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As we go to press with this issue, the final preparations are being made for the 14th IAAF World Championships in Athletics in Moscow. The jewel in the IAAF’s World Athletics Series, the championships will be the largest global sporting event in 2013 and a great opportunity to consolidate the growth in popularity that athletics experienced last year at the Olympic Games in London, especially with young people around the world. Large crowds are anticipated at the Luzhniki Olympic Stadium and the cumulative television audience is expected to be in the billions.

Moscow will also be a chance for the current crop of young stars to shine and, who knows, for newly discovered talent to make their mark at the highest level of the sport.

Valentin Balakhnichev, the President of the host All Russia Athletic Federation and an IAAF Council member, has said that one of the key aims for the organisers is to create a new generation of athletics fans in Russia. To this end, schools and youth groups in Moscow will receive free tickets to experience the morning qualification sessions and extensive use is being made of social media to promote the event to young audiences.

The organisers will be helped by the fact that the Russian team, which was number two on the medal table at London 2012, promises another strong performance. Among its many heroes are 21 year-old rising star Elena Lashmanova, the Olympic 20km Walk Champion, who should prove popular with young fans in the Russian capital.

I would like to point out that Lashmanova’s path to her Olympic title included wins at both the IAAF World Youth Championships in 2009 and the IAAF World Junior Championships in 2010. But her rise through the championship structure offered by the IAAF to young athletes is by no means unique. One of the surprises at London 2012 on the men’s side was the 400m victory of Grenada’s then 19 year-old Kirani James, who like Lashmanova has gold medals from both the IAAF Youth and Junior championships.

While the focus of the early part of the 2013 season has been on the Diamond League and the impressive marks coming from the national championships around the world, not least the USA and Jamaica, perhaps we can find who will provide Moscow’s most surprising performance by looking back at the results of the recent IAAF Championships for young athletes, including last year’s Junior championships in Barcelona.

Efforts by the IAAF to bring young people into the sport and retain them are not limited to staging world championships. Our long-running Kids’ Athletics programme and the strong partnership with “Nestlé Healthy Kids” have made big impacts on participation by school children in many countries around the world. In addition, we have helped to increase the awareness and knowledge of coaches about working with young athletes through important developments in the structure and contents of our Coaches Education and Certification System.

I believe that these efforts are enhancing the experience that young people have in athletics – helping to retain the top talents through to reaching their full potential at senior level and
providing many others with a solid and positive foundation for a life-long relationship with the sport as participants, volunteers and fans.

The focus of this double issue of NSA is another manifestation of our work to create the next generation in athletics. The articles in our special topic section and others in the rest of the magazine cover issues related to Youth Athletics from both the technical and socio-logical/developmental points of view. And this issue’s bibliography is an important resource for any one working with young athletes.

On behalf of the IAAF I would like to thank all the authors who have provided the materials published here and invite our readers to send me their feedback on any point raised or any other aspect of NSA.

And, of course, wherever you are, I hope you enjoy the championships!

Abdel Malek El Hebil
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Youth Athletics

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Introduction

How athletics serves and develops young people is critical for the future of the sport. Success in the area of talent development will impact performances at all levels and the quality of the future’s elite stars, who are essential for attention and support required for athletics to thrive. But the quality of the experience children and adolescents have in athletics is also important, because those who do not go on to become top performers are the number one source of the audiences, volunteers and supporters, and positive memories are great tools for keeping people close and engaged with the sport.

Responsibility in this area is shared among the sport’s leaders, coaches, teachers and others who need to be aware of a wide ranging set of issues touching the realms of physiology, psychology, training science, sociology and others.

The aim of this article is to provide an overview of the most prominent positions and informed thinking on the most important of these issues drawn from the current literature. The main points to be covered are:

- Developmental and Physical Characteristics
- Physiological Adaptations to Exercise and Training,
- Ranges of Sensitivity,
- Differences Between the Sexes,
- The Talent Problem,
- Training Issues,
- Strength Training,
- The Dropout Problem,
- Competition.

Developmental and Physical Characteristics of Children and Adolescents

Anthropometric differences between children and adults

Children have different proportions and composition than adults. They have relatively larger heads, shorter extremities, and smaller torsos than adults. Compared to an adult, the younger the child is, the greater the difference in proportion (Malina, 1984). At birth, the head is about 25% of total body length while for an adult the head is about 12% of the total body length. Similarly, adult leg length accounts for at least half of the total height; at birth, the legs are about 30% of total body length. The extremities grow faster than the torso which grows faster than the head. This means that, based on their short legs and large heads, tasks such as balancing and jumping are very difficult for young children (BUNS, 2011).
Muscle mass

Muscle mass increases steadily along with weight gain from birth through adolescence. In males, the skeletal muscle mass increases from 25% of total body weight at birth to about 40-45% or more in young men. Much of this gain occurs when the muscle development rate peaks at puberty. This peak corresponds to a sudden, almost 10-fold increase in testosterone production. In girls there is not such a sharp increase in muscle mass. Their muscle mass does continue to increase, although more slowly than boys', to about 30-35% of their total body weight as young adults. This rate difference is largely attributed to hormonal differences at puberty. In both boys and girls, muscle mass increases result primarily from fiber hypertrophy (increase in the size of muscle fibres) with little or no hyperplasia (increase in the number of muscle fibres). Muscle mass peaks in girls between ages 16 and 20 and in boys between ages 18 and 25, although it can be further increased through exercise and/or diet.

Balance, agility, coordination, strength, and running speed

As children grow, they develop better balance, agility and coordination as their nervous systems develop. Myelination, i.e., the process by which a fatty layer, called myelin, accumulates around nerve cells, must be completed before fast reactions and skilled movement can occur because conduction of an impulse along a nerve fibre is considerably slower if myelination is absent or incomplete.

Strength improves as muscle mass increases with age. Gains in strength with growth also depend on neural maturation because neuromuscular control is limited until myelination is complete, usually around sexual maturity. Peak strength is usually attained by age 20 in women and between ages 20 and 30 in men. The hormonal changes that accompany puberty lead to marked increases in strength in pubescent males because of the increased muscle mass noted above. Girls, on the other hand, experience a more gradual increase in strength and do not exhibit any marked change relative to body weight after puberty.

Running speed increases during childhood because of stride length increases. The stride increases as the legs grow longer and stronger and as the pattern becomes more efficient. As children progress, they take longer strides and stay in the air longer during the flight phase. When young children are asked to run faster, they generally take quicker steps – often in place. Rather than saying “Run faster,” coaches should therefore say, “take bigger steps.”

The fastest runners use their arms to pull themselves forward. The arms move in opposition, with the upper arm (humerus) driving forward forcefully. In young children, the arms may be stationary or may flail in no particular pattern. As skill increases, the arms begin to rotate in opposition, but this movement is generated by a twisting of the spine rather than by conscious movement of the humerus.

Skills change systematically for children from two years of age through elementary school. For example, a 2-year-old runs with arms high, extended, and straight, feet shoulder-width apart, and a short, flat-footed step whereas this kind of movement cannot be seen in an adolescent or an adult (BUNS, 2011).

Cardiovascular, respiratory, metabolic, and thermoregulatory function

During both submaximal and maximal exercise, a child’s smaller heart and blood volume result in a lower stroke volume than in adults. In partial compensation, a child’s heart rate is higher than an adult’s for the same exercise intensity. But even with increased heart rate, a child’s cardiac output remains less than an adult’s. In submaximal exercise, an increase in arterial-mixed venous oxygen difference ensures adequate oxygen delivery to the active muscles. But at maximal work rates, oxygen delivery limits performance in activities other than those in which the child merely needs to move his or her body mass, such as in running.

Lung volume increases until physical maturity, primarily because of increasing body size. Until physical maturity, maximal ventilatory capacity and maximal expiratory ventilation in-
increase in direct proportion to the increase in body size during maximal exercise.

Like pulmonary and cardiovascular function, aerobic capacity improves with continued physical development. VO$_2$max peaks between ages 17 and 21 years in males and between 12 and 15 years in women, after which it steadily decreases. The child’s lower VO$_2$max value (L/min) limits endurance performance unless body weight is the major resistance to movement, such as in distance running. When expressed relative to body weight, a child’s VO$_2$max is similar to an adult’s, yet in activities such as distance running, a child’s performance is far inferior to adult performance. Also, running economy is lower in children compared with adults, when VO$_2$ is expressed relative to body weight. This difference can be explained by the difference between children and adults in stride frequency for the same fixed-pace run.

Children’s ability to perform anaerobic activities is even more limited. A child has a lower glycolytic capacity, possibly because of a limited amount of phosphofructokinase or lactate dehydrogenase. Children have lower lactate concentrations in both blood and muscle at maximal and supramaximal rates of work. Children cannot attain high respiratory exchange ratios during maximal or exhaustive exercise, suggesting less lactate production. Anaerobic mean and peak power outputs are lower in children than in adults, even when scaled for body mass.

Children also have a lower hemoglobin concentration in the blood than adults. Hemoglobin is the part of blood that carries oxygen to the working muscles (e.g., in the heart and legs), so children transport less oxygen per unit of blood than adults. This means that children can do less work than adults. Hemoglobin content in the blood increases at puberty; however, the increase is not as great in women as it is in men (BUNs, 2011).

Laboratory studies suggest that children are more susceptible to injury or illness from thermal stress because they have a greater ratio of body surface area to mass when compared to adults. They are capable of less evaporative heat loss than adults because they sweat less. Heat acclimatization is also slower in children than in adults. In cold environments children are at a greater risk of hypothermia because they have greater conductive heat loss than adults.

**Physiological Adaptations to Exercise and Training**

Body composition changes with training in children and adolescents are similar to those seen in adults: loss of total body weight and fat mass and increase in fat-free mass. Resistance training during childhood and adolescence can lead to stronger, broader and denser bones. Strength gains achieved from resistance training in children result primarily from improved motor skill coordination, increased motor unit activation, and other neurological adaptations. Unlike adults, children experience little change in muscle size from strength training.

Although the endurance performance of children improves with aerobic training, such kind of training does not alter VO$_2$max as much as would be expected for the training stimulus, possibly because VO$_2$max depends on heart size.

In spite of their lower ability to perform anaerobic activities, children’s anaerobic capacity increases with anaerobic training.

**Ranges of Sensitivity**

Motor ability generally increases for the first 18 years of life. However, in girls it tends to plateau around puberty. This plateau can probably be attributed to increased estrogen levels, which promote greater fat deposition, and less muscle mass.

Awareness of age ranges sensitivity for the development of certain physical performance factors assists in obtaining best training results. Based on a study to establish the most suitable periods for the development of strength, power and speed capacities for boys and girls in the 10-18 years age range, LOKO et al. (1996) arrive at the following conclusions:
The sensitive period for the development of static strength occurs in the 13-16 years age range for boys with the largest increase (23.4%) taking place between 14-15 years. The most sensitive period for girls is in the 11-13 years age range with 39.7% of the total improvement.

The most sensitive development of leg power for boys takes place in the 12-17 years age range with the best results recorded between 13 and 16 years. In girls, the most sensitive period occurs from 10-12 years. During these two years (10-11 and 11-12), the standing long jump shows an improvement of 81.8%, the vertical jump 77.2% of the total achieved during seven years.

The most sensitive period for arm power development for boys is in the age between 13 and 17 years, while the girls record their best results in the 10-13 years age range.

The sensitive period for the development of running speed for boys falls within the range of 12-17 years, while girls achieve best results during the early ages of 10-13 years.

In general, the sensitive periods to develop various physical performance capacities are concentrated in the 12-17 years age range for boys and 10-13 years age range for girls.

The Difference between Boys and Girls

Although the bodies of girls and boys are more alike than different during childhood, differences emerge during puberty that give males a performance advantage in certain activities. At puberty, or about the 12-13 years of age range, the growth of girls slows dramatically and then stops completely at about 15-16 years of age. Males reach puberty about two years later than girls and therefore reach their adult size at about 17-19 years of age, thus growing two years longer than girls (MALINA, 1984).

Prior to puberty, boys and girls are very similar in height and weight although in elementary school the earliest maturing girls are likely to be taller than everyone else. This means when grouping athletes, children of similar skill should work together because it can be safer and motivations for success peaks when the challenge is appropriate.

As far as, for example, running speed is concerned, the average running speed for girls and boys is nearly the same during elementary school. Girls demonstrate the mature running form at a slightly earlier age than boys; most children demonstrate a mature form by seven years of age. At puberty, boys continue to increase running speed, whereas girls’ running speed tends to level off or decreases slightly.

The differences during elementary school are attributed to different treatment of boys and girls. For example, boys tend to have great opportunity, expectation, and encouragement, but there is no biological reason to expect differences during elementary school. Therefore, coaches need to provide equal opportunity, have similar expectations, and encourage boys and girls equally.

Respiration response is the same for girls and boys. As children train, respiration rate can provide information about level of fatigue. For example, a child who can talk easily while jogging is probably breathing steadily; when respiration interferes with talking, the child is moving toward fatigue.

