Coaching Youth Middle Distance Runners

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Author Note

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Abstract

This work is a supplementary text for coaches who train athletes aged between 6 and 18 years old to participate in running events between 800 and 5,000 m. It is intended to function as a review of available research in the field and as a set of guidelines on how to apply that research. Topics discussed include nutritional concerns, psychological considerations, effective training methods, and competition strategies. Special attention is given to potential differences between genders. An appendix includes selections for further reading.

Keywords: middle distance running, youth coaching, track and field athletics

Coaching Youth Middle Distance Runners

In their book *Practical Track and Field Athletics*, University of Wisconsin-Madison track and field coach John Graham and Olympic champion Ellery Clark (1904) issue practical advice to novice middle distance running coaches:

> With the change from the quarter to the half mile run, speed becomes of much less importance and endurance becomes an absolute necessity. Of course a first-class half-miler, a man who can beat two minutes, must be possessed of a fair amount of speed, but endurance must be cultivated at all hazards. Some cross country running during the winter, combined with gymnasium work for the upper part of the body, is the best preparation for the running season. (p. 35)

The information they offer is mostly correct, but it is also incomplete; the chapters regarding the middle distance events make up only one tenth of the book's length. Although much has changed in the scientific and athletic communities in the last century, coaching has in many ways remained a static field dominated by inadequate and outdated methodologies. Coaches may understand the basic concepts mentioned by Graham and Clark, but knowing what makes a good runner is not the same as knowing how to coach one.

Purpose

Though the benefits of rigorous exercise for young people are numerous and well documented, mere participation is not enough:

> Youth do not necessarily acquire the health and health-related fitness benefits that many parents and other adults assume will be achieved through participating in youth sports without deliberate efforts to ensure that the amount of moderate to vigorous exercise is sufficiently maintained for each young person. (Bergeron, 2007, p. 37)

Coaches, then, serve an important function: They must guide athletes in such a way as to help them find a balance between athletic success and overall wellness. Though a majority of surveyed coaches claim that "learning by doing" is the most common way they acquire knowledge about their sport, many have expressed a desire to learn more through guided education (Erickson, Bruner, MacDonald, & Côté, 2008). Both developmental and top-level middle distance coaches have called for more dissemination of the scientific knowledge in the field (Wiersma & Sherman, 2005; S. J. Williams & Kendall, 2007). While it is true that coaches can sometimes fail to implement the proven methods they are taught even after completing coaching education programs (Judge et al., 2013), and research on this subject is still relatively limited (Midgley, McNaughton, & Jones, 2007), there clearly exists a need to bridge the gap between researcher and coach. Therefore, this work is designed to supplement–but not replace–conventional texts with information related to coaching middle distance runners between the ages of 6 and 18.

Concerns

As with all physical activity, great care should be taken to consider individual circumstances before athletes can dedicate themselves to any training program. Coaches should also be concerned with the early detection of injuries, which can differ from those suffered by adult athletes due to growth-related issues (Krabak, Snitily, & Milani, 2016). This work will address how to correct some common contributing factors to injuries. Some concerns have also been raised regarding the age appropriateness of middle distance running for younger athletes, but a careful review of the available literature finds most of these unwarranted (Jenny & T. Armstrong, 2013). Most young athletes can safely race at distances even beyond 5,000 m if trained responsibly (Roberts, 2007). According to the American Academy of Pediatrics (1990), "if children enjoy the activity and are asymptomatic, there is no reason to preclude them from training for and participating in [endurance running events]" (p. 800). More important than race distance is the type and volume of training, which coaches should manage carefully so as to avoid overuse injuries or burnout (Brenner, 2007). Researchers have also raised a number of important questions regarding the nutritional, physiological, and psychological aspects of training female runners (Lynch & Hoch, 2010; Prather & Hunt, 2005). To address these, this work includes several sections related to specific gender differences that may arise while training young male and female athletes.

Style

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Nutrition

Proper nutritional practices alone cannot generate elite performances, but they can significantly affect athletes' performance in competition and overall wellness (Petrie, Stover, & Horswill, 2004). Maintaining a healthy energy balance, practicing effective hydration habits, and understanding the various aspects of supplementation practices can help athletes improve their performance and increase their enjoyment of the sport. Bingham, Borkan, and Quatromoni (2015) provide this practical advice for young athletes:

- Eat fresh, minimally processed foods.
- Ingest enough calories to remain healthy and competitive.
- Eat after exercising to recover.
- Consume enough fluids to maintain proper hydration levels.
- Plan meals ahead of time.
- Vary the content of meals to ensure they include a variety of nutrients.
- Seek help from a professional to address signs of disordered eating behavior.

