, MK4 has been shown to prevent osteoporosis in menopausal women when used in conjunction with vitamin D3 (Suda, 2003; Akiyara, 1994). It is Dahlquist's conclusion that the combination of these two vitamins warrants further research to determine the ideal dosing levels.

Toxicity

As mentioned above one of the caveats with taking the fat-soluble vitamins is the problem of toxicity. Traditionally it was practiced that chronic ingestion of greater than 10,000IU of vitamin daily would lead to hypercalcemia (Heaney, 2008; Cannell, 2008). To date, due to the ethical concerns of human experimentation, no studies have proven this point.

Van den Ouweland (2014) reported a case study of an accidental overdose of 2,000,000IU by two elderly patients with the only side effect being elevated calcium levels. It should be noted that this overdose was a "one-off' time and not a regular occurrence. Hypercalcemia has been reported when daily ingestion reached 40,000IU (>200nmol/L) while serum levels below 140nmol/L (28,000IU) did not cause hypercalcemia (Suda, 2003).

Recommended Levels

Daily recommendations have been given by the Institute of Medicine (IOM) and by Endocrine Society (ES). The IOM recommends a more general 400-800IU/day (50nmol/L) for children, adults and those older than 70 years of age. The ES breaks down their recommendations as follows: infants 400-800IU/day, child 600-100IU/day, adult 1500-2000IU/day to maintain serum levels of 75nmol/L. It was recommended that 70nmol/L be the lowest serum level to prevent noticeable health effects and it has recommended ingestion of 90-120nmol/L to replicate conditions of "sunlight rich environments" (Veith, 1999; Bischoff-Ferrari, 2006).

While specific studies are sparse on athletic populations and vitamin D usage there are some inferences that can be made from the available data. Decreased levels of vitamin D have been equated with an increased incidence of stress fractures (Heaney, 2011). Optimal bone health requires between 2000-5000IU/day creating a serum concentration level of 75-80nmol/L of 25(OH)D. Ingestion of 1000-3000IU/day is seen as inadequate (Logan, 2013). Maintenance of serum 25(OH)D levels ≥100nmol/L would require 6450+IU/day which is significantly more than was used in the studies mentioned in Dahlquist's review.

CONCLUSION

The old caveats about taking too much fat-soluble vitamins seems to have lost the threat of toxic overdose. With one researcher reporting 88.1% of the population deficient in vitamin D the conversation seems to have shifted towards increasing supplementation.

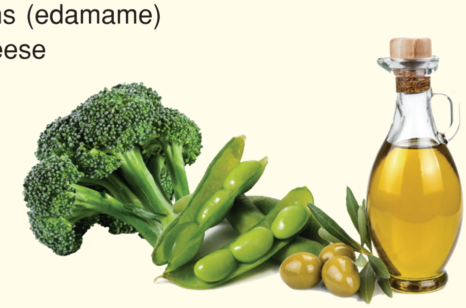
While research is in its early stages indications seem to point out that vitamin D does have a positive impact on the oxygen uptake for endurance sports and muscle protein synthesis for speed and power sports.

FOODS RICH IN VITAMIN D

Oily fish: salmon, tuna, trout, cod, sardines
Cod liver oil
Ham, pork chops, chicken, beef
Fortified (with Vitamin D) milk, cereals, yogurt
Fortified Orange Juice
Eggs (yolk)
Mushrooms

FOODS RICH IN VITAMIN K

Green leafy and other vegetables: broccoli, brussel sprouts, kale, asparagus, lettuce, spinach, scallions, cucumber (w/skin)
Soybeans (edamame)
Blue cheese
Prunes
Olive oil



Further research should also look to better understand the synergism between vitamin D and vitamin K. The synergism between vitamin D and vitamin K can play a central role in the prevention of stress fractures (Kidd, 2010) and the prevention of osteoporosis in menopausal women (Suda, 2003; Akiyara, 1994), a concern for the masters athlete. No doubt both vitamin D and vitamin K will come to be seen as important components in the prevention of the Female Athletic Triad (amenorrhea, osteoporosis and anorexia).

A final note would be that if one's life is viewed as a "endurance sport" vitamin D may come to be seen as an "anti-aging" vitamin as it potentially allows one to pursue one's goals longer and more completely due the enjoyment of improved health.

BIBLIOGRAPHY

Akiyama Y, Hara K, Tajima T, Murota S, Morita I. Effect of vitamin K2 (menatetrenone) on osteoclast-like cell formation in mouse bone marrow cultures. *Eur J Pharmacol.* 1994;263:181–5.

Alvarez-Díaz S, Valle N, García JM, Peña C, Freije JMP, Quesada V, et al. Cystatin D is a candidate tumor suppressor gene induced by vitamin D in human colon cancer cells. *J Clin Invest.* 2009;119:2343–58.

Ardestani A, Parker B, Mathur S, Clarkson P, Pescatello LS, Hoffman HJ, et al. Relation of vitamin D level to maximal oxygen uptake in adults. *Am J Cardiol.* 2011;107:1246–9.

Barker T, Schneider ED, Dixon BM, Henriksen VT, Weaver LK. Supplemental vitamin D enhances the recovery in peak isometric force shortly after intense exercise. *Nutr Metab (Lond).* 2013;10:69.

Bendik I, Friedel A, Roos FF, Weber P, Eggersdorfer M. Vitamin D: a critical and essential micronutrient for human health. *Front Physiol.* 2014;5:248.

Bikle DD. Vitamin D metabolism, mechanism of action, and clinical applications. *Chem Biol.* 2014;21:319–29.

Binkley NC, Krueger DC, Kawahara TN, Engelke JA, Chappell RJ, Suttie JW. A high phylloquinone intake is required to achieve maximal osteocalcin γ-carboxylation. *Am J Clin Nutr.* 2002;76:1055–60.

Bischoff-Ferrari HA, Giovannucci E, Willett WC, Dietrich T, Dawson-Hughes B. Estimation of optimal serum concentrations of 25-hydroxyvitamin D for multiple health outcomes. *Am J Clin Nutr.* 2006;84:18–28.

Cannell J, Hollis B. Use of vitamin D in clinical practice. *Altern Med Rev.* 2008;13:6–20.

Ceglia L, Niramitmahapanya S, da Silva MM, Rivas DA, Harris SS, Bischoff-Ferrari H, et al. A randomized study on the effect of vitamin D3 supplementation on skeletal muscle morphology and vitamin D receptor concentration in older women. *J Clin Endocrinol Metab.* 2013;98:E1927–35.

Chei CL, Raman P, Yin Z-X, Shi X-M, Zeng Y, Matchar DB. Vitamin D levels and cognition in elderly adults in China. *J Am Geriatr Soc.* 2014;62(11):2125–9.

Close GL, Leckey J, Patterson M, Bradley W, Owens DJ, Fraser WD, et al. The effects of vitamin D(3) supplementation on serum total 25[OH] D concentration and physical performance: a randomised dose–response study. *Br J Sports Med.* 2013;47:692–6.

Close GL, Russell J, Cobley JN, Owens DJ, Wilson G, Fraser WD, et al. Assessment of vitamin D concentration in non-supplemented professional athletes and healthy adults during the winter months in the UK: implications for skeletal muscle function. *J Sports Sci.* 2013;31:344–53.

Craciun AM, Wolf J, Knapen MH, Brouns F, Vermeer C. Improved bone metabolism in female elite athletes after vitamin K supplementation. *Int J Sports Med.* 1998;19:479–84.

Dhesi JK, Jackson SHD, Bearne LM, Moniz C, Hurley MV, Swift CG, et al. Vitamin D supplementation improves neuromuscular function in older people who fall. *Age Ageing.* 2004;33:589–95.

El Asmar MS, Naoum JJ, Arbid EJ. Vitamin K dependent proteins and the role of vitamin K2 in the modulation of vascular calcification: a review. *Oman Med J.* 2014;29:172–7.

Farrokhyar F, Tabasinejad R, Dao D, Peterson D, Ayeni O, Hadioonzadeh R, et al. Prevalence of vitamin D inadequacy in athletes: A systematic review and meta-analysis. *Sport Med.* 2014;5:365–78.

Fitzgerald J, Peterson B, Warpeha J, Wilson P, Rhodes G, Ingraham S. Vitamin D status and VO2peak during a skate treadmill graded exercise test in competitive ice hockey players. *J Strength Cond Res.* 2014;28:3200–5.

Forney L, Earnest CC, Henagan T, Johnson L, Castleberry T, Stewart L. Vitamin D status, body composition, and fitness measures in college-aged students. *J Strength Cond Res.* 2014;28:814–24.

Fusaro M, Crepaldi G, Maggi S, Galli F, D'Angelo A, Calò L, et al. Vitamin K, bone fractures, and vascular calcifications in chronic kidney disease: an important but poorly studied relationship. *J Endocrinol Invest.* 2011;34:317–23.

Garcia LA, Ferrini MG, Norris KC, Artaza JN. 1,25(OH)2vitamin D3 enhances myogenic differentiation by modulating the expression of key angiogenic growth factors and angiogenic inhibitors in C2C12 skeletal muscle cells. *J Steroid Biochem Mol Biol.* 2013;133:1–11.

Garcia LA, King KK, Ferrini MG, Norris KC, Artaza JN. 1,25(OH)2vitamin D3 stimulates myogenic differentiation by inhibiting cell proliferation and modulating the expression of promyogenic growth factors and myostatin in C2C12 skeletal muscle cells. *Endocrinology.* 2011;152:2976–86.