The Talent Problem

In his article review of the current state of affairs concerning what talent is and how it can be best discovered and developed, TRANCKLE (2004) points to the absence of a widely recognized definition of talent. Nevertheless, attempts have been made to make things clearer. For example, talent has been used to describe the raw material as well as the end product of a developmental process. This has led to the proposal of a distinction between between raw materials and the end product. This resulted in describing the raw material as “giftedness” and defining it as “the possession and use of untrained and spontaneously expressed natural abilities (called aptitude or gifts), in at least one ability domain,
to a degree that places a child at least among the top 10% of his or her age peers” (GAGNE as cited by TRANCKLE, 2004).

At the other end of the spectrum, the end product of a developmental process has been described as ‘talent’, which has been defined as “the superior mastery of systematically developed abilities (or skills) and knowledge in at least one field of human activity to a degree that places a child’s achievement within at least the upper 10% of age peers who are actively in that field or fields” (GAGNE as cited by TRANCKLE, 2004).

However, definitions are less interesting for sport theorists and coaches than the question how talent can be maximised in the lives of performers. So the sport community concentrates on talent detection (= the discovery of potential performers who are currently not involved in the sport in question), talent identification (= the process of recognising current participants with the potential to become elite athletes), and talent development (= the provision of performers with a suitable learning environment so that they have the opportunity to realise their potential) (TRANCKLE, 2004).

Among coaches, there is the widespread opinion that scientifically valid methods for talent detection do not exist and that as an alternative it is coaches’ judgements that are the best solution for detecting and identifying talent.

The following statement by KOZEL (as cited by TRANCKLE, 2004) can be regarded as a summary of the currently predominating view concerning the talent problem: “Talent is an extremely complex attribute; genetically determined, complicated in structure and subject to environmental conditions. It is for this reason that there is no consensus of opinion, nationally or internationally, regarding the theory and methodology of talent identification, selection and training in sport […]. Generally, it is still the coach’s eye and expert’s judgment which is decisive in the talent screening and selection process.”

As far as talent development is concerned, the following stages can be differentiated (COTE, 1999, as cited by TRANCKLE, 2004):

- The “sampling years” typically take place between the ages of six and 13 years. During this time, children experience fun and excitement through a range of extracurricular activities. These activities can also be called “deliberate play”, which can be characterised as being voluntary, pleasurable, providing immediate gratification and developing intrinsic motivation.
- During the “specialising years” children tend to narrow the focus of their involvement. This stage usually occurs between the ages of 13 and 15. Although fun and excitement remain as central elements in the children’s participation, there is a growing importance placed on sport-specific skill development.
- During the “investment years”, which begin at about the age of 15, there is more importance placed on strategic, competitive and skill development aspects of sport, along with an extremely intense commitment and tremendous amounts of practice.
- The investment years (until about the age of 18 years) are followed by the “maintenance years”, which involve the perfection and maintenance of talent, developed during the investment years.

A slightly different model of talent development is presented by DEMPSTER (2005):

- The FUNdamental phase (chronological age: 8-12, training age: 0): This phase is characterised by FUN and participation first and foremost. No formal training sessions are carried out.
- The “training to train” phase (chronological age: 13-16, training age: 1-4): The focus in this phase is to start to gradually introduce the concept of training as opposed to playing. FUN is still involved, but the activities are structured and presented in more of a “real session”.
- The “training to win” phase (chronological age: 21-24, training age: 9-12): In this phase everything is geared towards performance. The capacity to be able to handle
a heavy training schedule should be attained by this phase but full capacity in this area has not yet been reached.

According to this model, up until the athlete’s mid-twenties he or she is still in a development phase.

A very important factor in talent development is the influence of the teacher or coach. However, it is very rare for the same teacher or coach to progress an individual through all phases of talent development because of the different requirements at each stage of talent development. This has implications for athletes being encouraged to move on to different coaches as they advance and thus require more specialist or expert guidance (TRANCKLE, 2004).

In addition to the influence of teachers in the development of talent, a greater influence during childhood comes from the family. Talented individuals often come from so-called “complex families,” that are both integrated and differentiated. “Integrated” refers to the stable conditions among family members whereby the children feel a sense of support and consistency. “Differentiated” refers to the notion that members of the family are encouraged to develop their individuality by seeking out new challenges and opportunities (CSIKSZENTMIHALYI et al., 1996).

OGILVIE (1981) deals with the question how parents can play a wholesome supportive role in the life of the aspiring child. In Ogilvie’s opinion, the ideal would be that the parent should be a guest in the life of the child. This would permit the child to remain in control and invite the parent to share whatever they might be experiencing based upon their personal need. The child competitor should be in control of his or her own life and have total responsibility for valuing the experience in personal terms.

Training Issues

As outlined above, children differ from adults in many of their body responses to hard physical activity and they are not just ‘little adults’ physiologically (JONES, 1993). Children are adequately equipped to handle activities that require short but intensive exertion (phosphagen system) or more prolonged periods of moderate exertion (aerobic system). They are not well equipped to cope with training that demands a significant contribution from the lactacid system. Training of the lactacid system should therefore be refrained from until after the peak of the growth spurt has been reached. Similarly, children are responsive to muscular endurance training but work with heavy weights should be avoided until puberty is complete.

Training regimes introduced at the appropriate time in the child’s development will induce favourable changes in the child's physiology of a similar magnitude to those expected in adults. A period of detraining will cause many of these changes to gradually decay. There is no strong evidence to support the suggestion that training must be started early in order to experience success as an adult and early specialisation is counterproductive. Coaches need to be sensitive to the fact that childhood is often linked to the rate of maturation – early maturing boys have a distinct advantage in most sports but with girls it is often the late maturers who are successful. Children should be encouraged to internalise the motivation to exercise so that when the extrinsic motivation of the coach is removed they are not “turned off” (ARMSTRONG, 1992).

According to DICK (1980), fundamental to long-term development of competition performance is that the athlete has a sound technical model upon which to build, against a background of basic general strength, mobility and endurance. That is why the development of a sound technical model must have priority in coaching the young athlete (8-15 years for girls and 8-17 years for boys). The ranges permit exposure to a multiplicity of techniques from 8-11 years (girls) and 8-13 years (boys), followed by a period for stabilising specialised techniques. Implicit in this is that competitive success is not a priority at this juncture of the athlete’s development.
According to MCSTRAVICK (1990), the following points should be borne in mind when considering both the content and the strategy of athletics coaching with school-age children:

- provide an enjoyable experience for participants,
- provide a programme,
- programming must be geared towards success,
- the importance of play.

It is vital that competition for school age children be arranged so that all pupils have a positive experience. Late developers must not be placed in a situation where early developers will so dominate the competition that it becomes an unpleasant experience. MCSTRAVICK (1990) recommends group/team competitions and combined event competitions (where performance is related to score) because they provide excellent opportunities to stress self-improvement rather than winning and losing.

**Strength Training**

The pros and cons of strength training for children and adolescents have been a very up-to-date topic during recent years. For a long time physicians and physiologists were convinced that weight training did not produce significant strength gains in prepubescents (DUDA, 1986). Insufficient circulating androgens in children were considered as the predominant restriction to strength gains. Additionally, safety concerns regarding bone integrity, epiphyseal continuity and risk of injury have been common.

Although even in recent articles, the opinion is held that in prepubescent children the time might better be spent doing something else than weight training (BUNS, 2011), most newer investigations support significant strength gains in prepubescents as a result of weight training. Further, based on recent findings of short-term prepubertal weight training, no damage to bone, epiphyses, growth tissue, or muscle has been reported (JACOBSON & KULLING, 1989). The risk of injury also ap-
reached their top performance. She identifies the following factors as decisive for the termination of one’s career – and vice versa – for continuing one’s competitive career: stresses and strains at school and work, injuries, missing free time, conflicts in the athletic environment: with coaches, club, the training group and officials, lack of support by the family, missing or inadequate motivation, low social mobility, a critical attitude toward competitive sport. According to BUSSMANN, the risk of dropout can be minimised by:

- including the conditions outside sport (such as school and job/professional education) in the planning of the individual career,
- supporting the athlete in the process of overcoming an injury,
- discussing and solving conflicts between the competitive sport activity and leisure-time activities,
- a socially supportive and harmonious climate in the club and training group,
- ensuring that the athlete is supported by his or her family,
- ensuring that the athlete’s coaches have a basic knowledge of performance motivation in general and of their respective athlete’s motivation in particular,
- supporting the athlete’s social mobility and attitude toward competitive sport.

Ideas on how parents can play a wholesome supportive role in the life of the aspiring child are provided by OGILVIE (1981). In Ogilvie’s opinion, the ideal would be that the parent should be a guest in the life of the child. This would permit the child to remain in control and invite the parent to share whatever they might be experiencing based upon their personal need. The child competitor should be in control of his or her own life and have total responsibility for valuing the experience in personal terms.

In addition to the dropout reducing factors listed by BUSSMANN, LEE & OWEN (1984) point out that dropout can also be reduced by promoting fun and intrinsic interest as well as setting individual goals.
RIEWALD (2003) places particular emphasis on the fun factor and lists the following strategies to incorporate fun into the youth athletics environment:

- bring more relays to youth athletics,
- structure multidiscipline competitions, i.e., each athlete competes in a throwing, jumping and running event,
- allow for or create opportunities to interact with friends,
- as a coach, know the athlete as people,
- communicate/provide feedback to each athlete on a regular basis,
- be creative with scoring so that many experience the positive feelings of success.

The incorporation of “fun” in athletics means that athletics for children requires moderations (FREY, 1992). A proportionate athletics programme for students should be many-sided and supported by motivational psychology. The training volume, training frequency and the number of competitions should not be simply a scaled down copy of training programmes for adults. A variety of different situations makes participation in athletics more attractive and can therefore reduce the number of dropouts.

The British concept of Fun in Athletics has been made particularly attractive by moving the competitions, which take place in autumn, winter and spring, indoors. This makes it possible to provide a different environment for the novel events, conducted as a team competition. Emphasis in fun competitions is placed on a team effort, creating a need for all team members to play their part, even when they have to line up events that are not among their favourites. This approach assists in avoiding early specialisation. Although certain competition rules are applied to the fun events, disqualifications are avoided as far as possible in order to have all performances acknowledged (BUSSE, et al., 1998).

Kid’s Athletics is a team athletics programme that has been developed by the IAAF to avoid early specialisation and events are therefore not scale models of adults’ competitions. It is based on three age groupings: Group 1 – children 7-8 years; Group 2 – children 9-10 years; Group 3 – children 11-12 years. Teams are mixed and generally comprise 10 members and most events are conducted in some relay format. Events are sprinting and running, throwing and jumping. Scoring is designed to keep the event outcome unpredictable and give participants a feeling that they can actually win the event they participate in. The programme that was developed was based on meeting the following requirements: a) to offer children attractive athletics; b) to offer children accessible athletics; c) to offer children instructive athletics. Kid’s Athletics is intended to bring excitement into playing athletics. The most important objectives are:

- that a large number of children can be active at the same time,
- that varied and basic athletic forms of movement are experienced,
- that not only stronger or faster children make a contribution to a good result (WEST, 2009).

Competitions for children and youths (including performance development aspects)

On the international level there are the following athletics championships:

- the IAAF World Junior Championships for Athletics, for athletes of 18 or 19 years on 31st December in the year of competition, held biennially since 1986,
- the IAAF World Youth Championships in Athletics, for competitors who are 17 or younger, held biennially since 1999,
- the European Athletics Junior Championships, first held in 1970, held biennially since 1973,
- the European Athletics U23 Championships, for athletes under 23 years of age, held biennially since 1997,
- the Youth Olympic Games (YOG), held every four years for athletes between 14 to 18 years of age, first held in Singapore from 14 to 26 August 2010 and to be held for the second time in 2014 in Nanjing (China).
The introduction of international championships for young athletes has not met with unanimous agreement. For example, in a roundtable discussion dealing with the 1st World Youth Championships (CHIMIER et al. 2000), it was pointed out that the main danger in staging the WYCA is that some coaches and young athletes start to specialise in just one event or their training only focuses on the improvement of performance at all costs in order to get good results in the championships. This could lead to many problems that could hinder the development of these athletes in the future. It was recommended that the IAAF should limit the age of the athlete to 16-17, athletes who are younger should not be allowed to enter the championships.

This aspect of international championships for young athletes is also taken up in a very interesting article by BAUMANN & MALLOW (1998). In their analysis of the performance situation in German junior middle and long distance running they arrive at the conclusion that in Germany junior middle and long distance runners train extremely hard without, however, showing correspondingly improved performances in their senior years. According to the authors, the cause of this is, besides a too early concentration on running training and the neglect of under- and over-distance competitions and cross-country races, the fact that today’s ambitious juniors all aim to take part in the European and World Junior Championships. In the seventies and eighties, when German distance runners were more successful, World Junior Championships did not exist, cross-country racing used to be regarded as a must for middle-distance runners, and a wide approach to performance development meant racing in over- and under-distance competitions. Fartlek used to be very popular among the former German distance runners, who trained a lot on undulated cross-country trails. This promoted the natural development of the important factor of strength endurance. In general, the early training years of the former German elite distance runners were characterised by a refreshing simplicity. They learned early how to guide themselves and how to deal flexibly with the training plan. Because of this naturalness, combined with spontaneity, training was an uncomplicated and therefore enjoyable activity.