Caloric Intake

Many elite runners maintain high carbohydrate, low-fat nutritional programs (Schröder et al., 2008). One study by Achten et al. (2004) indicates that significantly higher carbohydrate intake can improve running performance and mood. Couto et al. (2015) found that a diet high in carbohydrates correlated with a faster sprint speed in the final 400 m of a distance race. That said, children and adolescents have smaller glycogen stores, meaning that they are more likely to process fat during exercise (Jeukendrup & Cronin, 2011), and a higher fat content diet does not inhibit endurance or anaerobic activities in runners (Horvath, Eagen, Fisher, Leddy, & Pendergast, 2000). The quantity of calories ingested should depend on the individual athlete and the current training phase; higher volume and intensity should necessitate greater caloric intake (Stellingwerff, Boit, & Res, 2007). Obese children and adolescents often lower their caloric intake while participating in a structured physical activity (Schwartz, King, Perreira, Blundell, & Thivel, 2016).

Hydration

Athletes should understand that dehydration is unhealthy and detrimental to performance. There is little doubt that "(a) dehydration is a major and common problem within children exercising in the heat; and (b) children do not have the capacity to translate hydration awareness to successful hydration strategies" (Kavouras and Arnaoutis, 2012, p. S11). Stearns et al. (2009) found that improper hydration habits can even affect a runner's pacing ability. Education programs for athletes, such as a short group lecture on the importance of hydration, are an effective tool for improving young athletes' endurance performance (Kavouras, Arnaoutis, et al., 2012). Although adolescent runners can effectively gauge the amount of fluid they consume during exercise (Wilk, Timmons, & Bar-Or, 2010), even experienced runners tend to underestimate the amount of fluids they lose through sweat (O'Neal et al., 2012), and they sometimes struggle to manage their hydration needs by ingesting fluids *ad libitum*–that is, "at one's pleasure" (Passe, Horn, Stofan, Horswill, & Murray, 2007). Therefore, coaches should carefully monitor athletes' fluid intake during training and competition to avoid dehydration:

> The athlete should consume approximately 500 to 600 ml (17 to 20 US fl oz) of water or a sports drink 2 to 3 hours before exercise and 300 to 360 ml (10 to 12 US fl oz) of

water or a sports drink 0 to 10 minutes before exercise (Casa, 2004, p. 7).

Sports Drinks. So long as the athlete has ingested an adequate meal approximately three hours before exercise, carbohydrate-based sports beverages such as Gatorade provide no physiological or psychological advantages over other drinks (Rollo & C. Williams, 2010). They can also lead to a higher rate of gastrointestinal complaints than water alone (van Nieuwenhoven, Brouns, & Kovacs, 2005). Medical groups, such as the American Academy of Pediatrics, caution against the overreliance on such drinks, and they strongly oppose the use of energy drinks containing stimulants (Schneider & Benjamin, 2011). A possible alternative–aside from water–is tart cherry juice, which has been shown to reduce runners' pain levels and aid recovery after a strenuous race (Howatson et al., 2010; Kuehl, Perrier, Elliot, & Chesnutt, 2010). In warmer temperatures, ingesting a "slurry" of crushed ice prior to a workout can improve athletes' endurance capabilities (Siegel, Maté, Brearley, et al., 2010; Siegel, Maté, Watson, Nosaka, & Laursen, 2012). Ingested immediately post-exercise, low-fat chocolate milk has been shown to be a more effective recovery drink than water or carbohydrate-only drinks (Lunn et al., 2011; K. Pritchett & R. Pritchett, 2012).

Supplementation

Nutritional supplements are widely used among national-level youth track and field athletes (Nieper, 2005; Petróczi et al., 2008), but with very few exceptions, conventional supplements do not improve middle distance runners' performance (Burke, Millet, & Tarnopolsky, 2007; Schubert & Astorino, 2013). For some athletes, especially females, iron or calcium supplementation may be beneficial (Nickerson et al., 1989; Rowland, Black, & Kelleher, 1987; Winters-Stone & Snow, 2004). That said, even though many athletes report that their coach exerts the most influence on their supplementation practices (Nieper, 2005), this is not an appropriate role for a youth coach; rather, "an appropriate dietary intake rather than use of supplements (except when clinically indicated) is recommended to ensure young athletes participate fully and safely in athletics" (Meyer, O'Connor, and Shirreffs, 2007, S73).