Gregory SM, Parker BA, Capizzi JA, Grimaldi AS, Clarkson PM, Moeckel-Cole S, et al. Changes in vitamin D are not associated with changes in cardiorespiratory fitness. *Clin Med Res.* 2013;2:68.

Grudet C, Malm J, Westrin A, Brundin L. Suicidal patients are deficient in vitamin D, associated with a pro-inflammatory status in the blood. *Psychoneuroendocrinology.* 2014;50C:210–9.

Guillot X, Prati C, Wendling D. Vitamin D and spondyloarthritis. *Expert Rev Clin Immunol.* 2014;10:1581–9.

Hamidi MS, Cheung AM. Vitamin K and musculoskeletal health in postmenopausal women. *Mol Nutr Food Res.* 2014;58:1647–57.

Heaney RP. Assessing vitamin D status. Curr Opin Clin Nutr Metab Care. 2011;14:440–44.

Heaney RP. Vitamin D in health and disease. *Clin J Am Soc Nephrol.* 2008;3:1535–41.

Holick M. Vitamin D deficiency. *N Engl J Med.* 2007;357:266–81.

Holick MF. Sunligth "D"ilemma: Risk of skin cancer or bone disease and muscle weakness. *Lancet* 2001:4–6.

Holick MF. Vitamin D: its role in cancer prevention and treatment. *Prog Biophys Mol Biol.* 2006;92:49–59.

Houghton L,A, Vieth R. The case against ergocalciferol (vitamin D2) as a vitamin supplement. *Am J Clin Nutr.* 2006;84:694–7.

Iwamoto J. Vitamin K2 therapy for postmenopausal osteoporosis. *Nutrients.* 2014;6:1971–80.

Jastrzębski Z. Effect of vitamin D supplementation on the level of physical fitness and blood parameters of rowers during the 8-week high intensity training. *Facicula Educ Fiz şi Sport.* 2014;2:57–67.

Kidd PM. Vitamins D and K as pleiotropic nutrients: clinical importance to the skeletal and cardiovascular systems and preliminary evidence for synergy. *Altern Med Rev.* 2010;15:199–222.

Kinuta K, Tanaka H, Moriwake T, Aya K, Kato S, Seino Y. Vitamin D is an important factor in estrogen biosynthesis of both female and male gonads*. *Endocrinology 2000AD,* 141:1317–324.

Koundourakis NE, Androulakis NE, Malliaraki N, Margioris AN. Relation of vitamin D level to maximal oxygen uptake in adults. *Am J Cardiol.* 2011;107:1246–9.

Logan VF, Gray AR, Peddie MC, Harper MJ, Houghton LA. Long-term vitamin D3 supplementation is more effective than vitamin D2 in maintaining serum 25-hydroxyvitamin D status over the winter months. *Br J Nutr.* 2013;109:1082–8.

Masterjohn C. Vitamin D toxicity redefined: vitamin K and the molecular mechanism. *Med Hypotheses.* 2007;68:1026–34.

Mauras N, Hayes V, Welch S, Rini A, Helgeson K, Dokler M, Veldhuis JD, Urban RJ. Testosterone deficiency in young men: Marked alterations in whole body protein kinetics, strength, and adiposity. *J Clin Endocrinol Metab.* 1998;83:1886–892.

McCollum E, Simmonds N, Becker J, Shipley P. An experimental demonstration of the existence of a vitamin which promotes calcium deposition. *J Biol Chem.* 1922;1922:293–8.

Mowry DA, Costello MM, Heelan KA. Association among cardiorespiratory fitness, body fat, and bone marker measurements in healthy young females. *J Am Osteopath Assoc.* 2009;109(10):534–9.

Ogan D, Pritchett K. Vitamin D and the athlete: risks, recommendations, and benefits. *Nutrients.* 2013;5:1856–68.

Pilz S, Frisch S, Koertke H, Kuhn J, Dreier J, Obermayer-Pietsch B, et al. Effect of vitamin D supplementation on testosterone levels in men. *Horm Metab Res.* 2011;43:223–5.

Polak MA, Houghton LA, Reeder AI, Harper MJ, Conner TS. Serum 25-hydroxyvitamin D concentrations and depressive symptoms among young adult men and women. *Nutrients.* 2014;6:4720–30.

Reddy Vanga S, Good M, Howard PA, Vacek JL. Role of vitamin D in cardiovascular health. *Am J Cardiol.* 2010;106:798–805.

(Continued on page 7081)

DO DISTANCE RUNNERS REALLY NEED TO STRENGTH TRAIN?

Jason Karp is always a welcome contributor to these pages. His expertise as a PhD in exercise physiology and his long experience as a coach and personal trainer make him a knowledgeable, authoritative voice of clarity in running trianing matters.

BY JASON R. KARP, PHD

When I was in eighth grade, I broke the school record for chin-ups. I still have the certificate of achievement from the school's principal proudly displayed on my wall. I still brag about the accomplishment to others. It doesn't matter that it was so many years ago or that some tough kid has probably come along since to break my record. At the time, I had the strongest biceps and forearms in junior high. I used chin-ups to show off to the girls in class. My mother even bought a chin-up bar and attached it to my bedroom door frame so I could train at home. I did chin-ups every day. Until I became a distance runner.

At first glance, distance running doesn't seem to have much to do with lifting weights to get big, strong muscles. Indeed, the best runners in the world are quite small, with slim legs and arms that would make some Hollywood actresses drool. But as I tell the runners I coach, what your muscles look like isn't important; what they do is what matters. And if people train them properly, they can teach their muscles to do some amazing things. Just ask the Kenyan and Ethiopian runners with the skinny legs.

These days, athletes in all sports lift weights to supplement their sport-specific training. Even distance runners have jumped on the bandwagon. Indeed, much has been written about strength training for the runner—everything from lunges while holding dumbbells in your hands to calf raises on the edge of a stair to endless repetitions of abdominal crunches while balancing on a big, lime green exercise ball. Does anyone else reading these training suggestions ever wonder if they will really lead to a new 5K or marathon personal best?

My research on the training characteristics of the 2004 U.S. Olympic Marathon Trials qualifiers, published in *International Journal of Sports Physiology and Performance* in

2007, found that these marathoners did little, if any, strength training. During the entire year of training leading up to the Olympic Trials, the men averaged less than one strength workout per week and the women averaged 1.5 strength workouts per week. About half of the athletes did not do any strength training at all.

One of two conclusions can be drawn from this—either the U.S.'s elite marathoners do not believe that strength training will make them better marathoners, or they do not have the time to strength train given the time they devote to running.

WHY STRENGTH TRAINING WON'T MAKE YOUR ATHLETES FASTER

Runners have only so much energy and time for training, so they want to get the greatest return on their investment. If someone runs 30 miles per week and has a choice between staying at 30 miles and adding strength training or running 10 more miles per week, the latter strategy has a greater impact on his or her performance. Provided there are enough weeks to train to slowly and carefully increase his or her weekly mileage, running more miles is a better strategy. I, and many other coaches who have come before me, starting with Arthur Lydiard in the 1950s, believe that runners can get a lot more out of running hill sprints or bounding up a hill than by doing lunges while holding dumbbells.

Unlike most sports, which require strength, speed, and power to be successful, distance running performance is primarily limited by the delivery and use of oxygen. And there are no studies showing that strength training improves oxygen delivery from lungs to muscles. Strength training does not improve the most important factors that enable a runner to run faster, including the following:

- Cardiac output, which determines how much blood the heart pumps per minute.
- The amount of hemoglobin in the blood, which determines how much oxygen is transported in the blood to the muscles.
- Muscles' capillary density, which determines how much oxygen is delivered to the muscles.
- Amount of mitochondria in the muscles, which determines how much oxygen the muscles use to regenerate energy (ATP) for muscle contraction.
- Ability to dissipate heat when running for a long period, which affects cardiovascular function and the ability to maintain the pace in a long race like a half-marathon or marathon.
- Muscles' ability to use fat as fuel, which occurs by making more mitochondria and by running long enough that the muscles start running out of carbohydrate.

Since strength training can't improve aerobic ability, it can't directly make someone a better distance runner. The most direct way to become a better runner is to run.

Strength training may actually hinder a runner, especially if he or she does it at the expense of more run-specific training. The physiological changes that result from strength and endurance training are contradictory. For example, when strength training with heavy weights, muscles are stimulated to get larger. Larger muscles increase body weight, which reduces running economy because more oxygen is needed to transport a heavier weight. In contrast, endurance training decreases body weight, optimizing the use of oxygen.

SINCE STRENGTH TRAINING CAN'T IMPROVE AEROBIC ABILITY, IT CAN'T DIRECTLY MAKE SOMEONE A BETTER DISTANCE RUNNER

Larger muscles also have a smaller density of capillaries and mitochondria, which is detrimental to endurance. Runners want as many capillaries and mitochondria per area of muscle as possible to facilitate the delivery and use of oxygen. Endurance training causes muscles to respond in an opposite way, increasing the number of capillaries and mitochondria in the muscles. Runners don't want bigger muscles to run, especially a long race.

Despite the different physiological adaptations between strength and endurance training, many runners still lift weights, typically with light to moderate loads and a high number of repetitions, programs that are geared toward increasing muscular endurance (the ability to sustain or repeat a submaximal force) rather than strength (the maximal amount of force muscles can produce). But is performing a few sets of 10 to 20 repetitions going to increase muscular endurance over and above what your athletes already achieve from their weekly running or what they would achieve by running more miles?