However, the rather negative point of view expressed by BAUMANN & MALLOW concerning German distance running is not shared by SCHOLZ (2006), who conducted an analysis of the throwing events at the IAAF World Junior Championships. He arrives at the conclusion that the IAAF World Junior Championships are a springboard for entry into the elite class. He even states that for the future it can be assumed that athletes without international experiences in the Junior category will only in exceptional cases be successful in big events (e. g. in World Indoor Championships, World Championships, Olympic Games). Experiences as well as statistics confirm that for the “young stars” the World Junior Championships are an interim station. However, winning a title is no guarantee for victory at the Olympic Games or World Championships.

The results of a study of the performance development of the finalists at the 1999 IAAF World Youth Championships conducted by GRUND & RITZDORF (2006) are comparable to the results of SCHOLZ’ study. GRUND & RITZDORF found, among other things, that 90% of the finalists (n=266) at the first WYC continued to improve in the subsequent years and 88% made the world top 100 in their best disciplines. They conclude that as 21% of the group qualified for the IAAF World Championships in Athletics and/or the Olympic Games between 2000 and 2004, there is no basis on this point for rejecting international youth championships as a valuable element of the world competition calendar.

According to DIGEL (2008), the decision to create a Youth Olympic Games, with the first edition held in Singapore in 2010, creates opportunities for the International Olympic Committee (IOC) and the international sport federations to promote positive values in a
sustainable way. However, he also points out that the organisation and staging of the Games entails serious risks of creating unintended and undesirable side effects that could threaten the success of the event or even lead to the self-destruction of the current sports system. For example, each strengthening of a big global sport event like the Olympic Games inevitably leads to a reduction of interest in the individual sports they comprise. For some time already it has been possible to see that the existence of some Olympic sports is dependent on the financial aid coming from the IOC. This problematic development would be accelerated by the introduction of the Youth Olympic Games. For many sports, the Youth Olympic Games cannot, or can only to a very limited extent be justified on the basis of training theory, medical and developmental-psychological reasons. An Olympic competition inescapably leads to athletes preparing for such Games with enormous amounts of intense training. This will lead to an earlier age of high performance in most of the Olympic sports, which contradicts the scientific consensus on the ideal for long-term development. According to this consensus, early specialisation should be avoided in almost all Olympic sports. In view of the doping problem, which affects most of the sports intensively, a trend towards top performances at an earlier age would be fatal. In some sports there is even the danger that performances achieved by youths would be better than those of adults. The effect would be a depreciation of the adult Olympic medals, which cannot be in the interest of the IOC. Against this background, DIGEL recommends that the organisers find creative concepts to address the issues raised and that research be conducted so that lessons for preparation of future editions can be learned.

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FOOTNOTES

Page 9: If not otherwise indicated, the statements in this chapter are based on Kenney, Wilmore and Costill (2012, pp. 428-443).
Page 11: The statements in this chapter are based on Kenney Wilmore and Costill (2012, pp. 440).

REFERENCES


Predicting Sustained Participation in Competitive Sports: A Longitudinal Study of Young Track and Field Athletes

by Niilo Konttinen, Antero Toskala, Lauri Laakso and Raimo Konttinen

ABSTRACT

This study looked at the role of goal orientation and perceived competence, as well as interaction of the two, in young the athletes. Past research has suggested that task orientation more often than ego orientation protects sport participants from disappointments and lack of motivation, especially when ego orientation is combined with low perceived ability. Accordingly, emphasis on task orientation and high perceived competence should lead to a greater persistence, and a reduced dropout rate, when an athlete's performance is exceeded by others in competitive situations. A prospective, longitudinal design was used to determine causal effects over a 3.5 years period (2002 to 2005) in Finnish junior athletes (n=1,747). The authors found that self-reported task orientation and perceived competence correctly predicted sustained participation in competitive athletics in 70.1% of cases. In contrast to findings in past literature, it appears that ego orientation does not seem to play any role in predicting persistence. The results suggest that the investigation of goal orientation together with perceived competence may provide additional information concerning young athletes' persistence in sport, even in the face of failures and disappointments, and help to inform strategies to reduce dropout.

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Introduction

Dropout or withdrawal from organised youth sports has become a central topic among sport organisations and clubs as well as in sport and exercise sciences. The reason is evident: more than one-third of all participants between 10 and 17 years of age quit their sport every year (GOULD & PETLICHKOFF, 1988), although the attrition rates may vary depending on the sport and population in question (WEISS & PETLICHKOFF, 1989). Too little is known of the sport participation process over several years...
in the life of young athletes to understand the mechanics of withdrawal or sustained participation in competitive youth sports.

In the present study, young track and field athletes were followed from the age of 15 to 18. Loss of achievement motivation is an obvious reason for quitting competitive sports at that age. An attempt was made to examine this issue based on the achievement goal theory (AGT) of motivation developed by NICHOLLS (1984, 1989), which follows from the idea that achievement is a manifestation of the goals an individual sets, and that there are several qualitatively different types of goals involved in achievement. Goal setting is a social-cognitive process in the sense that goals are not set in terms of records, times and scores, but are set in terms of what an individual thinks is success or achievement, and which goals he or she conceives to maximise achievement in the particular social context.

The AGT has emerged as one of the most prominent theories of sport-specific achievement motivation (DUDA & NICHOLLS, 1992; ROBERTS, 2001). According to it, there are two dispositional perspectives, task and ego orientation, which determine how subjective success is evaluated. Task orientation refers to self-referenced perception of ability. In a state of task involvement, the individual believes that subjective success is evidenced through developing skills, exerting effort, and improving personal performance. Conversely, when ego-involved, the individual’s focal concern is towards demonstrating superior competence based upon normative comparisons relative to others.

Past research on goal orientation and persistence has suggested that a task orientation more often than the ego orientation protects the athlete from disappointment and a lack of motivation (BIDDLE et al., 2003; CURY, et al., 1997; DUDA, 1989; WHITEHEAD, 1990). Accordingly, emphasis on task orientation can be expected to lead to a stronger persistence. Much of the empirical evidence is derived from studies correlating goal orientation with other questionnaire measures presented at the same time, but not with such behavioural variables as participation in sports. In their review of empirical studies, BIDDLE et al. (2003) found positive associations of behavioural variables with task orientation, but not with ego orientation. However, behavioural variables included also other variables than persistence and only one (SPRAY, 2000) of the 25 reviewed studies was longitudinal, and even that study was related to physical education rather than to competitive sports.

FOX & CORBIN (1989) suggested that the effects of ego orientation are manifested through its interaction with task orientation. NICHOLLS (1989) conceived ego and task orientations as independent of each other, and the results from subsequent empirical studies have supported this view (CHI & DUDA, 1995; Robets et al., 1996). Consequently, all the combinations or profiles of ego and task orientation (low-low, low-high, high-low, and high-high) should be found. Comparing participation in competitive sports for the various goal orientation profiles is the same as finding out the interactions of ego and task orientation in predicting participation. Direct empirical evidence of the interactive effects related to sports is, however, still missing (HARWOOD et al., 2000).

Persistence in sports depends also on perceived competence (FOX & CORBIN, 1989), and in competitive sports perceived competence could be expected to be decisive for persistence. In the AGT, the interplay of perceived competence with goal orientation is considered important also for understanding motivation (NICHOLLS, 1989; DWECK, 1999). It is assumed that the likelihood of withdrawal from sports will increase if a person whose goal is to beat others (high ego orientation) experiences little success (low perceived competence). The other three combinations of low and high ego and task orientations are not assumed to have any effect on persistence.

It could be expected that an interaction of ego orientation and perceived competence in
predicting persistence in competitive sports should be found, but empirical evidence is inconsistent. Cross-sectional studies have not consistently supported the hypothesis of interaction of ego orientation and perceived competence (CURY et al., 1997; LIUKKONEN et al., 1998). In a longitudinal study of track and field athletes, WHITEHEAD et al. (2004) did not find any interaction between dispositional goal orientation, perceived ability and sport persistence.

The study by PAPAIOANNOU et al. (2006) seems to be the only longitudinal study of the relationships of sports activity examining both goal orientation and perceived competence. As the part of a larger study, the authors followed up the development of task orientation, ego orientation, perceived competence, and frequency of sport and exercise involvement (SEI) outside school for 14 months among 882 pupils from fifth to eleventh grade. Using structural equation modelling, task orientation had an effect to the SEI 7 fourteen months later. The relationship of task orientation and SEI was reciprocal, i.e. the SEI also affected task orientation. Ego orientation was not related to SEI. Perceived competence had a causal relationship with SEI over the whole 14 months period, and reciprocally, SEI had a causal effect on perceived competence. The interaction effects of ego orientation with task orientation and perceived competence were not related to SEI. The effects of age were also studied and task orientation, perceived motivation, and interest in sports activities were found to decrease during the follow-up period.

The results of the PAPAIOANNOU et al. (2006) study lend support to the view of the positive effects of task orientation and perceived competence and of the lack of any effects of ego orientation. The study was exceptional in demonstrating also the positive reciprocal effects of sport and exercise involvement on the development of task orientation and perceived competence. Although some of the participants in the study must have been competitive athletes, the results cannot be directly generalised to competitive sports without further study.

Based upon the AGT, several hypotheses can be derived for predicting persistence in competitive sports with goal orientation and perceived competence. However, much of the empirical research is related to verifying the hypotheses in fields other than competitive sports. Also, most of the studies have been cross-sectional, which are not suitable for verifying causal relationships. In the present study, the aim was to find the role of goal orientation and perceived competence, as well as interaction of the two, among young competitive track and field athletes. A prospective, longitudinal design was used to determine causal effects over a 3.5 years period among the Finnish athletes of the 15 years-old cohort.

**Method**

The data collection of this follow-up research project was carried out during the period between May 2002 and November 2005. The participants for the study were Finnish junior level track and field athletes. There were two inclusion criteria: (a) the athlete was born in 1987, and (b) the athlete had a valid competition license from the Finnish Athletic Federation (FA). A total of 1,747 youth athletes (904 females, 843 males) met the inclusion criteria. At the time of the initial data collection, the participants ranged in age between 14 and 15 years (mean ± S.D: age 14.9 ± 0.3 years).

The data was collected using a multi-section survey questionnaire that was mailed to all the FA licensed athletes born in 1987. A cover letter was included providing instructions for completing and returning the survey. In this letter, the participants were informed that participation in this study would involve completing a questionnaire once a year during the following 3.5-year period. The time required to complete the form was estimated to be less than 30 minutes. The participants were reminded that there would be no direct benefits to them for their participation in this study. The participa-
tion was ensured to be completely voluntary, and the participants were offered the option to withdraw from the study at any time without any negative repercussions.

Given that the purpose of the study was to re-contact the respondents for follow-up information, they were asked to provide their names and addresses on the completed survey forms. To avoid production of socially acceptable and dishonest answers, confidentiality procedures were carefully explained and guaranteed through a written specification of the respondent’s level of confidentiality. The cover letter also included pre-addressed postage-paid envelopes to make it easy for respondents to return their surveys.

The first section of the survey included items describing the population in terms of demographics and athletic experience. The second section of the survey gathered information about the participants’ goal orientation strategies and perceived competence.

Goal orientation in competitive sport domain was assessed using the Finnish version of the Perception of Success Questionnaire or POSQ (LIUKKONEN, 1998; ROBERTS et al., 1998). In the POSQ the respondent is asked to indicate the most preferred alternatives responding on a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). The scale consists of task and ego orientation subscales, with six items on both. The stem for each item is: “When I am doing sports, I feel most successful when …”. The task orientation subscale consists of items that place emphasis on effort, self-improvement, and learning a task (e.g. “I try hard”, “I really improve”, “I succeed at something I couldn’t do before”). The Cronbach alfa reliability coefficient of the scale was .77. The ego orientation subscale consists of items emphasizing superior ability and being better than others (e.g. “I beat other people”, “I accomplish something others cannot do”). The Cronbach alfa reliability coefficient of the scale was .89. The perceived competence (PC) index was based on one item aimed at tapping the athlete’s evaluation of his or her own competence compared to that of other track and field athletes of the same age. The PC item elicited scores on domain-specific perceptions of competence through the stem “Compared to other athletes of my age and sport, my skill level is …”. The item was answered on a 5-point Likert scale ranging from 1 (clearly below the average) to 5 (clearly above the average). For the data analyses, the scale was dichotomised by combining first three categories as Low PC, indicating that the respondent perceived his or her competence as average or lower than average, and the last two categories were combined as High PC, indicating that the respondent considered himself or herself as an above average athlete.

A valid competition license of the Finnish athletics federation (FA) was used as the indicator of persistence in competitive track and field 3.5 years after the initial survey questionnaire. That was in 2005, when the participants were at the age of 18. In order to describe the development of withdrawal, the license data were also collected for the years 2003 and 2004.

A reminder letter with an additional copy of the survey was sent to the recipients who had not replied two weeks after the initial mailing of the survey. A total of 802 athletes responded to the questionnaire. The overall response rate to the survey was forty-six percent. The response rate was 50% for girls and 42% for boys.

Results

Termination of sport participation

Of all those who had a competition licence at the age of 15, only 23.9 per cent continued active competition three years later at the age of 18. For girls the percentage was 22.0 and for boys 25.9. As can be seen in the Figure 1, the decrease in participation was highest between age years 15 and 16, and the decrease was higher for girls than for boys.