Gender Differences

There are sex-specific factors that play a role in the bone health - which is closely tied to nutrition - of adolescent runners (Tenforde, Fredericson, Sayres, Cutti, & Sainani, 2015). Most notably, the female athlete triad of disordered eating, amenorrhea, and osteoporosis makes athletes more susceptible to long-term injuries, such as stress fractures. While it should be noted that “participation in distance running at an elite level does not in itself predispose to an eating disorder” (Hulley, Currie, Njenga, and Hill, 2007, p. 521) and mere participation in competitive athletics has no negative effect on bone mass levels in young females (Lucas et al., 2003), coaches should be well aware of the signs and symptoms of these conditions and be willing to address them.

One of the primary factors affecting these conditions is inadequate caloric intake (Gabel, 2006). Female runners are less likely than their male counterparts to meet the caloric intake requirements of an active young athlete (Barrack, Nichols, Rauh, & Van Loan, 2014; Hawley, Dennis, Lindsay, & Noakes, 1995). Female runners who exercise dietary restraint are more likely to have low bone mineral density (Barrack, Rauh, Barkai, & Nichols, 2008), and those who are “careful about their weight” are eight times more likely to sustain a stress fracture than those who are not (Bennell et al., 1995). Nieves et al. (2010) also found that “in young female runners, higher intakes of calcium, skim milk, and dairy products were associated with lower rates of stress fracture” (p. 146). Female runners often lack essential knowledge in this area (Wiita & Stombaugh, 1996; Zawila, Steib, & Hoogenboom, 2003), so coaches must be prepared to educate others involved in the process:

> Such efforts may include educating athletes, coaches, and parents about overtraining, the importance of rest and recovery, sports nutrition, and signs and symptoms of disordered eating as well as the female athlete triad. Education should also include discussion of the myths associated with endurance sports training, including the misperception that more training and lighter weight is always associated with performance improvements. (Voelker, 2013, p. 172)

One such education program for high school athletes improved students' nutritional knowledge by 32%. All of the participants claimed to have made changes to their food intake as a result of the program (Sarkisian, 2016).

Psychology

Since at least the late 19th century, scholars have analyzed the correlations between psychological attributes and athletic success (as cited in Raglin & G. S. Wilson, 2008, p. 211). As Kruger, Pienaar, Du Plessis, and van Rensburg (2012) concluded, it is "important to consider psychological skill development in young long distance athletes to enhance their athletic performance" (p. 413). Focusing on the overall well-being of athletes, including their mental states, can also foster positive overall development (Henriksen, Stambulova, & Roessler, 2010). A one-size-fits-all approach to this field is not advisable (G. Jones & Spooner, 2006). An athlete's motivation can be affected by his or her gender, age group, and locality (Chin, Khoo, & Low, 2012), so coaches should approach each athlete from an individual perspective. Coaches can often misjudge the psychological skills of their athletes, even if they feel confident in their assessment (Leslie-Toogood & G. L. Martin, 2003), and can threaten the athletes' psychological well-being by treating them disrespectfully (Gervis & Dunn, 2004). Therefore, they should use the research in this field, not just their intuition and experiences, to guide their actions.

Motivation

A middle distance coach's role as a psychological motivator is important during competition, but it is perhaps even more important during training (Goose & Winter, 2012). While dedicated, deliberate practice is generally not considered enjoyable in most sports (Ericsson, Krampe, & Tesch-Römer, 1993), there is some evidence that middle distance runners perceive their most difficult and relevant activities as their most enjoyable (Young & Salmela, 2002), making a coach's job that much easier. Coaches should focus on creating specific task-oriented goals in an effort to improve athletes' intrinsic motivation (Barić, Cecić-Erpič, & Babić, 2002; Ferrer-Caja & Weiss, 2000). Goudas, Biddle, Fox, and Underwood (1995) found that one way to engender this kind of motivation among young track athletes was to give them some control over their own workout. This kind of perceived autonomy has been shown to have significant positive and long-lasting effects on retention (Almagro, Sáenz-López, & Moreno, 2010; Jõesaar, Hein, & Hagger, 2012). Care should be taken, however, to ensure that highly motivated runners do not endanger their health by running to the point of collapse (St Clair Gibson et al., 2013). Perhaps most importantly, coaches must instill a feeling of long-term hope in their athletes; Curry, Snyder, Cook, Ruby, and Rehm (1997) found that cross country and track athletes with a higher sense of personal hope were more likely to excel in both academics and athletics.