Think about how many repetitions they perform while running just five miles. Surely a mere 20 to 60 reps extra in the gym is not going to make them faster. While some studies have found that this type of strength training may help inexperienced runners who have a low fitness level improve their performance, other studies have shown it to be ineffective. A 20-minute 5K runner is better served by improving the cardiovascular and metabolic parameters associated with endurance than by strength training.

WHY STRENGTH TRAINING MAY MAKE YOUR ATHLETES FASTER

Although strength training can't improve the most important factors that enable someone to run faster, it can play a supportive role in increasing muscle strength and power and reducing the risk of certain types of injuries that are related to muscle weakness, especially in new runners. Beginners are more likely to get injured because they haven't yet run enough to strengthen their anatomy to withstand the stress of running. (To a certain extent, running itself has a prophylactic effect on injury because it toughens the structures vulnerable to injury. That's why Lydiard had his athletes do bounding drills up hills—to strengthen the Achilles tendons and lower leg muscles prior to his athletes transitioning to the faster workouts on the track.) While I strongly believe that strength training should never be done at the expense of run training when the goal is to become a better runner, there are some cases in which a runner can benefit from strength training:

- Run training has already been maximized by increasing both mileage and intensity. For an advanced runner who is already running more than 70+ miles per week and is including lactate threshold runs and interval workouts, and he can't do any more or higher quality running, he may want to give strength training a try if he still has more time and energy to train.

- The physical stress of running more miles can't be handled and the runner would get injured if he/she ran more. If someone is running as much as his/her body can handle without getting injured and still wants to do something else to potentially become a better runner, try strength training.

- A new runner is training for his first marathon. If training for a first marathon only 5 or 6 months away, the person probably isn't going to be able to increase his running mileage above 30 to 35 miles per week without drastically increasing the risk of injury. In this case, he may benefit from strength training because it can increase overall fitness without the physical stress of more running.

- The genetic limit for adaptation to run training has been reached. Not everyone can keep running more and more miles and keep adapting. Some runners, like Olympians, may continue to adapt with 100+ miles per week, while others may stop adapting at 30 miles per week. Our DNA controls how responsive to training we are. If someone has tried running more and it hasn't worked for him, strength training can be another option to improve performance.

THERE ARE SOME CASES IN WHICH A RUNNER CAN BENEFIT FROM STRENGTH TRAINING

Although many runners claim that strength training does everything from reducing injuries to improving posture in a race, perhaps its most beneficial effect is the increase in muscular power, which is the product of force (strength) and speed. Athletic performance is ultimately limited by the amount of force and power that can be produced and sustained. Force and power are influenced by a number of physiological traits, including neuromuscular coordination, skeletal muscle mechanics and energetics, efficiency of converting metabolic power into mechanical power, and the skeletal muscles' aerobic and anaerobic metabolic capacities.

Most movements in sports occur too quickly for muscles to produce maximal force; it is far more important to increase the rate at which force is produced. When racing, your athletes' feet are in contact with the ground for only a fraction of a second, not nearly enough time to generate maximal force. Thus, the best way to strength train to become a better runner is ironically similar to what football players do—train with heavy weights and explosive movements to improve muscle power. Power is the product of muscle strength and speed. For muscles to be powerful, they must be strong and they must be fast.

Research suggests that power training—either lifting near maximal weights a few reps per set to focus on the strength component of power or plyometrics and sprints to focus on the speed component of power—can improve running economy, which is the amount of oxygen used to run at a given submaximal speed and is one of the three major players affecting distance running performance (the other two are VO_2max and lactate threshold).

While the studies on training power with heavy weights or plyometrics found improvements in running economy, they didn't find changes in other cardiorespiratory measures important to distance running, such as VO_2max or lactate threshold. This is an important finding because it suggests that the improvements in running economy do not result from cardiovascular or metabolic changes, but rather from some other (neural) mechanism.

When lifting maximal weights (strength component), or when performing quick, plyometric movements (speed component), your athletes recruit a lot of muscle fibers, which trains the central nervous system. As a result, muscles increase their rate of force development, getting stronger, quicker, and more powerful, without the negative side effect of increasing muscle size. The more effective muscle force production translates into better running economy.

To add strength training to your athletes' programs, start with a muscular endurance base, with lighter weights and more reps to accustom the person to strength training before progressing to heavy weights and plyometrics. Don't jump right into heavy weight lifting, which can make your athletes sore and negatively affect their run training.

Periodize their annual training plan to circumvent the incompatibility between strength and endurance training. Use specific periods of the year during which they focus on aerobic endurance and strength/speed/power. Have them do the bulk of their strength training during their speed phase of training rather than during their aerobic endurance phase, since speed, strength, and power are more closely related physiological traits than are strength and endurance. Likewise, have them do their strength/power workouts on their speedwork days rather than on their recovery run or long run days so that the recovery days are truly recovery days.

If your athletes train smart enough, not only will they get faster, they may even be able to break my middle school chin-up record (it stands at 24).

Jason Karp, PhD, is the 2011 IDEA Personal Trainer of the Year, founder and coach of REVO$_2$LUTION RUNNING ELITE, and creator of the REVO$_2$LUTION RUNNING™ certification for coaches and fitness professionals. He has more than 400 published articles in international running, coaching, and fitness magazines, is the author of eight books, including *The Inner Runner, Run Your Fat Off*, and *101 Developmental Concepts & Workouts for Cross Country Runners*, and speaks at fitness conferences and coaching clinics around the world.

CHECK FORM THE LOW TECH WAY

Elementary, Watson! You can fix form faults just through careful, focused observation.

BY GLENN G. DAHLEM, PH.D.

Coaches wishing to evaluate a track athlete's form these days have access to all sorts of optical and electronic gadgetry available to use. The only problem is many track and field programs lack budgetary resources to acquire, operate and maintain necessary equipment needed for checking form properly. A few procedures exist, however, for appraising dash, distance and hurdling performances using the old fashioned way. "Just watching" can go a long way toward evaluating form if a few basic tenets are applied, turning mere spectating into scientific analysis of a track and field performance.

This "low tech" analysis of running form, when properly conducted, involves checking four important bodily characteristics during straightaway running for both dashes and distance events. A second analysis, of hurdlers, is conducted by noting three critical body positions from the side at the precise moment an athlete clears the hurdle. Counting steps taken between hurdles is also part of that analysis.

Specific characteristics observed during straightaway portions of a race are: leg/foot swing-out, arm swing-out, vertical head bobbing, horizontal head bobbing. It's best to check for each condition during a separate observation, so a coach can concentrate on one specific problem at a time.

"Swing-outs," both arm and leg, are very subtle deviations from direct forward momentum, and not easy to detect. For this reason, an observer must be careful to align his/her line of sight exactly with the runner's route. It's best to make two observations, one of a race from behind the runner's start, another of the on-rushing athlete from behind the finish line. The goal is to detect any sideways deviation of leg or arm.

When observing longer distance events, sampling observations may be made during straightaway places during a race, not at the very start and finish.

Dash observations occur during an entire event, except for longer dashes that may include a curved portion of the track. Any subtle deviation of arm or leg from the straight and narrow, no matter how slight, detracts just a tiny bit from overall speed—possibly the difference between winning or losing. There's no magic formula for eliminating both leg and arm swing-outs. An athlete just needs to concentrate on the problem while practicing running at different speeds, receiving frequent observational data from the coach.

WHILE SWING-OUTS AND BOBBING ARE DETECTED DURING DIRECTLY BEHIND AND IN-FRONT OBSERVATIONS, HURDLING PROBLEMS ARE DISCOVERED FROM THE SIDE.

Up and down, or vertical head bobbing occurs a tiny bit when every person runs. The goal is to minimize it. The head is a heavy body counterweight, and any deviation from its stability detracts from running speed. As an observer sights down a runner's path, up and down head movement is easy to detect. Vertical head bobbing is corrected by practicing running stability at different speeds; stride analysis leads to elimination of any automatic up and down head movement that might tend to occur normally.

Side to side, or horizontal head bobbing, is less common than vertical head bobbing. It's generally caused by neck muscle weakness. A few head and neck exercises in the gym, such as face up and face down bridging may help, as well as stronger straightahead eye concentration while running.

While swing-outs and bobbing are detected during directly behind and in-front observations, hurdling problems are discovered from the side. Directly positioned beside the track next to a hurdle, the coach looks for three things as an athlete goes over the hurdle: hand to toe reach, body forward lean, and amount of space between body and top of hurdle. If he/she notices the reaching hand isn't close enough to the lead toe, or body is too upright, and/or too much air exists between body and hurdle, then it's time for some coaching during practice. Counting the steps between hurdles is also important. Count must stay the same from meet to meet. Actual numbers differ for high and low hurdles, by gender, and from junior high to high school to college and olympic levels. It behooves all coaches to know required numbers and make sure each hurdler does too!

Much analysis of dash, distance and hurdling boils down to common sense. All coaches know what to look for as they seek to improve an athlete's performance. If a track and field program is well heeled, such an an Olympic training facility or large university program, with videotape and film analysis, it's easy to check for flaws in an athlete's performance, however difficult such detection might be. Just tell an equipment manager to run a tape and count someone's steps between hurdles, for example.

However, most small rural high schools can't afford fancy visual aids, so the coach is going to miss a few of the subtleties, no matter how competent he or she is.

A few carefully planned and carried out visual observations, specifically designed to pick up hard to notice imperfections, can make up for lack of high tech gear. These specialized observations can go a long way toward improving running and hurdling form. After all, isn't that what coaching is all about—observing an the athlete performance, then telling he or she how to improve it?