The athletes had first joined sports clubs quite young, typically in the age of eight years
The correlations were of the same magnitude as those BIDDLE et al. (2003) found in their meta-analysis of 29 previous studies. The result implies that athlete’s subjective perception of the attained success does not depend on goal orientation, i.e. on how he or she considers as a success.

Gender was related to ego orientation but not to task orientation. Boys defined success in sports more often than girls in terms of beating others and being better than others. However, gender difference was not strong, point-biserial correlation between gender and Ego orientation was .15 (p = .000). Gender was also related to perceived competence (CHI square = 6.252, df = 1, p = .012). Girls rated themselves more often as above average than boys, but the difference was small (Contingency coefficient = .06).

*Dependencies between gender, goal orientation and perceived competence*

Gender, goal orientation and perceived competence were used as the predictors of persistence, but the associations between these traits also illuminate the characteristics of young athletes. Task orientation and ego orientation were relatively independent of each other (r = .09), as proposed by NICHOLLS (1989) and verified in subsequent studies (CHI & DUDA, 1995; ROBERTS et al., 1996). The result was also a prerequisite for using profiles or interactions of task and ego orientation in predicting persistence.

It could be expected that those who find their achievements inferior to others define success in sports differently from those who consider themselves competent. Our data did not support this expectation. The correlations of perceived competence with task orientation and ego orientation were low, .05 (n.s.) and .15 (p = .000), respectively. The correlations were of the same magnitude as those BIDDLE et al. (2003) found in their meta-analysis of 29 previous studies. The result implies that athlete’s subjective perception of the attained success does not depend on goal orientation, i.e. on how he or she considers as a success.

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*Goal orientation, perceived competence and persistence*

Forward stepwise logistic regression with an LR test for removing variables was used to predict persistence in competitive sports three years after the first measurements. The dependent variable consisted of two values, one for those who had valid competition licence in 2005 and zero for the others, i.e. for those who
had totally quit active athletics competition between the years 2002 and 2005. The dependent variable was predicted by task orientation, ego orientation, perceived competence, gender, and by their two-way interactions.

The fit of the final regression model (Table 1) was statistically significant (Chi square = 106.244, df = 3, p = .000). In addition to the constant, it consisted of task orientation main effect, perceived competence main effect and gender by task orientation interaction. With the model, persistence could be predicted correctly for 70.1% of the participants. With the regression equation both quitting and persistence could be predicted, but the prediction for quitting was to some extent more accurate (73.4%) than prediction of continuing competitive sports (62.6%).

It is interesting to note, which variables did not predict persistence. Ego orientation alone or via its interactions was not related to persistence. The lack of task orientation by ego orientation interaction indicated that the data did not lend support for the profile hypothesis, in which the dominance of one orientation over the other is assumed to predict persistence. The intercorrelations between the predictor variables were low and the result could not be due just to multicollinearity.

Also, there was not any statistically significant gender by perceived competence interaction indicating that lack of perceived competence was linked with decision to quit competitive sports among both boys and girls. The lack of task orientation by perceived competence interaction indicated that the effects of task orientation and perceived competence on the termination of competitive sports are cumulative, i.e. affect the termination independent of each other.

Logistic regression lines for the statistically significant effects are shown in Figure 2. Lines cover the whole range of possible task orientation scores, but the scores of the participants of the present study ranged from 10 to 30 and 95% of scores fell on the range from 20 to 30 points. Even over the range where most of the cases fell, the predicted probability of continuing for Task orientation score 30 was, depending on the group, .16 to .26 greater than for score 20.

In addition to the task orientation, probability for continuing competitive sports depended on the perceived competence and gender. From the Figure 2 it can be seen, that for persons considering themselves as better than average young athletes, the probability for continuing was .25 to .32 greater than for persons perceiving themselves as average at best. Gender modified to some extent the predictive power of task orientation. With the same task orientation score, a boy was more likely to continue competitive sports than a girl, indicating that other factors had greater effects among girls than boys.

### Table 1: Final logistic regression model for predicting persistence in young Finnish athletes

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task orientation (TO)</td>
<td>0.102</td>
<td>0.027</td>
<td>14.921</td>
<td>1</td>
<td>0.000</td>
</tr>
<tr>
<td>Perceived competence</td>
<td>-1.351</td>
<td>0.162</td>
<td>69.912</td>
<td>1</td>
<td>0.000</td>
</tr>
<tr>
<td>Gender by TO</td>
<td>-0.017</td>
<td>0.006</td>
<td>7.285</td>
<td>1</td>
<td>0.007</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.001</td>
<td>0.687</td>
<td>19.081</td>
<td>1</td>
<td>0.000</td>
</tr>
</tbody>
</table>
Persistence and participation in the study

In the first survey in 2002, 45.9 per cent of those who had valid competition licence responded to the questionnaire. Response rate is usually considered as a potential source of bias in the results. In the present case, response rate revealed an interesting phenomenon relating to persistence. Response rate turned out to predict the number of years the participant was going to hold a licence. Among those who did not apply for a licence a year later, the response rate was 26.9 per cent, whereas those still continuing competitive sports three years later, response rate was 71.4 per cent. Response rate increased with the number of years of continuing competitive sports.

In the cover letter, the participants were informed that participation in the study would involve completing a questionnaire once a year during the follow-up period. However, participation in the study was not a prerequisite for a competition licence. In their decision to participate in the follow-up study, young athletes transmitted, consciously or subconsciously, their commitment to competitive sports. It is noteworthy that participation in the study is even related to the degree of commitment, i.e. the number of years in the future that a person will continue competitive sports.

Participation in the follow-up study was also related to task orientation, but not to ego orientation. Respondents were divided into four persistence groups on the basis of how many years after the first mail survey they held licences (one, two, three years, and continuing after the third year). In one-way ANOVA task orientation means differed statistically significantly between the persistence groups (F = 7.971, df = 3; 715, p = .000), but for the ego orientation the differences were not statistically significant.

It could be presumed that, for example, among those who quit competitive sports one year later, those who did not participate in the study had obtained similar scores in task orientation to those who participated in the study. Assuming the presumption correct, it could be concluded that participation in the study was related to task orientation lending evidence of the construct validity of the task orientation scale.

Figure 2: Probability for continuing competitive track and field as the function of task orientation among perceived competence groups of young male and female Finnish athletes
Discussion

Once a young athlete has decided to participate in an organised competitive sport, the next question in terms of motivation is what keeps him or her in the sport, even in the face of obstacles? As important as understanding why youth athletes participate in sports is understanding why they terminate their participation. These issues are of importance, not just because the withdrawal process may influence adolescents’ attitudes to competitive sports, but also because it can have a negative influence on physical activity and thereby their future life-style and health behaviour. The present study addressed these essential aspects of organised youth sports in a longitudinal study of persistence focusing upon competitive track and field athletes.

With regards to the estimates of attrition rates, the results of the present study were in line with the earlier findings on withdrawal from youth sports. It was found that seventy-six per cent of all the Finnish track and field athletes born in 1987 terminated their participation in competitive sports within the 3.5-year follow-up period (2002-05). A positive deviation from our expectations was that the attrition rate among girls was only four percentage units higher than among boys. The figures appear to be somewhat higher than the ones reported by GOULD & PETLICHKOFF (1988), but statistics concerning the whole age cohorts from different countries would be needed for more accurate generalisations. The attrition rate in the present study, however, was alarmingly high, challenging the way youth athletics is organised and conducted in Finland.

The young athletes in the present study had participated in organised athletics activities within sports clubs on average for 8 years. Holding a competition license at the age of 15 reflected relatively persistent involvement, and the license was not purchased just for occasional participation in competition. Quitting competitive athletics must have been an important turn of events as it meant the end of an activity to which sustainable efforts and time had been invested over several years. Any means to anticipate the event would help to make sure that the athlete has thought through the decision. This was the aim of the present study.

The main result was that young athlete’s task orientation and perceived competence at the age of 15 years predicted athlete’s persistence in competitive sports three and half years later, and that the prediction was correct in 70.1% of cases. The results of the present study confirm the results from PAPAIONNOU et al. (2006) longitudinal study and give additional support for the view that task orientation and perceived competence are directly related to persistence, and that ego orientation does not seem to play any role in predicting persistence, either directly or through interactions with task orientation or perceived competence. In addition, gender was found to moderate the effect of task orientation in the way that task orientation was more closely related to persistence among boys than among girls, but perceived competence predicted persistence in the same way among male and female athletes.

The importance of the finding is in demonstrating the role of task orientation and perceived competence as keys for understanding persistence in competitive sports. From the theoretical point of view, the results support the fruitfulness of the AGT as a framework to analyse the motivation of young athletes, even though there is much in the details that need further longitudinal prospective research. The results of the present study indicated that even among competitive sports, ego orientation as dispositional trait had no relation to persistence. However, it is possible that the goal of beating others in a competition, i.e. ego orientation as a state may have effects on athlete’s behaviour in specific situations.

From the practical point of view, the results point to possibilities to increase persistence in competitive sports. It is not suggested that task orientation and perceived competence could be used for selecting future champions. The...
prediction is still far from perfect and if using it mechanically, probably many future champions would be lost and many more would be chased away from sports practice.

The results of the present study demonstrate that the type of goal setting is important for the development of a young athlete. If he or she learns to set goals for the sports career, he or she has gained one essential prerequisite for the development towards becoming a champion and for persisting in competitive sports. The challenge for sports clubs and coaches is to invent developmental tasks, activities, and training and learning contracts, which foster young athlete’s view of success and competence. Goal orientation questionnaire could be used in opening discussion on these matters, but even more important are probably the discussions about the goals and success, and about their development in the long run.

One cue of the potential activities in developing young athlete’s thinking might be obtained from the result related to the willingness to participate in the present study. The result suggests that those who are at risk of quitting competitive sports may not be willing to discuss their personal views related to goal setting and success. Perhaps, more time should be spent in exploring young athletes’ thoughts about these matters. The results related to the participation also indicated that those in danger of quitting competitive sports hesitate in involving themselves even in such a long-term project as filling a questionnaire once a year over several years. It could be assumed that offering opportunities to join in long-term projects, either related to the athlete or to the athletic club, would help in clarifying goal setting.

Task orientation and perceived competence tended to affect an athlete’s behaviour three and half years later. The long time span in prediction implies that any changes in task orientation and perceived competence may have effects on athlete’s behaviour even years afterwards. Depending on the experiences that sports activities give the athlete, the effect may be in the positive or negative direction. The result should be seen as encouraging the design of interventions aimed at increasing task orientation and perceived competence, since their effects would probably extend over several years.

In the present study, the main focus was directed to persistence in competitive athletics. It is important that a young athlete’s decision to withdraw from competitive sports can be supported in such a way that he or she does not need to leave with the feelings of failure. After all, professional sports such as athletics also need persons are familiar and have a positive attitude towards them. Without officials, active individuals in sport clubs, and spectators at sports events and media audiences there would not be any world-class sports and or sports culture.

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REFERENCES


**Introduction**

Running speed is a basic human motor capability and part of the performance structure in many sports disciplines. It is notoriously hard to develop as it is substantially conditioned by heredity on the levels of the central nervous system, the structure of muscle fibres and the energy systems, all of which are difficult to influence through the process of sports training.

However, the period of the so-called “sensitive phase” in the development of children (9-13 years) is very suitable for the development of sprinting potential. The central nervous system...
is being developed, particularly the formation of the myelin nerve sheath of the nerves, which serves as a transporter of neural impulses from the central nervous system to active muscles. In this period, the speed of transfer of such impulses, which generate the speed of movement, can be influenced. For this reason, early identification of talent for sprinting and recognition of the kinematic parameters that influence this capability are very important. Ideally, the coach should understand those parameters of running velocity that are relatively independent of age and demonstrate high individual development, or ontogenetic, stability and thus can be used as predictors of sprinting ability.

Studies about the kinematics of sprinting are usually focused on high-level athletes and these have found that the most important generator of sprinting stride efficiency is the execution of the support phase, especially the ratio between the breaking phase and propulsion phase of the stride (COH, ŠKOF, KUGOVNIK & DOLENEC, 1994; ALCARAZ, PALAO, ELVIRA & LINTHORNE, 2008). To ensure maximal sprinting velocity, the force impulse must be as small as possible in the breaking phase, which is achieved through an economic placement of the foot of the push-off leg as close as possible to the vertical projection of the body centre of mass on the surface.

It has also been found that there is a linear independence between running velocity and support phase duration (BOGDANOV, 1974; TJUPA ET AL., 1978; KAMPMILLER & KOŠTIAL, 1986). This finding shows that it is a substantial criterion for determining the maximum running velocity of humans. Interestingly, the duration of the support phase in 13 to 16 year-old youths presents a stable factor in terms of ontogenesis (TABAČNIK, 1979; SIRIS, GAJDARSKA, & RAČEV, 1983).

The aims of this study were:
• to determine basic kinematic parameters of the running stride over 10m in cross-sectional age samples of boys and girls;
• to point out the ontogenetic stability of stride frequency, stride length, support phase duration and flight phase duration;
• to determine basic measures of location (mean) and of variability (standard deviation) in one-year intervals in samples of boys and girls.

Methods

The subjects were 7 to 18 years-old students from elementary and high schools in Bratislava, Slovakia. There were 1,299 boys and 1,288 girls in the samples. We used no research procedure that might have harmed the children either physically or psychologically and we made special efforts to explain the ac-
Kinematics of Sprinting in Children and Youths

Activities to the parents and be sensitive to any indicators of discomfort in the children.