Retention

Keeping young athletes engaged and excited about running can be a difficult task. Over a span of 25 years, Enoksen (2011) analyzed survey results of track and field athletes who had left the sport and found that the average "drop out" age was 17. There are many reasons a young athlete might leave an athletic program, including injuries and conflicts with work or school, but coaches can encourage retention by fostering a sense of competency in his or her athletes. In general, athletes who are task-driven with a higher sense of competency are more likely to remain in an athletics program (Konttinen, Toskala, Laakso, & Konttinen, 2013; Xiang, McBride, & Bruene, 2004, 2006). Conversely, young runners with a high ego orientation–that is, those who are primarily motivated by a desire to best others–and/or a low perception of their own abilities are more likely to drop out (Cervelló, Escartí, & Guzmán, 2007; Whitehead, Andrée, & Lee, 2004). Cashmore (2008) described this type of runner as someone who "may return a poor time in a 1,500-meter race, but, as long as she finishes in front of the field, it counts as more of a success than if she had run a personal record but finished second." (p.142) Setting performance goals based on time, rather than place, can help to avoid this mode of thinking (Lane & Karageorghis, 1997). G. M. Hill (2000) also listed a number of ways to encourage young runners to stay in their programs, including

- using imagery, such as having an athlete imitate the form of an elite runner;

- encouraging social interaction between athletes, such as positive feedback from peers or group-related running activities; and
- allowing self-pacing, rather than explicitly prescribing distances and times.

Feedback

Offering advice, criticism, and praise is an integral function of the coach-athlete relationship. As Stein, Bloom, and Sabiston (2012) concluded, “it is important that coaches realize the significance of giving feedback following good performances, and attempt to incorporate positive and informational feedback into their interactions with their athletes” (p. 488). Stoate, Wulf, and Lewthwaite (2012) found that runners who were given positive feedback about their form (in this case, fabricated) were more likely to improve over time than those who were given no feedback. Parents should also focus positive verbal feedback on their child’s effort, rather than an outcome like finishing place.

It is also important to consider the focus of the advice given to an athlete. Though a less experienced runner may react to a coach’s external cues–such as “pass that runner!”–positively, higher-level runners consistently report more internally-based thought processes–such as monitoring breathing and maintaining proper form–during competition (Nietfeld, 2003), and their coaches often focus much of their verbal feedback on promoting those internal processes (Porter, Wu, & Partridge, 2010). That said, Schücker, Anheier, Hagemann, Strauss, and Völker (2013) found that there were physiological benefits to maintaining an external focus during high intensity exercise. If nothing else, a simple confirmation of the distance remaining can be better than no feedback at all (Faulkner, Arnold, & Eston, 2011; Neumann & Piercy, 2013). Children will also find it easier to respond to cues related to distance than to time (Chinnasamy, St Clair Gibson, & Micklewright, 2013).

Gender Differences

In general, male and female athletes “want a coach who (a) implements instructional practices, (b) can perform the skills required of the sport, and (c) provide opportunities for the athletes to compete and achieve their goals" (S. B. Martin, Dale, and Jackson, 2001, p. 208). That said, preferred communication style may differ between genders: Male runners and coaches may prefer to focus the conversation between coach and athlete on competition and athleticism, while female runners may prefer to address a broader array of topics (Childs, 2010). Sources of motivation may also differ significantly. According to a study by Sirard, Pfeiffer, and Pate (2006), "boys are more attracted to the competitive aspects of sports whereas girls are more motivated by the social opportunities that sports provide" (p. 696). Gneezy and Rustichini (2004) found that "when children ran alone, there was no difference in performance. In competition boys, but not girls, improved their performance" (p. 377), although Dreber, von Essen, and Ranehill (2011) found no such effect in their similar study. A focus on competition, however, is not necessarily a stronger long-term motivational force: Young women may feel more motivated by the unity of their team (Smith & Ogle, 2006). In fact, Feltz, Lirgg, and Albrecht (1992) found that the young female runners in their five-year longitudinal study were more dedicated than the males.