Glenn Dahlem, age 83, Honolulu, HI resident, likes to write about coaching sports, teaching methods, farming/gardening, and linguistics. He coached track and other sports while guidance counselor with the Marshall, Wisconsin School District. Glenn holds B.S. and Ph.D. degrees from his original hometown school, the University of Wisconsin-Madison and an M.S. from Winona (Minnesota) State University.

STRENGTH TRAINING FOR INCREASED SPEED

A primer for the use of strength training to develop speed.

BY LIAM COULTMAN, THE SPEED PROJECT

Strength training for speed is a topic that I always get questions about. Athletes want to know if they are performing the right exercises, how often they should train and how much they should lift. These are all legit questions, however strength training and workouts for speed are more complicated than that, and certainly includes more than simply **lifting weights** in the gym.

Everyone within the sporting world would like to be faster. Whether its athletes on the track, footballers on the pitch or basketball players on the court, all athletes can highly benefit and increase their **sporting performance** by having this ability.

Therefore it's important to understand what training procedures you need to have in place to allow for optimal adaptation of speed. In this article we will look at different types of strength training, why each type is beneficial for increasing speed and workouts for speed.

TRAINING AGE

When we speak about an athlete's training age, we are not referring to the age of the athlete, but rather how long the athlete has been training. So if we had an athlete that started training at the age of 18 and he is now 21, his training age is three years. Therefore, it is possible that a younger athlete can be classed as having an older training age than another athlete who is older in years. The determining factor is the level of experience. An athlete's actual age is still important however, and is still a factor that needs to be considered when selecting exercise frequency, intensity, time and type.

When designing a strength training program it's important to determine an athlete's training age before you start putting pieces of the program together as this information will heavily influence it. Athletes with varying levels of experience are unlikely to both benefit from doing the same session.

The appropriate training for the beginner may seem tedious for the more experienced athlete, and may be unable to cause enough stress to produce positive adaptations. Likewise, a beginner performing workouts suited for advanced athletes could be too challenged and you run the risk of burnout or injury.

Training Age	Time Training (in years)
Beginner	Less than 1.5 years
Intermediate	Between 1.5 and 3 years
Advanced	More than 3 years

MAXIMUM STRENGTH

Maximum strength training increases relative strength and is what I refer to as the athlete's "base strength". This training involves the athlete working at submaximal efforts which will help prepare the body for more intense, explosive training later on in the season by developing muscle and connective tissue tolerance.

The length of this period of training will vary for athletes depending on training age. If you are a beginner, then this stage is often longer as you need more time to build your strength (develop your base strength), whereas advanced level athletes will be able to progress quicker and begin to focus more on exercises with more sport specific transfer.

This stage is usually carried out in the pre-season or during the early stages of a season. We use it as our athlete's first strength training phase. However,If you are new to resistance training, then it's recommended that you start off with a maximum strength program regardless of what stage you are at in your annual season. There's no point trying to attempt more explosive exercises if you can't perform technically sound max strength exercises such as the Barbell Back Squat and the Deadlift.

Be aware that it is important to assess an athlete based on his/her individual needs. Everything written here is only to be used as guidelines to help you organize your strength training more efficiently. Specific exercises can be used during any part of the season if there is requirement for it!

This stage of the training has no specific sport carryover with the focus being on **neural adaptations**. It's highly associated with **hypertrophic gains** and will prepare an athlete for more explosive work. The advantageous effect of this may depend on your sport (a rugby player may wish to increase his mass, however a 200m sprinter will want to stay lean). If an athlete comes in a bit heavy after this stage, coaches and athletes usually spend some time adjusting this in the next phase.

The type of exercises that you need to include during this phase are multi-joint **compound movements**. When performing an exercise, you should focus on keeping the **eccentric phase** of the lift slow and controlled. The **concentric phase** of the lift should be performed quicker with force. This is most favorable to the rate of force development. As you begin to improve and have a good structural balance, look to increase the weight used for each exercise. It's also important to make sure you perform all exercises with good technique and in a safe manner. Never sacrifice form so that you can increase the weight!

Examples of maximum strength training exercises:

- Back Squat
- Front Squat
- Deadlift
- Nordic Curls
- Lunge
- SB Hamstring Curl

EXPLOSIVE STRENGTH

Although maximum strength is an important aspect of an athlete's training, when looking to improve your sprinting ability, or short burst of pace, it's important to focus on applying force rapidly, rather than focusing on the maximum amount of force that you can supply.

Explosive exercises are highly used during strength training to increase speed as they require the athlete to perform accelerated actions. This requires the athlete to continue accelerating throughout the movement until the point of release or takeoff.

During this stage, athletes are able to improve their power production through using explosive movements under heavy loads. Due to the heavy loads moved at high speed, training facilitates a higher threshold of motor units. These exercises have a higher muscle activation, force, power and concentric velocity than the previous maximum strength exercises we spoke about.

Remember that before attempting the exercises in this phase it is important that you have good base strength and sound technique. Don't start performing exercises such as the clean or snatch if you cannot execute a sufficient Squat or Deadlift. The exercises here are technically more demanding so it it's even more important that you're able to perform them correctly to avoid injury. I recommend that a coach evaluate your technique or film yourself so can look out for any mistakes.

Examples of explosive strength training exercises:

- Power Clean
- Snatch
- Squat Jump
- Med Ball Toss
- Box Jump
- Standing Long Jump
- Reactive Strength

During our training, reactive strength will come in a little later but will actually cross over with our explosive training (for example, Mon: explosive strength, Thurs: reactive strength). At this point it's unlikely that we'll be performing any maximum strength sessions (unless the athlete is a beginner).

Our reactive strength sessions emphasize movements and exercises that most closely resemble sprinting with the focus being on minimal ground contact time. These exercises will have the highest carryover into your sprinting performances on the track, field or court.

With these exercises we are trying to mimic the force-velocity and movement pattern characteristics of sprinting. We can achieve this through using training aids such as weighted vests, sleds, medicine balls etc.

PLYOMETRICS

One great way to employ this training is through the use of plyometric drills. These drills mostly involve performing bodyweight jumping exercises and are an effective way for you to increase your power. Again, these exercises have direct crossover to your sporting performance as you are learning to exert maximum force in the minimum amount of time.

Plyometric training is usually performed at high intensities and is not always suitable for an athlete. Suitability will depend on training age, ability and fitness levels. There are however lower intensity exercise that can be performed as an introduction to plyometrics for beginners.

It's important that you select the correct type of exercises for your program. Some of the exercises can be extremely stressful on the nervous and skeletal system and should only be performed by well conditioned athletes. Again, if you're untrained, go back to the Phase 1 maximum strength exercises and form a strong base before attempting plyometric training.

When performing plyometric exercises:

- You only want to produce high quality reps, performed with maximal effort. If the quality of the reps diminishes then stop with the sets
- Maximal effort/explosive movements
- Make sure exercises performed allow for minimum contact time.

- These exercises can be highly stressful. Bounding and jumping exercises can be especially stressful for your shins. Make sure you perform plyo exercises on a soft surface—sprung floor or grass work well. Just make sure the ground in which you are performing on is not too hard. You don't want to pick up any unnecessary injuries that could otherwise be avoided.

Examples of reactive strength training exercises:

- Ankling
- Low Hurdle Jumps with Bounce
- Hops
- Sprint Bounding
- Vest Sprints

MAXIMUM STRENGTH PROGRAM EXAMPLE

Exercise	Sets	Reps	Rest	Intensity
BB Back Squat	4	6-8	2 minutes	8 RM
BB Bench Press	4	6-8	2 minutes	8 RM
Deadlift	4	6-8	2 minutes	8 RM
Pull-Up	4	6-8	2 minutes	8 RM
Military Press	4	6-8	2 minutes	8 RM

EXPLOSIVE STRENGTH PROGRAM EXAMPLE

Exercise	Sets	Reps	Rest	Intensity
Power Clean	3	3-4	3 minutes	70% 1 RM
Snatch	4	5	2 minutes	7 RM
Squat Jump	4	5	2 minutes	5% BW
Med Ball Toss	4	6	2 minutes	10 Kg
Plank	4	1 minute holds	1 minute	BW

REACTIVE STRENGTH PROGRAM EXAMPLE

Exercise	Sets	Reps	Rest	Intensity
Box-to-Box Depth Jumps	3	6	2 minutes	BW
Sled Sprints	6	2	6 minutes	10% BW
Explosive Step-ups	4	6	2 minutes	5% BW

The Speed Project aims to supply practical information to athletes and coaches who want to improve their speed and agility for enhanced performance. The site provides access to informational articles, resources, blog posts, and interviews with world-class athletes. The creator, Liam Coultman, is a sprint and conditioning coach, and certified PICP Athlete Performance Specialist. He's currently located at the National Performance Centre for Athletes in Spain. If you have any questions for Liam you can contact him by email: liam@thespeedproject.com. Check out The Speed Project website: www.thespeedproject.com and follow The Speed Project on social media: Facebook: @officialspeedproject / Instagram: @officialspeedproject

Plausible Ergogenic Effects of Vitamin D on Athletic Performance and Recovery

Continued from page 7071

Sato Y, Iwamoto J, Kanoko T, Satoh K. Low-dose vitamin D prevents muscular atrophy and reduces falls and hip fractures in women after stroke: a randomized controlled trial. *Cerebrovasc Dis.* 2005;20:187–92.

Schoenmakers I, Francis RM, McColl E, Chadwick T, Goldberg GR, Harle C, et al. Vitamin D supplementation in older people (VDOP): Study protocol for a randomised controlled intervention trial with monthly oral dosing with 12,000 IU, 24,000 IU or 48,000 IU of vitamin D3. *Trials.* 2013;14:299.