The subjects were asked to run at maximum velocity over 25m. The velocity for the final 10m (after 15m flying start) was recorded using timing gates in standard conditions (gymnasium, sports hall).

The final segment of the run was carried out on a contact platform that was 17m long and consisted of two conductive layers separated by non-conductive elastic grading. During the contact of a foot with a surface, the platform worked as an electric circuit switch, during the flight phase, the circuit was disconnected.

The contact platform was used in combination with the measuring device “Lokomometer”, which through computer technology evaluates basic kinematic parameters of the running stride in the 10m section (velocity, stride frequency and stride length, duration of the support and flight phases and the efficiency index, which is defined by duration of the support phase and the running phase ratio). Stride length parameters measured by “Lokomometer” were calculated according to the method of ŠELINGER & KAMPILLER (1994).

Measuring of the time variables was carried out with 0.001 sec accuracy, length variables with ± 0.005m accuracy, body height with ± 0.005m accuracy and body weight with ± 0.5kg accuracy. The age of the subjects was determined with 0.1 years accuracy.

The study participants were divided into sample groups according to age with one-year gaps between the groups, on average from 6.5 to 17.5 years old. Means and standard deviations were calculated. Ontogenetic tendencies were represented graphically and by means of significance of difference by two-sample statistical t-test of middle values of inter-annual increase. Statistical significance was evaluated on 1% and 5% level. In addition, a correlation analysis was made with the IBM SSP program.

Results

In Table 1 and Table 2, basic statistical characteristics of the observed parameters can be seen. Figure 1 gives a course of average running velocity, which shows parallel and linear growth from 6.5 to 13.5 years of age in both boys and girls. Later on, velocity in boys increases steeply but stagnates in girls. A similar trend shows on Figure 2 (average stride length). The stride frequency (Figure 3) shows a very stable tendency with slight decrease at the end of observed period. This parameter changes significantly only during pre-pubesence and at the beginning of the pubescent period (from 10.5 to 14.5 years of age).

The duration of the contact of a foot with a surface (Figure 4) displays a course similarly stable to stride frequency. As a result of biological changes, this support phase duration lengthens between 10.5 and 13.5 years of age and gradually returns to the values the values seen at 7 years of age. This parameter of the kinematic structure of the running stride also displays high level of ontogenetic stability, which is proved by interannual t-test values in Table 1, 2.

Values of the flight phase duration can be studied on the Figure 5. Their course is parallel in both boys and girls with duration showing a lengthening tendency until 12.5 years of age followed by slightly shortening tendency until 17.5 years of age. Similar is the course of the efficiency index in Figure 6. It is clear that these parameters duration of the support phase and the flight phase, flight phase and support phase ratio and frequency) confirm a high level of ontogenetic stability (compared to unstable parameters, such as running velocity and stride length, which are dependant on age.

Relationship analysis in the form of Pearson correlation coefficients, which are shown in Table 3, confirms the statistically significant dependence of running velocity, indicators of decimal age, body height, body weight, duration of the support phase and the flight phase, stride length and stride frequency (girls); rela-
Table 1: Statistical characteristics of Age, somatic and kinematic parameters of the maximal velocity sprinting stride over 10m after a 15m flying start and significance of difference between the variables - Boys

<table>
<thead>
<tr>
<th>Group</th>
<th>Statistic</th>
<th>Decimal</th>
<th>Body</th>
<th>Support</th>
<th>Flight</th>
<th>Stride</th>
<th>Stride Frequency (Strides/sec)</th>
<th>Relative Velocity (m/s)</th>
<th>Relative Stride Length (sec)</th>
<th>Flight/Support (sec)</th>
<th>Statistic</th>
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</thead>
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<tr>
<td>1</td>
<td>Mean</td>
<td>-13.59</td>
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<td>0.96</td>
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<td>-0.98</td>
<td>0.02</td>
<td>Sig</td>
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<td>0.72</td>
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<td>0.96</td>
<td>3.48</td>
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<td>-0.98</td>
<td>0.02</td>
<td>Sig</td>
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<tr>
<td>3</td>
<td>Mean</td>
<td>-25.00</td>
<td>4.56</td>
<td>0.72</td>
<td>0.39</td>
<td>0.96</td>
<td>3.48</td>
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<td>-0.98</td>
<td>0.02</td>
<td>Sig</td>
</tr>
<tr>
<td>4</td>
<td>Mean</td>
<td>-25.00</td>
<td>4.56</td>
<td>0.72</td>
<td>0.39</td>
<td>0.96</td>
<td>3.48</td>
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<td>-0.98</td>
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<td>Sig</td>
</tr>
<tr>
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<td>3.48</td>
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</tr>
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<td>0.72</td>
<td>0.39</td>
<td>0.96</td>
<td>3.48</td>
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<td>Sig</td>
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<td>0.96</td>
<td>3.48</td>
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<td>0.72</td>
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<td>0.96</td>
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<td>0.02</td>
<td>Sig</td>
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Table 2: Statistical characteristics of Age, somatic and kinematic parameters of the maximal velocity sprinting stride over 10m after a 15m flying start and significance of difference between the variables - Girls

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (yrs)</th>
<th>Height (cm)</th>
<th>Body Weight (kg)</th>
<th>Minimal Velocity (m/sec)</th>
<th>Maximal Velocity (m/sec)</th>
<th>Time (sec)</th>
<th>Length (cm)</th>
<th>Frequency (times/second)</th>
<th>Stride Length (cm)</th>
<th>Flight Support (sec)</th>
<th>Body Support (sec)</th>
<th>Falling Support (sec)</th>
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<tr>
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<td>10.9 ± 0.5</td>
<td>142.6 ± 5.2</td>
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<td>4.3 ± 0.2</td>
<td>1.9 ± 0.1</td>
<td>120.1 ± 7.4</td>
<td>9.7 ± 0.4</td>
<td>137.4 ± 7.8</td>
<td>0.18 ± 0.03</td>
<td>0.18 ± 0.03</td>
<td>0.18 ± 0.03</td>
</tr>
<tr>
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<td>Mean</td>
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<td>9.7 ± 0.4</td>
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<td>1.9 ± 0.1</td>
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<td>1.9 ± 0.1</td>
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<td>137.4 ± 7.8</td>
<td>0.18 ± 0.03</td>
<td>0.18 ± 0.03</td>
<td>0.18 ± 0.03</td>
</tr>
</tbody>
</table>

**Note:** The table continues with similar data for other groups.
Kinematics of Sprinting in Children and Youths

**Figure 1:** Average maximum sprinting velocity (over 10m after 15m flying start)

**Figure 2:** Average stride length at maximum sprinting velocity (over 10m after 15m flying start)

**Figure 3:** Average stride frequency at maximum sprinting velocity (over 10m after 15m flying start)
Figure 4: Average support time at maximum sprinting velocity (over 10m after 15m flying start)

Figure 5: Average flight time at maximum sprinting velocity (over 10m after 15m flying start)

Figure 6: Efficiency index - defined by duration of the support phase and the running phase ratio - at maximum sprinting velocity (over 10m after 15m flying start)
active velocity, relative frequency and efficiency index (boys). The results show that, for both sexes, the structure of the sprint stride changes drastically in connection to the stride length and frequency, the ratio between the support and the flight phases and the vertical force on the surface. The correlation coefficients show that the duration of the support phase, the relative stride frequency and the vertical force on the surface are good indicators of the sprinting potential of young runners.

The results of our research can be used as background for assessment of talent for sprinting. An individual can be considered talented if he or she achieves parameters of two standard deviations above mean values in indicators such as stride frequency, duration of the support phase and running velocity. It may contribute to a better understanding of the factors responsible for sprint performance in the population of athletes who are not top-level sprinters, i.e. they may be useful to PE teachers, coaches who work with novice athletes and physical conditioning coaches who work in other sports than athletics, to get a more thorough insight into the sprinting efficiency mechanisms.

Discussion

Stride frequency shows as a very stable parameter. Significant changes are only seen during the pre-pubescent period and these can be explained by deterioration of coordination, which is a result of increase in body height and weight. Moreover, ČOH, JOŠT, KAMP-MILLER & ŠTUHEC (2000) found that the development of maximal velocity is not constant, but has certain oscillations, particularly in the adolescence period, when morphological and motor characteristics of youth change. Due to acceleration of longitudinal parameters, stride frequency and stride length change; stride length increases and the stride frequency decreases significantly. Stride frequency does not change only as a result of morphological changes, but also due to disruption of proprio-receptive mechanisms for movement control.

The biggest differences in the development of maximal velocity in both genders occur between the ages of 12 and 14. We found that this coincides with a rapid reduction of the duration of the support phase in boys after the age of 12. This finding is in contradiction to BRAČIĆ et al. (2009), who determined that the improved velocity in boys is mainly due to development of strength. However others (MERO et al., 1986 and 1992) consider support phase duration as one of the main criteria for selecting young sprinters.

Our results are comparable to earlier research by KAMP-MILLER & KOŠTIAL (1986) - which was carried out with smaller samples and modified methods at school stadiums, where it was not possible to achieve a high level of standard conditions of measurement - but are influenced by the new methods used. For example, the support phase duration is 0.02 sec longer than measured in the previous study. Our findings are likewise comparable with the values of the parameters of the support phase found by ČOH et al. (1994), who also used the Lokomometer and identified the most important kinematic-dynamic parameters, their developmental trend and their influence on efficiency in maximal running velocity for sprinters of both sexes from eleven to eighteen years of age.

We also determined that stride length and stride frequency are negatively correlated in maximal velocity running, which is the result of a positive correlation between skeleton dimensionality and stride length, on the one hand, and of a negative correlation between skeleton dimensionality and stride frequency, on the other. As far as we know, research has demonstrated integrally the mechanism of mutual relationships between subcutaneous fatty tissue, skeleton dimensionality, explosive power and kinematic parameters BABIĆ & DIZDAR (2010).
Table 3: Correlation coefficients and their significances of Age, somatic and kinematic parameters of the maximal velocity sprinting stride over 10m after a 15m flying start

<table>
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<tr>
<th></th>
<th>BOYS</th>
<th>GIRLS</th>
</tr>
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<td><strong>p&lt;0.01</strong></td>
<td><strong>p&lt;0.05</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Decimal Age</strong></td>
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<td>.839**</td>
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<tr>
<td>Body Height</td>
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<td>.732**</td>
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<td>Body Weight</td>
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<td>Flight Time</td>
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<td>Flight/Support</td>
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</table>

Kinematics of Sprinting in Children and Youths
Conclusions

The results of our research on the kinematic characteristics of the running stride in the population of seven to 18 year-old youths allows us to present following conclusions:

Running velocity measured over 10m with a 15m approach (flying start) has a linear growth tendency in the male population until 13 years of age, followed by phase of even steeper increase. In the female population after 14 to 15 years of age there is observable stagnation of the running velocity. Similar age dependence was detected while assessing the length of the running stride.

A high level of ontogenetic stability and independence from age was determined in kinematic parameters (stride frequency, support phase duration, flight phase duration, and partly in the efficiency index). These indicators can be considered predictors of maximal running velocity.

Partial deterioration of the kinematic parameters occurs in pre-pubescent and pubescent period.

Practical Recommendations

Based on our findings, we suggest that coaches and others involved in talent identification evaluate children and youths for sprinting talent on the basis of stride frequency and support phase duration. If an individual achieves values in aforesaid parameters that are two or three standard deviations higher than the population averages, as determined in our research, he or she should be considered as talented and directed to an appropriate programme of training and development.

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Doc. Mgr. Marian Vanderka
vanderka@fsport.uniba.sk
REFERENCES


Athlete Development - Reflections on the Pathway from Potential to Performance

by Frank Dick

ABSTRACT

The aim of this paper is to add perspective to the strategic planning process at the start of a new Olympic cycle with a focus on athletes and elite athlete development. After referring to a seven-stage athlete development pathway, the author, an experienced former head coach, outlines strategic and delivery tasks for an effective system. These include a coach development programme based on specialisation for working with athletes as "beginners", "developers" or "high performers" rather than progressing in parallel with the athlete on his/her development pathway. The focus is then turned to the period between junior (U20) competition and the age range for peak performance - 23 to 30 years (men); 24 to 31 (women). A statistical study suggests that the sport as a whole may not be effective in retaining and supporting talented athletes along the pathway to very top-level success: on average, less than 10% of the medallists at any of the six IAAF World Junior Championships in the years 2000 to 2010 were able to make the finals at the London 2012 Olympic Games. After discussing the study results, the author makes 11 recommendations for national federation and IAAF leaders.

AUTHOR

Frank Dick OBE is a motivational speaker and writer. He is the president of the European Athletics Coaches Association and a member of the IAAF Coaches Commission. From 1979 to 1994 he was the British Athletics Federation’s Director of Coaching.

Introduction

Systematic and positive development calls for a clear, well thought out strategy. Without strategy, success will be unpredictable, unsustainable and maybe unnoticed – that is, if it appears at all. This point applies to athletics, and it is the national athletics federation that is primarily responsible for elaborating and then delivering strategies to develop the sport in its country with the aim of success.

In designing a strategy for any aspect of athletics, a federation has three key objectives:

- increase participation,
- develop people,
- improve performance.