Training

Among the works written about the subject of training young middle distance runners, Loprinzi, Greenwood, and Cornwell (2012) summarize the subject well. From their conclusions:

> We suggest that, when feasible, coaches individualize and employ periodization into their runner's training regimen. Additionally, it may be beneficial to limit the intensity and frequency of training in the off-season and, to assess for overtraining, evaluate the runner's motivation and mood levels, as well as morning heart rate. To reduce the likelihood of injury, coaches should employ a systematic training regimen and runners are encouraged to develop their core strength and wear appropriate running shoes. (p. 35)

Most important among these tenets is the principle of individuality: "Training should be directed and tailored to the individual, taking into account the strengths and weaknesses and how these weaknesses can be addressed as development proceeds" (Kennedy, Knowles, Dolan, and Bohne, 2005, p. 42). Coaches should also be aware of the different responses to training that younger runners may have compared to more mature athletes (Bar-Or, 2012). While children are trainable, they may not develop as an adult would in similar training conditions (Bar-Or, 2012; Lemura, von Duvillard, & Carolinas, 1999). Additionally, their bodies do not adjust to warmer temperatures as well as those of adults, and thus may need more time to acclimatize (L. E. Armstrong et al., 1996).

Intensity and Volume

A strong debate exists between the proponents of various training philosophies advocating either high-intensity, low-volume or high-volume, low-intensity training programs (Enoksen, Shalfawi, & Tønnessen, 2011; Helgerud et al., 2007; Seiler & Tønnessen, 2009). In their review of the literature in this area, Nielsen, Buist, Sørensen, Lind, and Rasmussen (2012) found no definite correlation between running-related injuries and the volume, duration, intensity, and frequency of training. More training–either through increased intensity or volume–is not necessarily better. A study from Garcin, Fleury, and Billat (2002) found that highly trained athletes' physiological characteristics did not improve after adopting a more difficult interval training regimen, and their rating of perceived exertion (RPE) for equivalent work loads actually increased over that time. Nor is long, slow distance necessarily advisable: "in order to prevent overloading of the metatarsals in adolescent runners, excessive mileage at jogging pace should be avoided" (Fourchet et al., 2012, p. 685). Coaches often strive to achieve a balance between these approaches (Laursen, 2010), but the primary purpose of this work is to provide practical advice for coaches for the administration of young athletes' training programs, not to advocate specific training philosophies.

Tapering. Tapering is the process by which an athlete reduces his or her training load for a period of time prior to an important competition in order to improve performance. A taper that reduces volume–but not intensity–is an effective tool for improving race performance (Mujika, 2010; Mujika & Padilla, 2003). In a meta-analysis of the literature regarding the tapering process for athletes, Bosquet, Montpetit, Arvisais, and Mujika (2007) concluded that "a two-week taper during which training volume is exponentially reduced by 41–60% seems to be the most efficient strategy to maximize performance gains" (p. 1364). Even a three-week reduction in training has been shown to have no negative effect on endurance training adaptations (Houmard et al., 1990).

Warm-up

Although almost every coach mandates that his or her athletes perform a warm-up routine prior to practices and competition, few understand the scientific basis for such an activity. Warming up may help to avoid next-day soreness (Law & Herbert, 2007), but the literature regarding warm-ups and stretching does not indicate that they lead to a reduction in injuries (Thacker, Gilchrist, Stroup, & Kimsey Jr, 2004; van Mechelen, Hlobil, Kemper, Voorn, & de Jongh, 1993). Static stretching, i.e. reaching down to touch the toes, is not an effective warm-up technique. In fact, static stretching prior to a race may actually increase the energy cost of running and thus hurt performance (J. M. Wilson et al., 2010).Although performing dynamic stretches, i.e. high knees, may not improve elite runners' race performance (Wunderlich, 2012; Zourdos et al., 2012), they are a much more effective warm-up protocol than static stretching for young athletes (Faigenbaum, Bellucci, Bernieri, Bakker, & Hoorens, 2005) and distance runners in general (Leon, Oh, & Rana, 2012). Regarding stride-outs, i.e. short runs of increasing speed and intensity, performed as part of a warm-up routine Ingham, Fudge, Pringle, and Jones (2013) showed that running two 50 m stride-outs followed by a 200 m run at race pace as a warm-up improved 800 m time trial performance more than running six 50 m stride-outs.