Smith DT, Broughton KS, Larson-Meyer DE. Vitamin D status and biomarkers of inflammation in runners. 2012;3:35–42.

Stratos I, Li Z, Herlyn P, Rotter R, Behrendt A-K, Mittlmeier T, et al. Vitamin D increases cellular turnover and functionally restores the skeletal muscle after crush injury in rats. *Am J Pathol.* 2013;182:895–904.

Suda T, Ueno Y, Fujii K, Shinki T. Vitamin D and bone. *J Cell Biochem.* 2003;88:259–66S.

Sukumar D, Shapses SA, Schneider SH. Vitamin D supplementation during short-term caloric restriction in healthy overweight/obese older women: effect on glycemic indices and serum osteocalcin levels. *Mol Cell Endocrinol.* 2015;410:1–5.

Todd JJ, Pourshahidi KL, McSorley EM, Madigan SM, Magee PJ. Vitamin D: Recent advances and implications for athletes. *Sport Med.* 2015;45:213–29.

Tripkovic L, Lambert H, Hart K, Smith CP, Bucca G, Penson S, et al. Comparison of vitamin D2 and vitamin D3 supplementation in raising serum 25-hydroxyvitamin D status: a systematic review and meta-analysis. *Am J Clin Nutr.* 2012;95:1357–64.

Van den Ouweland J, Fleuren H, Drabbe M, Vollaard H. Pharmacokinetics and safety issues of an accidental overdose of 2,000,000 IU of vitamin D3 in two nursing home patients: a case report. *BMC Pharmacol Toxicol.* 2014;15:57.

Vieth R. Vitamin D supplementation, 25-hydroxyvitamin D concentrations, and safety. *Am J Clin Nutr.* 1999;69:842–56.

Wang T-T, Tavera-Mendoza LE, Laperriere D, Libby E, MacLeod NB, Nagai Y, et al. Large-scale in silico and microarray-based identification of direct 1,25-dihydroxyvitamin D3 target genes. *Mol Endocrinol.* 2005;19:2685–95.

Webb AR. Who, what, where and when-influences on cutaneous vitamin D synthesis. *Prog Biophys Mol Biol.* 2006;92:17–25.

Wehr E, Pilz S, Boehm B, März W, Obermayer-Pietsch B. Association of vitamin D status with serum androgen levels in men. *Clin Endocrinol (Oxf).* 2010;73:243–8.

Welch TR, Bergstrom WH, Tsang RC. Vitamin D-deficient rickets: the reemergence of a once-conquered disease. *J Pediatr.* 2000;137:143–5.

FASCIA AS A SENSORY ORGAN

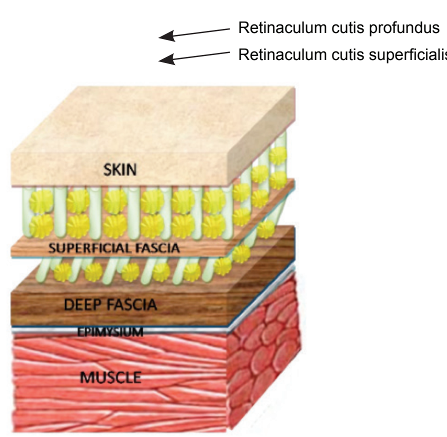
Recent research has shone a light on fascial dysfunction as a source of pain or injury in track & field and other sports. In the second half of this article, Editor Russ Ebbets asks the author specific questions to clarity the subject matter.

BY EMMET J. HUGHES, D.C., M.S.

Fascia is a component of the connective tissue made up of sheets of collagen and elastic fibers that are associated with loose connective tissue. This loose connective tissue allows normal gliding of the individual layers of collagenous and elastic sheets that make up the deep fascia. It is a continuous, three-dimensional supportive structure found throughout the body, enveloping every blood vessel, nerve, muscle, bone, and organ. It is richly populated with sensory receptors providing a continuous feedback mechanism to the central nervous system. It is crucial for local coordination of groups of muscles, allowing them to act synergistically to enact movement.[1]

There are three main types of fascia found in the body: superficial, deep (which includes both aponeurotic and epimysial fascia), and visceral fascia.

Superficial fascia is found deep in the superficial adipose tissue (SAT) just below the dermis. It is firmly adhered to the skin via vertical septa (retinaculum cutis superficialis) interposed between the SAT. It is also connected via diagonal septa (retinaculum cutis profundus) found in the deep adipose tissue (DAT) layer to the deeper fascial layers known as aponeurotic fascia and epimysial fascia.



Epimysial fascia consists of two to three layers of fibrous sheets, mainly collagen fibers with some elastic fibers, with layers of areolar connective tissue in between each sheet. Previously, the arrangement of the collagen fibers was thought to be disorganized. Recent studies demonstrate that the arrangement in each layer is quite organized along specific lines of stress.[2] Each sheet is oriented in a different direction giving the tissue the appearance of disorganization, thus the descriptive term dense, irregular connective tissue.

Multiple layers of collagenous and elasitic fibrous sheets in deep fascia

The hyaluronan between each sheet acts as a lubricant, allowing the layers to glide over one another. Changes in pH, inflammation and direct trauma can cause the hyaluronan to polymerize, entangling the molecules and changing the consistency from a lubricant to more like honey or glue. These areas have been termed densifications. *This can be a significant source of pain and dysfunction.*[3]

Without the normal gliding of the fascial sheets, dysafferentation from proprioceptors in the fascia cause a discoordination of the muscle groups controlling the joint they are associated with. On average, 47% of the muscle fibers are not continuous with the tendon, but rather are invested in fascia. These fibers tense the fascia causing mechanical stress and firing of mechanoreceptors. Abnormal stresses in the fascia due to changes in the hyaluronan can lead to abnormal movement and joint damage.

To restore normal glide to fascia, a practitioner must be able to identify the specific points in the fascia where the densifications occur. A thorough history of traumas suffered over the patient's lifetime is essential in honing in on where the densifications may be that are causing the current symptoms. Treatment involves manual deep friction over the densifications to restore normal gliding. This can be achieved using knuckles or elbows.

Patients who suffer from insidious pain syndromes and chronic pain should be evaluated for fascial dysfunction. By restoring the normal function of the fascia, the normal proprioception is restored and allows for proper coordination of movement. Many of these patients can function optimally and with minimal or no pain after years of suffering with chronic pain and dysfunction.

1. Benjamin M. The fascia of the limbs and back--a review. J Anat. 2009 Jan;214(1):1-18.
2. Klingler W, Velders M, Hoppe K, Pedro M, Schleip R. Clinical relevance of fascial tissue and dysfunctions. Curr Pain Headache Rep. 2014;18(8):439.
3. Pavan PG, Stecco A, Stern R, Stecco C. Painful connections: densification versus fibrosis of fascia. Curr Pain Headache Rep. 2014;18(8):441.
4. Stecco A, Stern R, Fantoni I, De Caro R, Stecco C. Fascial Disorders: Implications for Treatment. PM R. 2016 Feb;8(2):161-8.

1. What is the fascia? Fascia is a dense "irregular" connective tissue that forms a 3-D structure, enveloping muscles, nerves, blood vessels, lymphatics and organs.

2. How has our understanding changed about the fascia in the last 20 years? Fascia was previously thought to be inert. We now know that fascia acts as a sensory organ and has contractile elements.

3. How would one know if they have a "fascia problem" as opposed to a muscle tear or chronic tendonitis? A fascial problem is generally recognized as different from a strain or sprain in that there is an insidious onset, usually to an area of the body that hasn't had trauma. Chronic tendonitis (tendonopathy) can be due to fascial dysfunction. The history of the patient would be another clue as to whether or not it is a fascial problem.

4. Warren Mattes said the fascia is one of the water storage areas of the body...has this understanding changed? It is much more than a water storage area. Although the hyaluronan does imbibe water, I wouldn't consider it a water storage area.

5. What do you see as the most common fascial injuries? How do they present? Chronic "trigger points", compartmental syndromes, insidious neck and low back pain are common fascial problems. Often they will present with unexplained weakness in a muscle or group of muscles, without any neurological deficit.

6. Are the "densifications" you mentioned the same thing as adhesions? It depends on what an adhesion is described as. A densification is an increase in the density of hyaluronan, not an increase in collagen. That would be better described as a fibrosis. A densification fits the definition of an adhesion in my view.

7. How does a healthy fascial system aid one's symmetry of motion? What about force and power production? A healthy fascial system is crucial to symmetry of motion. It allows proper recruitment of muscles to move a joint in a specific plane.

8. What type of health care practitioners do fascial work? How would one find someone in their locality? What questions should one ask? Rolfers, massage therapist, physical therapists and chiropractors do fascial work. However, looking at the fascia in a holistic way is different than the traditional therapist. It is an approach that requires extra training. In my experience, Fascial Manipulation (Stecco method) is superior in that it takes that holistic approach.

9. If the fascia is healthy how does it contribute to the stretch reflex? (I am thinking about the pronation/supination of the hands and feet that tighten the fascia and make it more spring like—is this a correct assumption?) It does contribute to the stretch reflex. The most recent research on this has turned our basic understanding of the physiology of muscle activation on its head. It is understood that the gamma motoneuron is first stimulated by descending pathways (corticospinal tract) and that activates the muscle spindle. The contraction of the muscle spindle activates the Ia afferents (spiral endings) which relay a signal to the cord activating the extrafusal fibers associated with that spindle. It acts as an "on" switch for the extrafusal fibers.