While these apply to all involved in athletics, the focus here is on athletes and athlete development. The aim of this paper is to add perspective to the strategic review and planning process that many federations will be going through at the start of a new Olympic cycle.
**Development Pathways**

The pathway of an athlete’s development has been variously described. Figure 1 covers the journey well over seven stages. For some, the pathway will lead to high-performance arenas during the age range for peak performances – 23 to 30 years (men); 24 to 31 (women). For others, the common initial three stages are preparation for a lifetime of activity for recreation and/or well-being objectives.

It may be worth noting that the idea of exciting or motivating someone to participate is not a one-off exercise as part of the recruitment programme, but is a continuing exercise in the retention programme. This is important, because electing to commence the pathway is of little value unless the athlete commits to going the distance by deciding to do so. There are a number of influencers when it comes to this decision, according to age and culture. Whether they are parents, peers, social media or whatever, it is critical that they are identified so that we can “influence the influencers”. This applies equally to those athletes who may have the talent to deliver high performance or simply the wisdom to have an active and healthy lifestyle.

To narrow the focus of this paper further, it is the pathway to high performance that is considered here.

While the various stages of the Athlete Development Pathway suggest a simple sequential build, it would be naïve to assume that it will develop its own momentum. It is sensible, then, to:
- design and deliver a talent action plan,
- ensure effective leadership of the process by a coach or coaches competent to do so,
- create a supportive environment that reflects understanding of the athlete’s changing needs in a rapidly changing world.

**Talent action plan**

A talent action plan might be built on a simple framework:
- Identify (talent spotting on basis of performance potential),
- Recruit (attract talented athletes to travel the pathway),
- Coach (lead the process and those who have input to it),
- Conduct (create the motivational climate to retain a flow of talented athletes),
- Involve (prepare athletes to take ownership of his/her development and performance pathway).

**Coaching competence**

The key, on-the-ground facilitator of the process is the coach. The scope and quality of the coach’s knowledge and competencies, and the effectiveness of the coach’s work is the outcome of his/her coach development pathway. To understand how coach development relates to athlete development, the following points must first be understood:

1. Different skills and areas of competence are required according to the athlete’s age, development stage etc. (A similar situation occurs in education when we consider, for example, the specifics of experience and expertise required in teaching infants as opposed to teaching teenagers in high school.)

2. Beginner athletes should not be exposed to beginner coaches.

3. The science of coaching may be taught; the art can only be learned. (This means

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<tr>
<th>Excite to Participate</th>
<th>Participate to Practice</th>
<th>Practise to Prepare</th>
<th>Prepare to Perform</th>
<th>Perform to Compete</th>
<th>Compete to Learn</th>
<th>Learn to Win</th>
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*Figure 1: The Athlete Development Pathway*
that coach development involves both curricular education and experiential growth).

4. Early in the coach development pathway there is greater priority on the science and reliance on previous practice, later the priority is on the art and judgement calls. Throughout the pathway there must be a consistency in living core values and the coach’s code of ethics.

In this context it is clear that there is error in considering the coach development pathway as progressing in parallel with the athlete development pathway. Consequently it may be appropriate to pursue a different paradigm, where coach development appropriate to the picture of athletes as “beginners”, “developers” or “high performers”, for example, is pursued.

The might be illustrated as in Figure 2, where the athlete development pathway progresses horizontally, and the coach development pathway vertically in a framework defined by the IAAF’s five-level Coach Education and Certification System for reference.

**Supportive environment**

For the most part, federations assume that the sport’s culture affords an adequately supportive environment for the athlete. The annual cycle of training for, and participation in, competition in this context becomes the cultural framework into which the athlete fits.

There are particular concepts of competition that have been designed to enrich the culture and facilitate the athlete development pathway as a process. The IAAF Kids’ Athletics programme (for ages 6-8; 8-10; 10-12) and the IAAF Team Athletics Championships (13-15) are excellent approaches, which both in principle and in practice reflect the seven critical factors that deliver a valuable and valued experience for these athletes:

1. Universal access
2. Age appropriate
3. Dosage and duration
4. Fun
5. Incentives and motivation
6. Feedback to athletes
7. Teaching/coaching/mentoring

**Figure 2: The athlete development pathway (horizontal axis) and performance level-appropriate coach development pathways (vertical axis)**
These naturally lead into the notion of age group championships first at national then at Area and IAAF level. The most significant are at U18, U20 and now U23 (e.g. European Athletics). U16 also features in many national federation and school programmes and in a few instances we even see U14 championships.

It is less important whether or not such exist than it is to consider them not as ends in themselves, but as monitoring or control points in a development process preparing athletes for senior competition in the peak performance age range. So they are to be seen by the athlete as “where am I now in the context of where I am aiming to be”. The coach must not only see things in that light, but address preparation and motivation accordingly. This situation would reflect that we are effectively addressing our three primary strategy objectives.

Once an athlete enters the stages in the development pathway that feature championships, it is relatively easy to track those athletes who show achievement or talent as medallists as they progress. The overall numbers of athletes participating can also be determined.

Unfortunately we have come to see reducing numbers from early to later age group championships almost as a fact of life. So for many federations, it is considered normal for participating numbers of athletes to drop by around 30% (U16 to U18) and 35% (U18 to U20) – males and females combined. Some of these athletes will be the more talented. But why should we accept this situation as normal? Increased participation is one of our primary objectives, so surely this must be addressed. And what can be more distressing than unfulfilled potential of our talented young people? When this happens we are failing to deliver on the other two primary objectives.

**A Reality Check**

Some might say that these issues only affect the years leading through to the junior age group (U20). Unfortunately a study following the London Olympic Games appears to indicate otherwise in the apparent failure of talented high-achievers who medalled at IAAF World Junior Championships (WJC) to demonstrate similar levels of achievement at the Olympic level in subsequent years.

We chose a 12-year timescale leading up to London 2012 because it is understood that when an athlete competes in the WJC he/she will be coming into his/her peak performance years in such a period (we have allowed extra time at both ends of the roughly eight-year age range to accommodate exceptional early and late-bloomers).

From 2000 to 2010, there were six editions of the WJC, from which emerged 360 male and 354 female medallists (excluding relays). Clearly some athletes covered by this analysis from all parts of the world will have enjoyed successes at the 2004 and 2008 Olympic Games and the IAAF World Championships in Athletics during this period or will be successful at future major events. However, the focus here is on London 2012 and secondarily on European athletes.

We have calculated on the basis of 176 finals positions (top 8) and 68 medals for men¹ (there were three bronze medals in the high jump) and 168 finals positions and 63 medals for women in all the events in London (again, relays were excluded).

**Men’s results**

In the case of the men, the 360 WJC medallists in the 10-year period translated into 33 finalists in London (Figure 3) who took 18.7% of the Olympic final positions available. Average that out over the six editions of WJC in question and it comes to about 9% of the male medallists from the WJC in any year going on to earn an Olympic finals place London.
The 360 male WJC medallists also took 14 Olympic medals in London (20.6% of those available). Averaged over the six editions of the WJC, it comes to about 3.8% of the male medallists at the WJC in any year going on to take an Olympic medal.

For European men, the 127 WJC medallists translated into nine finalists in London who took 5% of the Olympic final positions available (Figure 4). Over the six editions of the WJC it comes to an average of 4.7% of male European WJC medallists in any year going on to earn an Olympic finals place in London (for this calculation, I assumed that the WJC medals won by Europe’s men were spread evenly over the six editions).

The 127 European male WJC medallists took one Olympic medal in London (1.5% of those available). Averaged over the six editions of the WJC, it comes to about 0.8% of the male European medallists at the WJC in any year going on to take an Olympic medal.

**Women's results**

In the case of the women, the 354 WJC medallists in the 10-year period translated into 30 finalists in London (Figure 4) who took 17.8% of the Olympic final positions available. Averaged that out over the six editions of WJC in question and it comes to about 8.5% of the female medallists from the WJC in any year going on to earn an Olympic finals place London.

The 354 female WJC medallists also took 18 Olympic medals in London (28.6% of those available). Averaged over the six editions of the WJC, it comes to about 5% of the female medallists at the WJC in any year going on to take an Olympic medal.

For European women, the 169 WJC medallists translated into 11 finalists in London who took 6.5% of the Olympic final positions available. Over the six editions of the WJC it comes to an average of 6.4% of female European WJC medallists in any year going on to earn an Olym-
The 169 European female WJC medallists took seven Olympic medals in London (11.1% of those available). Averaged over the six editions of the WJC, it comes to about 3.9% of the female European medallists at the WJC in any year going on to take an Olympic medal.

In my view, the attrition rate we see from these figures is significant and substantial. Of course, not every medallist in six editions of the WJC can expect to earn one of the limited finals places at one edition of the Olympic Games. But the athletes considered here presumably represent the best of their generation and presumably they benefitted from large investments of attention, time, effort and money. Given this, is a top figure of 9% making an Olympic final an acceptable return?

And focusing on Europe, will governments and sponsors continue to support high-performance programmes and accept the odds for success when we say that, for all the European males, from the whole continent, sent to the WJC and coming back with WJC medals over an entire decade, the net result was that we were able to help one, just one, go on and win an Olympic medal?

**Discussion**

The questions athletics leaders at the national and international level need to ask are:

- Are the environment and services provided making it possible for an acceptable number of our very best juniors to progress through the final stages of the athlete development pathway and excel at the very top level?
- If not, what could be done better?

**Figure 4: Female medallists at the IAAF World Junior Championships 2000 - 2010 and their success at the London 2012 Olympic Games**
What prevented so many the top juniors in this period from fulfilling their potential or, worse, persuaded them to drop out of the sport? What was missing from their further preparation and environment to compromise their progress?

And for those athletes who continued to progress or emerged – what kept them going? What factors in their training raised their game?

The type of statistical data presented here cannot give us causes and there will always be a number of contributing factors impacting these years in an athlete’s life. But whatever they may be, would it not be prudent to consider a national, Area and global strategy to at least reduce the attrition?

**Recommendations**

Once the dust has settled from an Olympic Games, many federations, having reviewed the past few years, look to make changes. These range from personnel to policy. Given the issues raised here, it may also be appropriate to review and revise strategy in affording athletes their athlete development pathway experience. As a guide in this, the following points are offered.

For national federations:

1. Clarify the relationship between the three primary objectives and the athlete development pathway.

2. Ensure that high performance and active lifetime choices are both catered for.

3. Create athlete retention/motivational climate support environment programmes specific to age groups and developmental levels. One size does not fit all.

4. Design and deliver a talent action plan that takes athletes through to fulfilling performance potential in the peak performance age range.

5. Review coach education and development programmes to prepare coaches to be more effective in meeting the needs of athletes at specific stages of development.

6. Monitor coach development through a dedicated tracking programme to be more responsive to addressing individual coach development needs.

7. Establish clear understanding in all involved, that age group championships are not ends in themselves but milestones in the process of athlete development.

8. Prepare an online national athlete tracking system to ensure appropriate guidance and support is available for athletes and their coaches once the athlete is identified as having talent for high performance.

9. Remain constantly in touch with development in performance science and medicine, realigning athlete development pathway programmes and coach education content accordingly.

For the IAAF and Area associations:

1. Prepare an online Area athlete tracking system to do so for athletes who are medallists/finalists in Area age group championships.

2. Prepare an online IAAF athlete tracking system to do so for athletes who are medallists/finalists in IAAF age group championships.

3. In each case, establish an online interactive information and support service for these athletes and their coaches.

On a slightly bigger scale of action, it is worth considering if the situation could be improved by a change to the competition structure? In Europe, we have the European Ath-
A Final Thought

It is our highest priority to prepare our athletes for sport and through it, for a better life. The world in which we live is changing faster and faster. We cannot assume that what worked for our generations will work for them. So we must become more agile in being adaptable and creative if we are to be effective in guiding them to being all that they can become. Like every relationship in life, ours with the athletes must be worked at persistently. The athletes have choices of course. For the relationship to be strong we must focus more carefully on making athletics their choice and provide that sense of partnership that lets them take ownership of the future.

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FOOTNOTES

Page 50: There were three bronze medals in the men’s high jump
Championships have become firmly established as targets for almost all young athletes aspiring to be senior champions and a new, highly-visible event, the Youth Olympic Games, has been established. At the same time, many changes and factors in society, technology and communications have impacted sport and its role in young people’s lives.

The organisers sought to address issues, particularly with regard to athlete preparation, that have emerged along with developments in the last decade and the Conference theme, “Training and Competition of the Youth Athletes” reflected this practical approach. In preparing the programme, they set the following five aims:

1. To identify, share and compare the contributions made in the field of youth athletics by universities, research and training centres, companies, sports federations, the media, and the community of athletes, coaches and other professionals involved in this sport around the world.

2. To facilitate the exchange of experience and research results, and to promote dialogue between athletics professionals working in diverse fields.

3. To collaborate in developing those areas of knowledge and fields of research associated with science in athletics.

4. To collaborate in developing the latest scientific proposals for youth athletics.

The Conference was co-hosted by Spain’s International Athletics Documentation, Research and Development Centre (CIDIDA) Foundation and staged on collaboration with the University of Barcelona’s Institut Nacional d’Educació Física de Catalunya (INEFC), which is located walking distance from the famous Estadi Olímpic where the competition took place. Additional support was provided by the Barcelona City Council.