Equipment

Middle distance running is a relatively inexpensive sport; however, there are many misconceptions regarding the few pieces of equipment required to participate. Products can be purchased as needed, but most will have little or no real impact on performance. Athletes may feel that they prefer a product even when it provides no real benefits. In a study comparing conventional socks to the fitted socks often sold at running specialty stores, Purvis and Tunstall

(2004) found that the subjects preferred the specialty socks; however, they produced no physiological advantage and the runners still described the conventional sock as comfortable. Ali, Creasy, and Edge (2010) found a similar "comfort only" effect with compression socks, made popular by professional athletes like Paula Radcliffe, although Kemmler et al. (2009) did find that they significantly improved running performance. Lower body compression garments may improve some physiological measurements, but have not been shown to improve performance (Dascombe, Hoare, Sear, Reaburn, & Scanlan, 2011). Manufacturers often advertise clothing made of synthetic material as some kind of aid for sweat evaporation, but there is no evidence to suggest that these garments aid thermoregulation or comfort during exercise (Gavin, 2003). Treadmills should only be used as a last resort for training. In their study, LaCaille, Masters, and Heath (2004) found that

> the treadmill setting was rated as least satisfying, while resulting in the highest RPE and slowest performance time. Alternately, the outdoor route resulted in the highest levels of positive engagement, revitalization, tranquillity, and course satisfaction, while also yielding the lowest levels of physical exhaustion and RPE. (p. 461)

Footwear. Training shoes can significantly alter adolescent runners' biomechanics (Mullen & Toby, 2013), but athletes are often confused by marketing approaches. Running shoes are often sold as a way to either increase comfort or avoid injury, yet there is no valid evidence to justify manufacturers' practice of focusing on pronation control or amount of cushioning (Richards, Magin, & Callister, 2009). Enke, Laskowski, and Thomsen (2009) found that almost three fourths of the adolescent cross country runners they surveyed claimed that arch type was most important factor when buying running shoes, but only a little more than one half knew their own arch type; this lack of self-knowledge holds true for recreational runners in general (Hohmann, Reaburn, & Imhoff, 2012). Athletes should wear what feels comfortable for them, not what costs more. Clinghan, Arnold, Drew, Cochrane, and Abboud (2008) found that "low- and medium-cost running shoes in each of the three brands tested provided the same (if not better) cushioning of plantar pressure as high-cost running shoes" (p. 189). One notable exception to this rule may apply if similar styles are available as models for both children and adults. Forrest, Dufek, and Mercer (2012) found that these versions differed sharply in their composition and kinematic effects, even among the same size. They recommend using the adult version when available.

Although significantly different from true barefoot running (Bonacci et al., 2013), the use of so-called “minimalist” running shoes has attracted attention from some researchers, primarily because runners who prefer such footwear may be more likely to use a forefoot strike pattern–that is, they hit the ground with the ball of the foot first, followed by the heel (Goss & Gross, 2012). Some researchers have associated this pattern with a reduced risk of overuse injury (Daoud et al., 2012), but the use of minimalist footwear has not yet been shown to have a corrective effect on habitual rearfoot strikers (TenBroek, Rodrigues, Frederick, & Hamill, 2013), and can pose a risk for bone injury (Ridge et al., 2013). According to a review of the literature by Goble, Wegler, and Forest (2013), “current evidence is insufficient to indicate that barefoot runners are faster, perform better, or are any less prone to injury than shod runners who prefer a heel-striking gait” (p. 53). As suggested by Nigg and Enders (2013), “the important aspects of performance and/or injuries are more related to (a) individual preference and (b) individual running style, independent on whether the athlete runs in shoes or barefoot” (p. 6). In some cases, customized shoe orthoses may improve the comfort levels of athletes with chronic injuries (Hirschmüller et al., 2011).