10. Who are some of the pioneers in the fascial work? Ida Rolfe, Meyers, Mattes, and Luigi Stecco are certainly the ones I think of. Carla and Antonio Stecco have done a lot to advance our more recent understanding of fascia.

11. How do their philosophies or approaches differ? I think that the Steccos have advanced treatment of fascia way beyond anyone before them. They bring the unique perspective of treating fascia from the point of view that old injuries affect the ability of the fascia to convey sensory information and that by restoring glide to the fascia, one restores the sensory function as well.

12. One of the common training maxims is to train "movements not (individual) muscles." Why does this make sense as one understands the fascial plane? It is perfectly matched to the most recent research. I think it is quite ridiculous to think that we can train a single muscle. In my view, that is a primitive way to look at movement.

13. How can the fascia be injured? Changes in pH, trauma, chronic inflammation, overstressing are all ways to "injure" the fascia. This leads to densifications and fascial dysfunction.

14. Is there any way to "strengthen" the fascia? I'm thinking here of isometric-type exercises, other movements, nutrition, etc. Certainly movement in specific patterns (i.e. plyometrics) help to maintain the function of fascia. I'm not sure that increasing the density of the collagenous structure would be a good thing for the fascia.

15. What effect does traditional static stretching have on the fascia? It has a beneficial effect. However, as far as I know, it will not resolve densifications.

16. How do disciplines such as Tai Chi and yoga affect the fascia? What about disciplines like Feldenkrais Method and Alexander Technique that actors use? These are all great to maintain the function of the fascia, but will not address densifications.

17. Track & field has a high incidence of hamstring injuries and Achilles injuries—how could the fascia be involved with these areas? I believe that underlying densifications are a causative factor in these injuries, as well as other injuries.

18. How does the fascia affect posture or conversely how does posture affect the fascia? Densifications in fascia will negatively affect posture and vice versa. Poor posture can lead to the development of densifications.

19. How does one's warm-up affect the fascia? What about a warm-down? I think that warm-up is more important in preventing injuries. Post-exercise stretching is an excellent way to maintain the proper function of fascia.

20. Should one think of "loosening up" the fascia or is it more an elastic tissue that responds better to range of motion type exercises (or something else)? In my experience, deep cross-friction massage over densifications is what does the trick. This is the only way that I know of that a manual medicine practitioner is able to restore the glide in fascia. I know that there are some successes using injections of hyalruonidase (an enzyme that breaks down hyaluronan).

21. There are many tools on the market that purport to treat the

fascia—are there any you recommend more than others? (foam rollers, Tiger Tal, etc.) Without the knowledge of how the fascial system works, these are limited in their value. Looking at agonists and their antagonists is a critical way to restore the gliding to the fascial system.

22. If you look into your crystal ball—what changes do you see with regards to care of this tissue in the next 10-15 years? I was just at a "master class" in Arizona. We were training the Arizona Diamondbacks manual medicine team (athletic trainers, strength coaches and massage therapists) in this technique. I think it will become a staple of all professional sports teams. I believe that this is a revolution in the way fascia is looked at and treated.

23. Are there any YouTube videos that you feel are valuable or would recommend? I haven't seen many that are that helpful. I did see a woman from Finland who works with children who suffered brain injuries. She had some amazing videos of dramatic improvements in the ability of these kids to ambulate after being treated using Fascial Manipulation.

24. Anything else you'd like to add? I encourage manual medicine practitioners to learn the technique. I encourage coaches and teams to seek out someone who is adept at doing this technique. This will help to keep your athletes competing instead of nursing chronic injuries.

Emmett J. Hughes, D.C., M.S. earned his doctor of chiropractic degree from the University of Bridgeport College of Chiropractic in 1997. He is an Associate Professor of Basic and Clinical Sciences at UBCC and has been teaching there for 20 years. He has published numerous articles on nutrition, basic science, and fascia and continues to do research in those areas. He maintains a private practice in Huntington, NY.

FROM THE EDITOR

Continued from page 7066

In fact, the fascia is everywhere in the body. The role and function of the fascia is minimally studied, often seen as "junk" tissue by many and a tissue that serves no purpose.

But consider that the network of the body's fascia is so extensive that you would be visibly recognizable if you somehow lost all your skin and only your fascia remained. A key word here is "network" because recent study (over the last 20 years) has confirmed that the fascia is connected in lines or tracks that crisscross or run the length of the body and coordinate and facilitate movement.

Truthfully this is revolutionary thought, especially for those mired in a "systems approach" mindset about the body. The fascia is the tissue that connects and helps coordinate the closed kinetic chains of the body, the stretch reflexes and helps produce a powerful summation of forces.

Hydration plays a role in the functioning of the fascia. In that the fascial sheaths slide over each other dehydration can cause the body's fascia to stick to surrounding tissues forcing the body to work against itself creating unnecessary tension and producing early fatigue.

It is premature to call the fascia the "last frontier" in the study of the human body but I certainly see it as a frontier. Research and debate continues in attempts to define the function of the various fascial lines, how to recognize the presentation of fascial dysfunctions and ultimately how to resolve those dysfunctions. This knowledge will have a direct effect on how well an athlete can run, jump or throw.

In an effort to shed some light on the subject this issue includes a short article on the fascia and some questions and answers from Dr. Emmett Hughes, who has done much pioneering work in this area. It seems almost ironic as I write this that the study of this "system" may help promote the alteration of the "systems approach" to anatomy and physiology, generating an impetus to adopt a more holistic view of the body, more closely aligned to the way the body really works.

FROM START TO FINISH: THE WOMEN'S 100M HURDLES

This is a piece of track & field history—a concise description of correct technique in the women's 100 hurdles by the late Canadian master coach, Brent McFarlane. It is an excerpt from McFarlane's definitive book, *The Science of Hurdling and Speed* and is adapted from *The Coach,* Spring 2008.

BY BRENT MCFARLANE

THE NATURE OF THE EVENT

The purpose of the women's 100m hurdle race is to generate as much speed as possible over the distance while clearing 10 equally spaced hurdles, set 8.5 meters apart, which are 84cm in height.

The distance between the start line and the first hurdle is 13 meters and the distance from the last hurdle to the finish line is 10.5 meters. The athlete's center of gravity (center of mass) is kept as close to its normal sprinting path as possible while clearing the hurdles in order to minimize the length of time in the air.

The 100m hurdles are typical of all hurdle races in having identifiable elements which must be blended into one unified effort. The seven elements, expressed in time sequence are:

- start;
- sprint approach to the first hurdle;
- hurdle clearance (takeoff, layout, descent);
- landing;
- follow-up stride;
- re-acceleration to the next hurdle;
- sprint to the finish line.

Combined together, these elements give, in effect, eleven different "races"; from the blocks to the first hurdle, nine other clearances and the run-in to the finish line.

THE START AND THE SPRINT APPROACH TO THE FIRST HURDLE

The 100m hurdles is a sprint event. A good start and maximum acceleration to the first hurdle are necessary in order to maintain the fastest possible rhythm between hurdles. Sprint hurdlers cannot attain their maximum velocity because there are normally only eight strides from the start to the first hurdle. This means that the lead leg is in the back block, except for a few of the tallest, strongest hurdlers who are able to take seven strides with a fast rhythm.

Optimal acceleration is achieved when *the greatest amount of force is applied to the track in the shortest amount of time.* (This product is known biomechanically as "impulse"). Force is applied through the foot but it is generated by the summation of forces in other joints working in unified sequence, principally the ankle, knee and hip. The need for *a big force in a short time* is an idea of fundamental importance which results in speed, the product of stride length and stride frequency.

Since stride length is predetermined, the development of stride frequency is the most important factor in a hurdler's preparation. In this pure acceleration phase, the free leg swing, when the leg is not in contact with the ground, is also a dynamic action. It is brought about by flexion in the same hip, knee and ankle joints which are extended to provide the driving force in the previous stride. The flexed joints shorten the whole lower limb complex. This enables the hip joint to rotate forward faster by reducing the biomechanical resistance to the rotation, known as the moment of inertia.

For these biomechanical reasons, eight shorter strides from the blocks normally permit greater acceleration than seven longer strides. The distance covered is the same but there is one more opportunity to exert force to the ground.

The speed of movement of the joints, that is, their angular velocity, is likely to be greater. Assuming a faultless

BILL LEUNG, JR/GEEK MEDIA

hurdle clearance in both cases, the eight stride hurdler is likely to be carrying a quicker rhythm over the hurdles. The pure acceleration action of the lower leg is characterized by a low shin angle between the shin and the ground, a cocked or dorsiflexed foot and a casting motion which is often described as "stepping forward" below the opposite knee.

HURDLE CLEARANCE—TAKEOFF

The distance from the hurdle on takeoff depends on several factors—speed of the approach run, length and speed of the lead leg, height of the athlete, height of the hurdle and the flexibility of the hip, knee and ankle joints. There are three clearly identified strides between hurdles, but hurdling should not be considered "three strides and a jump". It is rather a continuous four stride pattern with the last stride merely longer and accentuated in its action. The takeoff distance for women before the hurdle will vary between 1.95m to 2.10m on the takeoff before the hurdle and between .80m and 1.0m on the landing after it. The female hurdler touches down closer to the hurdle than her male counterpart because the hurdle is lower.

Four actions need attention in this phase of hurdling:

- lead leg;
- trail leg;
- arm action;
- body lean.