Since the IAAF’s first action in this field, an international workshop entitled “The Future of Youth Athletics” in 2002, much has changed in the sport and for young athletes in particular. The level and depth of international competition has increased in most disciplines, the IAAF World Junior and the IAAF World Youth Championships have become firmly established as targets for almost all young athletes aspiring to be senior champions and a new, highly-visible event, the Youth Olympic Games, has been established. At the same time, many changes and factors in society, technology and communications have impacted sport and its role in young people’s lives.

The speakers at the Conference Opening Ceremony were the President of the CIDIDA Foundation and the Conference Organising Committee, Dr José Luis López, IAAF Vice-President and pole vault world record holder Sergei Bubka and the Deputy Mayor of Barcelona, Maite Fandos.

Since the IAAF’s first action in this field, an international workshop entitled “The Future of Youth Athletics” in 2002, much has changed in the sport and for young athletes in particular. The level and depth of international competition has increased in most disciplines, the IAAF World Junior and the IAAF World Youth
5. To encourage the development of innovative proposals regarding the future of world athletics, designing programmes and initiatives that respond to the challenges of the modern social world.

The programme comprised keynote speeches, presentations and a scientific poster exhibition. Brief summaries of the three main keynotes follow.

The Scientific Basis of Endurance Training for Young People
Alan Barker (GBR)

Barker, from University of Exeter focused on the specific needs and considerations of young people developing athletic and endurance potential. Stressing the fact that there are only a few controlled training studies on elite young athletes with holistic aerobic endurance outcomes, he asked if young people benefit from endurance training.

What is known is that aerobic fitness is trainable in young people and, in general, trained individuals have a higher aerobic power, have a higher blood lactate threshold, are more economical in running and have a faster change in their aerobic metabolism during exercise. But the only evidence based training recommendation for young people is related to peak O₂ uptake. Training intensity above 80% HRmax appears to be the critical factor to elicit positive adaptations and there seems to be a maturity trigger threshold, but improvements from training may be blunted in those with high baseline aerobic fitness. Other factors might have an influence on training results, but the ideas are speculative and cannot be backed up by the available data.

Barker’s evidenced based training recommendations included continuous or interval training (in combination) using large muscle groups for a minimum of 3-4 sessions per week with the following loading parameters:

- duration / intensity of 40-60 min at 80-85% HRmax for continuous training,
- 30-60min at >90% HRmax using training intervals of 1-3 min with appropriate recovery,
- <30 min of all-out sprints using training intervals of > 30 sec duration with appropriate recovery.

Long-Term Training for Youth
Wolfgang Killing (GER)

Killing, who is a national coach for the German Athletics Federation (DLV), said that the key to a successful career in athletics is a carefully planned long-term development. This process can easily last 12 years from the beginning of sport-oriented activities to a top result at senior level. Focusing on the period from 12 to 15 years old, he said different emphasis should be given to the development of physical qualities according to the different stages of development the individual is going through.

Using the example of the high jumper Falk Wendrich (GER), Killing explained the typical training programmes used in different training periods in detail. His main conclusions can be summarised as follows:

- athletes need fun and motivation for training and competitions,
- there is a need for developing a wide range of coordinative skills,
- the main techniques and coordination skills of athletics should be acquired,
- speed and velocity in the sprints, jumps and throws are critical,
- techniques in other sports should be learned (e.g. gymnastics, weight lifting, basketball),
- there is a need for developing the overall strength of the body muscles,
- prophylactic strengthening of typical weak points will limit the occurrence of injuries.

The Application of Growth and Development Knowledge in Designing Programs That Will Enhance Long-Term Athlete Development
by Lyle Sanderson, (CAN)

Until his retirement in 2004, Sanderson was the head track & field coach and a faculty
member in the College of Kinesiology at the University of Saskatchewan in Canada and he is now a member of the IAAF School and Youth Commission. He started his presentation with the notions that “children are not scaled down miniature adults” and that the challenge athletics faces in the area of youth goes beyond talent identification to “talent entrapment”, in other words, to get potential athletes involved and keep them in the sport.

It is of the greatest importance that coaching methods and activities used with young people are appropriate to each athlete’s level of development and individual differences. There is a need for entry-level programmes that allow for particularities of physical, psychological and social development. These should be structured in a way that ensures that the participants have an enjoyable experience. After that, the Long Term Athlete Development Model coaches use as a basis for planning must be appropriate to the culture of the country.

The structure and content of coach education programmes must ensure coaches understand the various aspects of coaching youngsters and be able to think beyond loading and technical models. For example they must understand the changes taking place in pubescent females and adjust training demands accordingly. They must also ensure that coaches are sensitive to the effect their actions have on a young athlete’s self-esteem.

Other Presentations

The titles of other presentations given in the conference are as follows;

Basic and Advanced Resistance Training for Children and Youth
David G. Behm, University of Newfoundland (CAN)

Talent Identification in Athletics
Juan Manuel García Manso, University of Las Palmas de Gran Canaria (ESP)

Estudio comparativo del rendimiento de jóvenes atletas con y sin discapacidad
(Comparative study of the performance of young able-bodied and paralympic athletes)
Miguel Ángel Torralba, University of Barcelona (ESP)

Diferencias en función del género en las motivaciones para la práctica atlética de jóvenes extremeños
(Differences in the motivation for the practice of athletic sports in young people from Extremadura)
Ruth Jiménez, University of Extremadura (ESP)

Evolución de la condición física en lanzadores junior participantes en un programa de tecnificación deportiva
(Evolution of the physical condition of junior throwing athletes in sports technical programmes)
Javier Brazo-Sayavera, University of Extremadura (ESP)

Evolución de la velocidad en un entrenamiento específico para corredores de 800m. Comparativa entre corredores Juvenil-Junior vs Promesas-Sénior en relación con la competición
(Speed evolution of specific training for 800 metres runners. A comparison between youth-junior and promising-senior athletes at competition level).
Antonio Montoya, University of Valencia (ESP)

Tendinopatía rotuliana: entrenamiento preventivo con jóvenes atletas
(Patellar tendinopathy: preventive training for young athletes)
Javier Peña, CIDIDA Foundation (ESP)

Propuesta metodológica para la evaluación de jóvenes talentos en atletismo
(Methodological plan for the evaluation of young athletics talents)
Javier Brazo-Sayavera, University of Extremadura (ESP)
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**Prediccion de la fluidez disposicional desde la teoría de la autodeterminación**
(Predicting changes in the disposition using the self-determination theory)
Ruth Jiménez, University of Extremadura (ESP)

**Análisis comparativo de la estructura rítmica en 400m vallas en Campeonatos Mundiales de la IAAF: Junior (Barcelona 2012) y absoluto (Daegu 2011)**
(Comparative analysis of the rhythm pattern for the 400 metres hurdles event at IAAF World Championships: Junior (Barcelona 2012) and absolute (Daegu 2011)
José Luis López, University of Vic (ESP)

**Longitud y frecuencia de zancada en el entrenamiento de 600m: comparativa entre corredores de 800m juvenil-junior vs promesa-senior**
(Stride length and frequency during 600 metres training: A comparison between youth-junior and promising-senior athletes)
Antonio Montoya, University of València (ESP)

**Efecto de las actividades tóxicas sobre el aprendizaje de la técnica**
(Consequences of toxic activities on technique learning)
Joan Rius (ESP)

**Conclusion**

Elio Locatelli, the Chairman of the Conference’s Scientific Committee and Director of the IAAF Member Services Department, praised the organisers and supporters of the conference for their efforts.

He said that many of main presentations confirmed conclusions and recommenda-

**Further Information**

Limited copies of the conference DVD are available from the IAAF Bureau in Monaco.

*Reported by Harald Müller*

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Applied Research

contents

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An Objective and Individualised Method of Predicting Performances in Running Events

by Richard Watt

Introduction

It is often the case that coaches need to know what an athlete is capable of for a distance over which he/she has never actually competed. This might be the case of an athlete considering moving up in distance for competitive races, or it may be the case for working out appropriate times for interval training over a distance that is not a common competitive event. It may also happen that an athlete would like to know if his/her performances at one distance are of comparable quality to what he/she achieves at other, related, distances. For example, should an athlete with personal bests of 13:40 over 5000m and 28:00 over 10,000m be happy or disappointed with a performance of 8:10 over 3000m?¹

ABSTRACT

Often we are interested in attempting to get an estimate of the performance that an athlete should achieve in an athletics event. This may be for training purposes (i.e. since training is often over distances that are not commonly raced, we would like to know what our athlete is capable of in that distance at 100% in order to set realistic objectives for intervals), or perhaps to be able to compare an achieved performance against what the athlete should have been theoretically capable of, in order to judge the value of the performance. In this paper the author provides a method for doing this, based entirely on objective data of the athlete him/herself, i.e. without recourse to information on other athletes, or to guess-work, at all. Two performances over distances that are within the athlete's range of competence are needed in order to obtain an estimate of the athlete's capability over any other distance also within the range of competence. The methodology is shown to be accurate to within only a few percentage points by means of considering the actual and predicted times of some top international athletes.

AUTHOR

Richard Watt is an Associate Professor of Economic Theory in the Department of Economics, University of Canterbury in New Zealand. He is an athletics fan, a former athlete (400m hurdles) and currently coaches young 400m and 800m athletes.
Consider a coach who would like to have the athlete do a set of four intervals of 700m at, say, 80% effort. What time should the athlete be aiming to run in each interval? In this paper I provide a methodology that will allow us to calculate, with considerable accuracy, the athlete's maximum capability over that distance, using only information from other performances. For example, say our hypothetical athlete has known best times over 800m and 1500m (or it could be over 400m and 800m), then we will be able to accurately estimate what he/she would run over 700m at 100% effort, from whence it can be calculated what should be achieved at 80% effort. Similarly, if the coach knows what time the athlete can run at 80% effort over two reasonably similar distances (say 600m and 800m), then directly we can calculate the time at 80% effort over 700m.

It must be clearly pointed out that the methodology will only work accurately for distances within an athlete's range of competency. For example, it is not reasonable to use the 100m and 400m times of a 1500m runner to try to predict the capability of that athlete over 1000m. Likewise, the methodology will break down when trying to predict times beyond 200m based only on times at distances below 200m. This is simply because below 200m most athletes will run at the same pace always (full speed), and extrapolating into longer distance, say 400m, based on that data will lead to an absurd prediction of the 400m also being run at the full speed all the way. The methodology explicitly takes into account the fatigue that athletes will experience as they move into longer distances, but only when the two reference data points are also differentiated by some degree of alteration in basic pace. The methodology can be used to predict times at a distance objective times can also be done for intermediate distances that are not exactly half-way between the two extreme distances. Say the two distances with known times are \(d\) and \(d_2\), where \(d < d_2\). Any intermediate distance, say \(d_3\), can be expressed as \(d_3 = \gamma d_1 + (1 - \gamma) d_2\), where \(\gamma\) is a concrete number between 0 and 1. For example, in what we did above, we simply had \(\gamma = \frac{1}{2}\). However, using this general expression, we can easily calculate that, for any given \(d_1\), \(d_2\), and \(d_3\), the relevant weighting is \(\gamma = \frac{d_2 - d_3}{d_2 - d_1}\).

Predicting Within a Range of Known Performances

**Expected value time predictions**

To start with, let’s look at some logical options for our prediction. Take a base distance of \(d\) meters. Consider performance, measured in sec, over distances \(d\) and \(2d\). Call these times \(t_1\) and \(t_2\), respectively. The average time achieved is \(\frac{t_1 + t_2}{2}\).

This is one possible reference pont for the expected time for the distance \(\frac{d + 2d}{2} = \frac{3d}{2}\).

Let’s look at some hypothetical examples. Start with the distance 400m and 800m. Say an athlete has run 50 sec for 400m, 112 sec for 800m (1:52), and consider what this athlete should run over the distance 600m (exactly half-way between 400m and 800m). The average of the two reference times is \(\frac{50 + 112}{2}\).

That is, 1 minute 21 sec. This is our first approximation to the 600m time.

Another example. An athlete has run 22.5 sec for 200m, and 48.3 sec for 400m. How fast should he run for 300m? The expected time is \(\frac{22.5 + 48.3}{2} = \frac{70.8}{2} = 35.4\)

This method of locating intermediate distance objective times can also be done for intermediate distances that are not exactly half-way between the two extreme distances. Say the two distances with known times are \(d_1\) and \(d_{31}\), where \(d_1 < d_{31}\). Any intermediate distance, say \(d_{3}\), can be expressed as \(d_{3} = \gamma d_1 + (1 - \gamma) d_{31}\), where \(\gamma\) is a concrete number between 0 and 1. For example, in what we did above, we simply had \(\gamma = \frac{1}{2}\). However, using this general expression, we can easily calculate that, for any given \(d_1\), \(d_2\), and \(d_{3}\), the relevant weighting is \(\gamma = \frac{d_2 - d_3}{d_2 - d_1}\).
An Objective and Individualised Method of Predicting Performances in Running Events

Case 4: Haile Gebreselassie 2. Even though moving off the track is likely to introduce many imprecisions, let’s see how the formula works for Gebre’s performances over 5000m and half-marathon as a predictor of his 10,000m time. Over 5000m he achieved 759.4 sec, and over the half-marathon (21,195 meters) he achieved 58:55 (i.e. 3535 sec). For this data we get an estimated 10,000m time of 1616.3 sec. That is, 26:56.3.