Supplementary and Alternative Training

Specificity is an important part of a training program: Cross-training programs involving activities such as biking or swimming, for example, are not as effective at improving performance as a specific running program (Foster et al., 1995). Middle distance runners may still benefit from other forms of training, however:

- Well-designed, sport-specific resistance and strength training such as plyometric exercise can improve anaerobic performance without any significant negative effects on aerobic performance (Mikkola, Rusko, Nummela, Pollari, & Hakkinen, 2007; Sedano, Marín, Cuadrado,

& Redondo, 2013; Yamamoto et al., 2008).

- The use of a periodized core training program can also benefit runners (Fredericson & Moore, 2005).
- Balance training programs can significantly reduce the incidence of ankle sprains, a common running injury (McGuine & Keene, 2006).

Gender Differences

As with all other aspects of the sport, differences exist between genders on the approach to and the effects of middle distance training. For example, females' kinematic responses to competition footwear, such as racing flats or spikes, differs significantly from males' (Logan, Hunter, Feland, Hopkins, & Parcell, 2007). Most notably, younger female runners at are at a higher risk of overuse injury than males (Rauh, Margherita, Rice, Koepsell, & Rivara, 2000). In terms of acute injuries, boys are more likely to suffer from pelvic issues, while girls are more likely to sustain ankle injuries (Reid, Nelson, Roberts, & McKenzie, 2012). Stress fractures, one of the most common chronic issues affecting runners, are influenced by different factors for male and female runners:

> Multivariate regression identified four independent risk factors for stress fractures in girls: prior fracture, BMI [Body Mass Index] <19, late menarche (age menarche $\geq$ 15 years), and previous participation in gymnastics or dance. For boys, prior fracture and increased number of seasons were associated with an increased rate of stress fractures, whereas prior participation in basketball was associated with a decreased risk of stress fractures. (Tenforde, Sayres, McCurdy, Sainani, and Fredericson, 2013, p. 1843)

It is also important to note that "intensive endurance training during childhood and adolescence does not influence size attained and rate of growth in stature and body mass" (Eisenmann and Malina, 2002, p. 168); importantly, this holds true for female runners as well (Baxter-Jones, Thompson, & Malina, 2002). Some female runners may perceive strength training in a negative light as a physique-changing activity–they want to avoid the “ripped” look–but it is important to note that

> implementing a vigorous strength training program in previously untrained (strength) female distance runners may yield positive results in running economy. Upper and lower body strength improvements are evident and expected in a program of this type. Also, this improved strength is not associated with significant changes in body composition. The improvement in running economy would be significant for a competitive distance runner. It could shave vital seconds off her time and it is these seconds that determine a runner’s placement in a race. (Johnson, Quinn, Kertzer, and Vroman, 1997, p. 228)

Competition

To some extent, “the differences in variability of race times between types of race, ability groups, age groups, and sexes probably arise from differences in competitive experience and attitude toward competing” (Hopkins and Hewson, 2001, p. 1588). In other words, experience and competitiveness will affect an athlete’s race time more than most factors. There can also be no doubt that environmental factors, such as altitude and climate, can significantly affect competition performance (Hollings, Hopkins, & Hume, 2012). Among athletes with similar experience levels and competitiveness, however, oftentimes it is not the fastest runner who wins a championship middle distance race but rather the athlete with the best tactics (Thiel, Foster, Banzer, & De Koning, 2012). Coaches, then, should stress the importance of effective racing strategies.

Scheduling

When deciding appropriate events for individual runners, it important to understand that the label “middle distance” includes a wide range of competitions requiring distinct skills and tactics. Different races utilize various energy systems: The longer the race, the more aerobic energy is required; conversely, the shorter the race, the more the athlete’s body relies on anaerobic power

(Brandon, 1995; D. Hill, 1999). Athletes who participate in middle distance races can come from a variety of backgrounds; therefore, not all athletes who are suited for one race may be suited for the other. Additionally, the traditional schedule for many athletics competitions is structured for the organizers' convenience, not the athletes'. Coaches should be aware of the time required to recover between races, especially during meets held in warmer temperatures: "Youth athletes are capable of tolerating the heat and performing reasonably well and safely in a range of hot environments if they prepare well, manage hydration sufficiently, and are provided the opportunity to recover adequately between contests" (Bergeron, 2009, p. 513). Runners who compete in multiple events may prefer to adopt a more conservative race strategy (Brown, 2005).