HURDLE CLEARANCE—LEAD LEG

The lead leg attacks the hurdle beginning with a high knee action generated from the hip flexor muscles (ilio-psoas, rectus femoris) and the supporting muscles of the upper leg. The foot is always "cocked" by dorsiflexing the foot, or "pulling the toe up". These actions decrease the moment of inertia about the hip and therefore permit a high angular velocity in the subsequent movements of the lead leg.

The lead leg action is supported and enhanced by plantar flexion, or foot drive, of the trail leg to lift the body and keep the hips tall as the lead leg attacks the hurdle. The raised center of gravity enables the trajectory over the hurdle, a parabolic curve, to be as flat as possible. This keeps the path of the center of gravity as close as possible to a normal sprinting action. The rotational force, or torque, of the plantar flexion is generated by the gastrocnemius and soleus and other supporting muscles in the calf.

The hurdler should concentrate on "thigh up, knee up, toe up, heel up" to facilitate a quick takeoff and to reduce braking forces upon landing. Leading with the foot not cocked has a tendency to lock the knee prior to the heel reaching the hurdle. If this continues throughout the clearance, a delayed landing and greater braking forces will result.

The lead knee should cross the hurdle in a slightly flexed position. This allows an efficient, fast "step down" and landing and facilitates re-acceleration of the hip towards the next hurdle. The lead leg must be lifted straight up and down in the sagittal plane, that is, in the direction of running. If not, the hurdler will land off balance and with a braking action.

HURDLE CLEARANCE—TRAIL LEG

The ankle plantar flexors of the trail leg must be allowed to complete their full drive. This is shown by full extension of the trail knee joint at takeoff and is achieved by the contraction of the hip extensors (gluteus maximus and hamstrings) and the knee extensors and stabilizers (the group of three "vastus" muscles in the front of the thigh) in conjunction with the plantar flexor muscles at the ankle. The knee of the trail leg will be locked momentarily prior to the lead leg reaching the hurdle. This should be part of the natural running stride rather than being a forced action.

HURDLE CLEARANCE—ARM ACTION

As the lead leg is lifted, the opposite (lead) arm attacks the hurdle with an extension across the chest at shoulder level to the body's midline. It should not be thrust forward towards the hurdle, *nor cross over the midline.* This would tend to exaggerate the lateral rotation of the upper body resulting in a loss of balance and timing. Synchronization of the actions of this lead arm with the lead leg is critical since they serve to keep the shoulders square towards the hurdle and counteract any lateral movement in the hip. The other, off-side (trail) arm simply moves close to the trail hip in as close a movement to the normal sprinting action as possible.

HURDLING IS A CONTINUOUS ACTION. AT NO TIME DO THE LEGS OR ARMS STOP MOVING.

HURDLE CLEARANCE—BODY LEAN

Once in flight, the body's center of gravity describes a parabolic curve which cannot be altered. The elements of effective lift, attack and takeoff must therefore start while the hurdler is in contact with the ground. The effect of the driving forces described above is enhanced by a forward rotation caused by a forward body lean or "forward falling" at takeoff. This helps to keep the center of gravity as close to the normal sprinting path as the hurdle technique allows. To aid this position, the takeoff stride is sightly shorter than the others. The strength necessary for body lean is produced in the abdominal muscles (rectus abdominus and supporters) which strength in the back (erector spinae and supporters) provides for a quick recovery from the lean into the upright sprinting position.

In the takeoff phase, the errors to watch for are:

- **sinking the hips on takeoff** will cause the center of gravity to lower and thereby increase its parabolic curve across the hurdle;
- jumping **the hurdle** occurs when the takeoff is too close;
- **low lift of the lead leg** causes either a locked lead knee or an incomplete trail leg drive;
- **poor hip mobility** slows the entire action.

All of the above factors can also result in increased braking forces upon landing.

HURDLE CLEARANCE—LAYOUT

Hurdling is a continuous action. At no time do the legs or arms stop moving. Any deceleration or hesitation often observed in the layout is detrimental. The trunk is forward over the lead leg, the trail leg starts its first stages of the hip circle, the shoulders remain square, the lead arm is almost fully extended and the lead leg is flexed slightly as it crosses the hurdle. A clearly flexed knee over the hurdle allows for a quicker descent by decreasing the moment of inertia of the lower limb complex. If the knee is locked, there will be a jumping effect and a loss of speed. The trail arm moves downwards in a circular motion at the hip to maintain timing and balance in the upper body.

HURDLE CLEARANCE—DESCENT

When the foot of the lead leg advances over the hurdle and begins to move downward, the descent phase begins. At this point, the trail leg is advancing forward with an everted (turned out) toe, shoulders are still square, the trunk is still forward but the upper body is beginning to rotate upwards slightly as the lead leg drops. The knee flexor muscles (hamstrings; and gastrocnemius) are essential for a fast "cut down" of the lead leg.

If body lean or trail leg drive is insufficient, the hurdler will tend to land on her heel. Consequently, braking forces are considerable, speed will be lost and there is even a risk of injury.

The correct leg split in the takeoff and layout gives rise to the hip circle which continues with the thigh crossing parallel to the hurdle. If the angle at the trail knee is kept at 90 degrees or less, then once again angular velocity is increased in the clearance action of the hip. The trail leg is raised above the hurdle to a position which is almost at a right angle to the body. This requires abduction of the thigh at the hip joint by the gluteus medius muscle. The ankle of the trail leg is everted by the peroneus longus and brevis muscles of the calf.

Pulling the thigh through its complete action should be emphasized at this point. This pull through of the trail leg to the landing step is initiated by the hip flexor muscles (ilio-psoas and supporters) and the adductors of the thigh.

As the trail leg comes forward an equal and opposite reaction is produced. This is the backward "pawing" of the lead arm. If the shoulders are to remain square throughout the flight then these two actions must be equal. Since the leg has more mass than the arm, the arm must swing wider than the leg to counteract its action. Therefore, the lower arm and hand complex actually goes "down and around" the trail knee.

A useful cue is to "cut off" the knee. This action increases the moment of inertia of the upper body and thus provides a more solid reaction to, or absorption of, the action of the lower body in the same plane.

The arm action occurs mostly in front of the body and does not go behind the hip. The overall importance of actions in front of the body gives rise to the term "front-side mechanics".

The arm movement in hurdling has a three-stroke action:

- at takeoff: lead leg and lead arm attack;
- on clearance: the lead arm "cuts off" the trail leg. The off-side hand races the knee of the trail leg to "be tall";
- on landing: both hands drive tall for re-acceleration.

The pawing action terminates as soon as the lead leg hits the ground. Body lean is held, although rising slightly, as the body advances into the landing position of the trail leg.

LANDING, FOLLOW-UP STRIDE AND RE-ACCELERATION

Hurdling involves a "falling" and "recovery" action on each stride. After landing, the hurdler concentrates on immediate recovery to a normal sprinting stride. A good follow-up stride will place the center of gravity just slightly ahead of the body. It will land her on the ball of the foot and be moving strongly backward to pull the center of gravity forward and enable immediate application of impulse into the track once more—"A Big Force in a Short Time"—displacing the hip forward quickly. A landing too far ahead of the body will slow or prevent this backward movement and set up undesirable braking forces.

The trail arm must not be so fast or erratic as to upset shoulder alignment, since this will result in undesirable upper body rotation. The primary purpose of this arm is therefore to balance the upper and lower body, allowing the lead arm to drive backward as the body resumes its normal sprinting action in the re-acceleration towards the next hurdle.

Any mechanical errors during clearance can result in the common problems of braking upon landing, running flat-footed, low hips and center of gravity, overstriding and, most obvious, the loss of speed.

The three strides between hurdles are shorter than normal. The follow-up stride is always the shortest since its driving force is reduced by the preceding hurdle clearance. The second stride is the longest. The third and last stride is always slightly shorter than the previous stride. As we have discussed, it prepares the body for the next hurdle attack and once more assists the trajectory of the center of gravity on its parabolic curve during clearance.

FINISHING SPRINT

Having cleared the last hurdle, all attention is directed immediately towards the remaining 10.5m to the finishing line. Athletes should know exactly how many strides they need (generally about 6.5 strides) and regularly practice the dip on the last stride so that it becomes a normal part of their race.

USATF COACHING EDUCATION

2018 CALENDAR OF SCHOOLS

http://www.usatf.org/Resources-for---/Coaches/Coaching-Education/Calendar-of-Schools.aspx

Level 1

Jan. 5-7	University of South Carolina - Columbia, SC
Jan. 6-7	Florida Atlantic University - Boca Raton, FL
Jan. 12-14	Taylorview Middle School - Idaho Falls, ID
Jan. 12-14	Skyline High School - Ann Arbor, MI
Jan. 13-14	Chabot College - Hayward, CA
Jan. 13-14	*(LA84) San Diego Mesa College - San Diego, CA
Jan. 19-21	Parkview High School - Lilburn, GA
Jan. 26-28	Kennedy Catholic High School - Burien, WA
Jan. 27-28	Alhambra High School - Phoenix, AZ
Feb. 16-18	Christian Brothers College High School - St. Louis, MO
Feb. 17-18	Canby High School - Canby, OR
Feb. 17-18	Benedictine University - Lisle, IL
Mar. 9-11	Episcopal High School - Alexandria, VA
Mar. 10-11	Meridian Community College - Meridian, MS
Mar. 17-18	University of Nebraska - Lincoln, NE
Mar. 17-18	Villanova University - Villanova, PA
May 19-20	Allen High School - Allen, TX
June 2-3	National Training Center - Clermont, FL
June 8-10	Atlantic Sports Health - Morristown, NJ
June 8-10	Drury Inn La Cantera - San Antonio, TX
June 9-10	Wellesley College - Wellesley, MA
June 17-19	UNC Greensboro - Greensboro, NC
June 18-19	Stillwater High School - Stillwater, MN
June 22-24	Benedictine University - Lisle, IL
June 23-24	Union High School - Tulsa, OK
June 29-Jul 1	Ithaca College - Ithaca, NY
July 7-8	Ironwood Throws Facility - Rathdrum, ID
July 20-22	Johns Hopkins University - Baltimore, MD
July 20-22	Nassau Community College - Garden City, NY
Aug. 3-5	Yale University - New Haven, CT
Aug. 10-12	St. Martin's University - Lacey, WA
Sept. 28-30	Community College of Philadelphia - Philadelphia, PA
Oct. 12-14	Marian University - Indianapolis, IN
Oct. 13-14	University of Southern Maine - Portland, ME
Nov. 17-18	Allen High School - Allen, TX
Nov. 17-18	Wellesley College - Wellesley, MA
Nov. 24-25	Virginia Wesleyan University - Virginia Beach, VA
Dec. 1-2	Tennessee State University - Nashville, TN
Dec. 7-9	Westerville South High School - Westerville, OH
Dec. 29-30	Loyola University - New Orleans, LA