Drafting

Although minimizing distance is an important factor in successful middle distance running (A. M. Jones & Whipp, 2002), runners can position themselves slightly off the outside shoulder of other athletes during competition to draft off of them. For their master's theses, Corvalán-Grössling (1995), Arnett (2002) and Bailey (2011) measured the psychological and physiological effects of drafting off of other runners at various angles. All three found distinct advantages to the tactic. Not only did it reduce the oxygen need for the following runner, but running at a slight angle on the outside shoulder decreased his or her RPE, even though that method produced no physiological benefit over following directly behind. Even if the drafting runner is clearly better than the person he or she is following, it still makes sense to draft, since it takes away the possibility of the weaker athlete using the same drafting strategy (Pitcher, 2009).

Pacing

Pacing strategies for elite performances in middle distance running events differ markedly between events, with shorter races requiring faster starts and longer races necessitating more careful control of pace (Tucker, Lambert, & Noakes, 2006). While it is theoretically possible to achieve one's best performance with a simple "all-out" strategy in a middle distance race (Morton, 2009), this is often not the case in practice, and consistent and deliberate pacing is essential for young runners. Runners with an excellent recall and recognition of their own pace fare better in terms of timed performance (Takai, 1998). As athletes gain experience, they develop an internal clock that allows them to accurately gauge their speed and predictably run prescribed splits (Green, Sapp, Pritchett, & Bishop, 2010). Even well trained runners tend to slow their pace somewhat in the later stages of a race (Abbiss & Laursen, 2008). Starting with a more conservative pace will allow the athlete to run faster near the middle-to-late portions, when other runners tend to tire and slow down (Muehlbauer, Schindler, & Panzer, 2010).

If a runner is struggling with the physical task of shifting his or her running pace during a race, try to focus on form as a means of changing pace. For runners between the ages of five and 12 years old, increased stride length is more closely correlated to faster times than increased stride frequency (Cox & Beller, 2011, April). Above a certain speed, however, frequency ultimately becomes more important than length (Dorn, Schache, & Pandy, 2012). Runners are more likely to achieve this increased frequency by focusing on moving the recovery leg back to active position, rather than trying to "push off" the ground with more force (Kadono, Ae, Suzuki, & Shibayama, 2011).

800 m. Physiologically, the 800 m is more similar to the 400 m dash than other middle distance races (Brandon & Boileau, 1992; Hanon & Thomas, 2011), and it requires significant anaerobic capabilities (Deason, Powers, Lawler, Ayers, & Stuart, 1991). In theory, 800 m runners often attempt to run their second lap as fast as their first, but in practice, this usually is not the case; thus, most models of this race prescribe a slightly faster first lap than second (Prendergast, 2002; Reardon, 2013). Even so, runners should be well aware of the physical demands for this event, and pace themselves accordingly.

1,500 m-Mile. The 1,500 m, 1,600 m, or full mile run is typically held near the conclusion of a meet. Runners must find a balance during the start: It must be fast, to maximize oxygen intake at early in the race, but not too fast, as to prevent them from being able to surge at around the 1,200 m mark (Hanon, Levêque, Thomas, & Vivier, 2008; Hanon, Levêque, Vivier, & Thomas, 2007). Almost inevitably, the third lap will be the slowest (Noakes, Lambert, &

Hauman, 2009), but runners should be able to anticipate and plan for that portion of the race.

3,000-5,000 m. While experienced runners in shorter races like the 800 m almost always run their second lap slower than the first, the body's need for homeostasis during longer races will require a more thoughtful pacing strategy (Tucker et al., 2006). Though Gosztyla, Edwards, Quinn, and Kenefick (2006) suggested that runners in races 3,000 m and above should hypothetically begin their race at a slightly faster pace than their anticipated race pace, younger athletes are likely to do this anyway, given their inexperience.

Gender Differences

Most of the competition strategies mentioned here should apply to male and female athletes. Indeed, a number of the studies cited in this section regard experiments specifically conducted on female subjects. That said, as athletes reach adolescence and males develop more rapidly, the performance gap between genders increases (Malina et al., 2010). In their study on the performance developments of track and field athletes, Tønnessen, Svendsen, Olsen, Guttormsen, and Haugen (2015) found that "the 800 m performance sex difference evolves from 4.8% at the age of 11 to 15.7% at the age of 18" (p. 5). The authors recommend that coaches consider these differences when planning performance goals for athletes.

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