ANNOUNCEMENT OF THE COACHES REGISTRY EDUCATION STANDARD AS OF JANUARY 1, 2018

Purpose: To raise the professional credibility of the USATF Coaches Registry by establishing a baseline standard of professional education and/or coaching experience. In following best practices in the industry, align the USATF Coaches Registry with other USOC NGB's coach licensing protocols. A standard of professional education or coaching accomplishment in the sport of track and field would fully qualify an individual seeking admission to the Registry, thus receiving the benefits of the Registry as a track and field coach.

What: New component to the Coaches Registry, in addition to a coach having USATF membership, a current background screen from approved screening agency, and completion of USOC Safe Sport course.

Coaches meet this one time requirement as a component of the Coaches Registry for the Education Standard.

When: The educational standard will become a component of the Registry as of July 2018; **USATF coaches may add their education standard to their Coaches Registry profile beginning in July of 2018. Requirement of the education standard to receive benefits of the Coaches Registry will not be implemented until January of 2019.**

Who is the clearing house for evaluating education standard: USATF national office staff will provide oversight of all components of the Coaches Registry. An oversight sub-committee from the Coaches Advisory Committee will review and evaluate any issue with a coach's education standard.

Who can meet the education standard for the Registry: Any person who has completed one of the approved coaching education courses for track or field or who qualifies based on career accomplishments as a track and field coach.

Two Paths to meet the Educational Standard for the Coaches Registry:

1. Complete a verified course of education (completion of any one of the following courses):
   a. Level 1, 2, or 3 of the USATF CE Professional Pathway of Coach Certification
   b. Technical Basic course of the USTFCCCA Academy or any advanced course (online or classroom)
   c. NFHS Coaching Track and Field (online)
   d. USATF Cross Country Specialist Course
   e. Any approved course on USATF Campus (online)
   f. Completion of a USATF Event Skill Specialist Clinic (Learn by Doing)

   (certificate of completion for any of the above courses serves as verification of education standard)

2. Accomplish an education standard equivalency during one's coaching career

   Category 1. Credible Body of Work:
   a. Member of an international coaching staff selected by USATF over the last 5 Olympic quads
   b. Primary coach of record of a medalist athlete on any one of the BIG THREE teams (Olympics, World Championships, Pan-Am Games)
   c. Elite technical coach of USA National Team athletes over an 8-year period (coach must list athletes' name and contact information)

Category 2. Career Honors:

a. USATF Legend Coach
b. Hall of Fame Coach for USATF or USTFCCCA
c. National Coach of the Year for USATF or USTFCCCA, or USOC
d. USTFCCCA national assistant coach for men's or women's indoor and outdoor season
e. Hall of Fame Coach for National Scholastic Track Coaches Association

Category 3. Professional Coaching Career

a. Employment as a track coach at a scholastic or collegiate institution for a 10-year period verified by employers' information.

Coaches may add their education standard to their coach profile as they update/renew their Coaches Registry in 2018. Coaches should be prepared to produce proof of qualification if so requested.

RECERTIFICATION GUIDELINES FOR ALL CURRENT LEVEL 1 COACHES BEFORE DECEMBER 31, 2020 EXPIRATION

All current Level 1 coaches are certified with USATF through December 31, 2020. The qualifying period for a current Level 1 certification is course completion from January 1, 2013-December 31, 2020. For coaches who choose not to seek a Level 2 certification before December 31, 2020, the options below apply to extend your Level 1 certification through the next Olympic Quad, 2021-2024.

Options to recertify are the following, choose one:

Option 1: Renewal certification earned by completing **ONE** course offered on USATF CAMPUS, from January 1, 2018-December 31, 2020.

Option 2: Renewal certification earned by completing **ONE** Event Skill Specialist certificate (i.e. Learn By Doing Clinic or Cross Country Specialist Course), from January 1, 2018-December 31, 2020.

Option 3: As of January 1, 2020-December 1, 2020, register for the online recertification exam to retest on the methodology and content of the Level 1 textbook, "Track & Field Coaching Essentials."

A recertification application will be available in the last 12 months of the current certification period in which the coach will fill out with USATF membership number, coach profile, and the chosen option from one of the three above. After submission to the National Office coaching department, the option will be verified via the coach education databases and certification issued with an updated Level 1 certificate through 2024.

All offerings of courses or clinics available can be located on the Calendar of Schools.

Level 1 certification issued prior to December 31, 2012 are no longer current, and coaches will need to register and attend a Level 1 school.

Level 2 or 3 certified coaches are exempt from needing any recertification to maintain a current coach certification with USATF.

USATF COACHING EDUCATION AWARD WINNERS

USATF annually recognizes professional coaches for outstanding contributions and service to coaching education. Honorees were recently recognized at the 2017 USATF Annual Meeting.

Dr. Joe Vigil Sports Science Award: Dr. David Bellar, Director/Professor of School of Kinesiology, University of Louisiana at Lafayette

This award recognizes a coach who is very active in the area of scholarship, and contributes to the coaching literature through presentations and publications. This award identifies a coach who utilizes scientific techniques as an integral part of his/her coaching methods, or has created innovative ways to use sport science.

Ron Buss Service Award: John Gartland, Volunteer Assistant Coach, Indiana State University

This award recognizes a coach that has a distinguished record of service to the profession in leadership roles, teaching, strengthening curricula and advising and mentoring coaches. This person is a leader, whose counsel others seek, and who selflessly gives his/her time and talent.

Fred Wilt Coach/Educator of the Year Award: Tony Veney, Head Cross Country/Track and Field Coach, Ventura College

This award recognizes a coach that has a distinguished record, which includes sustained, exceptional performance. This award will be presented annually to recognize one individual who has exemplified passion and leadership nationally for the promotion of USATF Coaching Education.

Vern Gambetta/Young Professional Award: Erin Gilreath, Assistant Coach, University of Central Florida

This award recognizes a young coach in the first 10 years of his/her career that has shown an exceptional level of passion and initiative in Coaching Education. This award will be presented annually to recognize one individual who has exemplified passion and leadership nationally for the promotion of USATF Coaching Education.

Terry Crawford/Distinguished Female in Coaching Award: Jennifer Potter, Head Women's Track and Field Coach, Ithaca College

This award recognizes a female coach that has shown an exceptional level of accomplishment, passion and initiative in Coaching Education. This award will be presented annually to recognize one female coach who has exemplified passion and leadership nationally for the promotion of USATF Coaching Education.

Kevin McGill/Legacy Award: Dave Mills, Volunteer Assistant Coach, Boise State University

This award recognizes a veteran coach with 25+ years of involvement that has shown an exceptional level of passion and initiative in Coaching Education. This award will be presented annually to recognize one individual who has exemplified passion and leadership nationally for the promotion of USATF Coaching Education.

Level 2 Coaches/Rising Star Award: Kathy Butler, Development Team Coach, Boulder Track Club

This award recognizes a coach that has utilized the USATF level 2 CE program to make an impact on their coaching that includes sustained, exceptional performance. This award will be presented annually to recognize one individual who has recently completed the level 2 school and it has helped to make an impact on their coaching. This award winner exemplifies the impact of the USATF Coaching Education program.

TRACK TECHNIQUE/ TRACK COACH CONTENTS

TRACK TECHNIQUE/TRACK COACH BACK ISSUES. The issues listed below are the only remaining issues of the printed issues. If an issue is not listed, it is out of print and unavailable. These issues are available singly for $5.50 apiece postage-paid for U.S. delivery; $8.00 apiece postage-paid for foreign delivery. Order 5-9 issues, pay $4.00 apiece; 10 or more issues, $3.00 each, postage-paid. Non-U.S. orders—add $2.00 shipping per copy. Some issues are in short supply, so order early. Visa/MC/Amex orders accepted by phone: 650/948-8188 9 am-5 pm PT, M-F. Note: The periodical's name was changed from *Track Technique* to *Track Coach* with issue #131 (Spring 1995). Listed below are a few of the more prominent articles in each issue. There are more useful contributions in each number.

A one-year DIGITAL subscription (four issues) is $20 U.S. and foreign. *Effective with our Winter 2015 Issue #210, Track Coach became available by electronic format only. Digital issues will be sent to the email address used for placing your order.* **Order from:** Track & Field News, 2570 W. El Camino Real, Suite 220, Mountain View, CA 94040 USA. Email: subs@trackandfieldnews.com.

USATF.ORG