One thing is notable: for all four cases, the actual intermediate time achieved is faster than the predicted time. Given that, let’s look at a second option for predicting.

Predictions based on pacing

Another option for prediction is to use the average per meter pace. The average pace for a given distance \(d_i\) run in a time \(t_i\) is

\[
p_i = \frac{t_i}{d_i}
\]

Now take the intermediate distance, \(d_3 = \gamma d_1 + (1 - \gamma) d_2\). The weighted average of the two average paces is

\[
p = \gamma p_1 + (1 - \gamma) p_2
\]

Using this, a second estimate of expected time at the intermediate distance \(d_3\) is given by

\[
\frac{p \times d_3}{d_3 - d_1}
\]

Let’s go back to our three legendary case studies. We have

Case 1 (Coe): Using the pacing formula, and based on his times at 800m \((d_1)\) and 1500m \((d_2)\), the average pacing formula would have expected a 1000m time for Coe of 130.77 sec. That is, 2:10.8 more or less.

Case 2 (El Gerrouj): Based on his times at 1500m and 5000m, the pacing formula gives a 3000m time of 433.53 sec. The predicted time is an impressive 7:13.5!

Case 3 (Gebreselassie 1): Based on the performances at 3000m and 10,000m, the expected 5000m time is 756.0 sec, or 12:36.0.

Then, assuming as above that the time for distance is \(t\), and the time for distance \(d_1\) is \(t_1\), and the time for distance \(d_2\) is \(t_2\), the weighted average time is \(t = \gamma t_1 + (1 - \gamma)t_2\).

Substituting \(\gamma = \frac{d_2 - d_3}{d_2 - d_1}\) and \(1 - \gamma = \frac{d_3 - d_1}{d_2 - d_1}\),

this can be written as

\[
t = \frac{(d_2 - d_3)t_1 + (d_3 - d_1)t_2}{d_2 - d_1}
\]

Take, for example, an athlete who has run 1500m in 3:40 (i.e. 220 sec), and 5000m in 13:42 (i.e. 822 sec). What can we expect this athlete to run at 3000m? For this example, we have \(d_1 = 1500, d_2 = 5000, d_3 = 3000, t_1 = 220\) and \(t_2 = 822\). Our reference time is then

\[
t = \frac{(5000 - 3000) \times 220 + (3000 - 1500) \times 822}{5000 - 1500} = 478
\]

that is, 7:58.

Let’s take some concrete case studies to see how well \(t\) expected value methodology predicts intermediate times.

Case 1: Sebastian Coe. Coe ran 1:41.73 (101.7 sec) for 800m and 3:29.77 (209.8 sec) for 1500m. Substituting \(d_1 = 800, d_2 = 1500, d_3 = 1000, t_1 = 101.7\) and \(t_2 = 209.8\) into the equation for \(t\), we find that the expected time for 1000m is 132.59 sec, or 2:12.6. Of course, he actually ran a shade under 2:12.2. Not a bad approximation!

Case 2: Hicham El Gerrouj. Over 1500m, El Gerrouj still holds the world record at 3:26.00 (206 sec), and he also ran 12:50.24 for 5000m (770.4 sec). Therefore, using \(d_1 = 1500, d_2 = 5000, d_3 = 3000, t_1 = 206\) and \(t_2 = 770.4\), our estimation for his time over 3000m is 447.89 sec, that is 7:27.9. Again, a little slower than what he actually achieved, which was 7:23.09.

Case 3: Haile Gebreselassie 1. For 3000m, Gebreselassie ran 7:25.09 (445.1 secs.), and over 10,000m he achieved 26:22.75 (1582.8 secs.). Using this data, for 5000m, where his true best was 12:39.36 (759.4 secs.), we should have expected a time of 770.16 sec, i.e. 12:50.2 more or less.
Case 4 (Gebreselassie 2): Based on the performances at 5000m and half marathon, the expected 10,000m time is 1564.8 sec, or 26:04.8.

Of course, any number of cases can be studied. However, it is certainly notable that for each of the cases in question, the two predictions give us a range of times (i.e. a maximum and a minimum), such that the actual time achieved always falls within these two boundaries.

Given that observation, we should use as our final estimation for the intermediate time that should be achieved for a performance that is somewhere between the two boundary limits. For ease of calculation, and for want of any better number, let’s just take the mid-point of each range as our best predictor of the intermediate time. Thus, we set our best approximation at $t^*$, where

$$t^* = \frac{t + p \times d_3}{2} = \frac{t}{2} + \frac{p \times d_3}{2}$$

For Coe, this delivers a predicted 1000m time of $\frac{132.59 + 130.77}{2} = 131.68$ (that is, 2:11.7).

For El Gerrouj we get a 3000m time of $\frac{447.89 + 422.53}{2} = 440.71$ (that is, 7:20.7), for Gebreselassie 1 we get a 5000m time of $\frac{770.16 + 756.0}{2} = 763.08$ (i.e. 12:43.1), and for Gebreselassie 2 we get a 10,000m time of $\frac{1616.3 + 1564.8}{2} = 1509.6$ (i.e. 26:30.6).

We can see that these are now realistic predictions for all four cases, given what they each actually achieved.

**Predicting Outside of the Range of Known Performances**

Imagine now that we have an athlete with known times at two distances who wants to know what to expect in a third distance that is longer than the two for which he/she has times recorded. The formula for $t^*$ will still work. For example, go back to the athlete who has run 400m in 50 sec. He is planning to compete in his first 800m race, and is unsure about what time to run for the first lap. What can we advise? We get the athlete to run a 600m time trial at full effort in training, which, say, turns out to be 1:20.5, that is, 80.5 sec. We can then use our formulas to find out the expected time for 800m as follows.

We have the time for distance $d_1$ (400m), and now the time for the intermediate distance $d_3$ (600m). We need to find the time for the longer distance, $d_2$ (800m). We also know for this example that $g = \frac{f}{2}$ since 600 is exactly half-way between 400 and 800. Now, we are using as our time at the intermediate distance the best predictor, $t^*$, and so we take $t^* = 80.5$, and write out the equation for the best predictor at the distance of 600m:

$$t^* = \frac{f}{2} \times \left( \frac{50 + t_2}{2} \right) + \frac{f}{2} \times \left( \frac{1}{2} \times \frac{50}{400} + \frac{t_1}{800} \right) \times 600$$

Notice that the only unknown variable left in the equation is $t_2$, which is precisely the corresponding time for 800m. We need only solve the equation for $t_2$. Doing so gives us the result that $t_2 = 112.57$, that is, 1:52.6. This is then our best estimate of the time that this athlete would run for 800m. Therefore we might suggest that he tries to cover the first lap in about 55.5 sec.

More generally, we can take our best predictor for the time at the intermediate distance, $t^*$, and use that for $t_3$. Then, substituting our equation for the average time, $t$, and the prediction based on average pacing, $p \times d_3$, into the equation for the best predictor, $t^*$, we can see that our best prediction for the performance at the intermediate distance $d_3$ is

$$t_3 = \frac{t + p \times d_3}{2} = \frac{1}{2} \left( \frac{t_1 + t_2}{d_1} + \frac{t_2 + t_3}{d_2} \right) \times \frac{\left( \frac{t_2}{d_2} \times d_3 \right) + \left( \frac{t_3}{d_3} \times d_2 \right)}{d_2 - d_3} \times \frac{t_3}{d_3} \times \frac{d_2 - d_3}{d_3} \times \frac{t_2}{d_2} \times \frac{d_3}{d_2} \times \frac{t_1}{d_1} \times \frac{d_2}{d_1}$$

Notice that this equation can be expressed in terms of any of the three times, $t_2, t_1$ or $t_3$. All that is needed is the three distances, and recorded times at two of them. Concretely, a little algebra on the above equation for $t_3$ re-
We can see how all this works in a simple graph (Figure 1).

Figure 1: The graphs of average time, average pacing time, and the best predictor

Figure 1 describes points in the space of distances (on the horizontal axis) and time (on the vertical axis). Thus, a point in the graph is a performance measured in terms of time for a given distance. In particular, point A is a performance at a short distance \(d_1\), and point B is a performance at a longer distance \(d_2\). The straight (uppermost) line joining A and B is the graph of the average time, \(t\), and the lowermost curve joining the same two points is the graph of the predictor based on average pacing, \(p \times d_3\). The intermediate curve (containing point C) is located exactly halfway between \(t\) and \(p \times d_3\), and so it is the graph of the best predictor for the time run at distance \(d_3\). The three curves in the graph can be located with knowledge of only any two of the points A, B or C, although we do need all three distance measures \((d_1, d_2 \text{ and } d_3)\).

If, for example, we have knowledge of performances at two extreme distances and we are interested in a prediction at an intermediate distance, then we would be able to locate the coordinates of point A, which corresponds to the known performance at distance \(d_1\), and point B, which corresponds to the known performance at distance \(d_2\). Given that we have the two extreme points, we are then able to draw the intermediate curve. We then only need to look at the height of this curve at any intermediate distance \(d_3\) to get the best approximation for the performance at that distance, point C. Second, say we want to find point B given two known performances at two shorter distances. In this case, we locate points A and C at the two shorter distance performances, and again we are able to trace out the intermediate curve, and thus locate the height of point B. The case of finding point A given two points C and B is analogous.

To see how this process works with some real data, let’s find the best estimate of each of the longer distances for our three legends, based on their performances at the two shorter distances. In each case, we need only to use the equation above for \(t\).

Case 1 (Coe): Using the times of 1:41.7 for 800m and 2:12.2 for 1000m, what time should we have expected for 1500m? The answer is 212.0 sec, or 3:32.0. Just over 2 sec slower than what he actually achieved.

Case 2 (El Gerrouj): Using the times of 3:26.0 for 1500m and 7:23.1 for 3000m, what time should we have expected from him over 5000m? Our equation tells us that he should have run 777.38 sec, or 12:57.38. Of course he actually ran some 7 sec faster than this.

Case 3 (Gebreselassie 1): Using the times of 7:25.1 for 3000m and 12:39.4 for 5000m, what time should we have expected from him
Table 1: Predicted times for each distance based on results achieved at the other two distances (actual best times in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>( d_1 )</th>
<th>( d_2 )</th>
<th>( d_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coe</td>
<td>1:42.4 (1:41.8)</td>
<td>2:11.7 (2:12.2)</td>
<td>3:32.0 (3:29.8)</td>
</tr>
<tr>
<td>El Gerrouj</td>
<td>3:28.8 (3:26.0)</td>
<td>7:20.7 (7:23.1)</td>
<td>12:57.4 (12:50.2)</td>
</tr>
<tr>
<td>Gebreselassie 1</td>
<td>7:21.2 (7:25.1)</td>
<td>12:43.1 (12:39.4)</td>
<td>26:05.6 (26:22.8)</td>
</tr>
<tr>
<td>Gebreselassie 2</td>
<td>12:36.3 (12:39.4)</td>
<td>26:30.6 (26:22.8)</td>
<td>58:21 (58:35)</td>
</tr>
</tbody>
</table>

Note: for Coe \( d_1 = 800 \), \( d_2 = 1000 \) and \( d_3 = 1500 \). For El Gerrouj , \( d_1 = 1500 \), \( d_2 = 3000 \) and \( d_3 = 5000 \). For Gebreselassie 1 \( d_1 = 3000 \), \( d_2 = 5000 \) and \( d_3 = 10,000 \). For Gebreselassie 2 \( d_1 = 5000 \), \( d_2 = 10,000 \) and \( d_3 = 21195 \).

A negative value in Table 2 indicates that the athlete actually ran faster than the prediction at that distance based on performances at the other two. Note, for example, that the largest number (in absolute value) corresponds to El Gerrouj for 1500m. This says that his 1500m best was significantly better than what he achieved at the two longer distances. The same can be said of Coe over 1500m relative to what he achieved over 800m and 1000m. However, in both of those cases, it is the intermediate distance (3000m for El Gerrouj and 1000m for Coe) that is the real culprit. That is, both El Gerrouj and Coe underperformed at their intermediate distance compared to the two extremes (which we should expect, given that they ran these intermediate distances very infrequently, and they ran the two other distances very often).

Gebreselassie 1 has the opposite result. He has a positive percentage difference at the two extremes (3000m and 10,000m), and a negative difference at 5000m. This says that Gebreselassie over performed over 5000m relative to what he managed at 3000m and 10,000m. Again, we may ascribe this to a lack of opportunities at the two extreme distances; he ran the 3000m infrequently, and the majority of the 10,000m races he ran were championship events rather than events in which record chasing can be done.

Finally, the case of Gebreselassie 2 is also noteworthy. In this case, the numbers are really low (less than half of a percent, either positive over 10,000m? Our equation gives the answer as 1565.6 sec, or 26:05.6, about 17 sec faster than what he actually achieved.

Case 4 (Gebreselassie 2): Using the times of 12:39.4 over 5000m and 26:22.8 over 10,000m, what should we have expected over the half marathon? We find that he was worth 3500.8 sec, or about 58:21, something that although he did not quite manage, he was certainly capable of.

Similarly, we can use our equation for \( t_1 \) to calculate the prediction for Coe over 800m based on his times at 1000m and 1500m, for El Gerrouj over 1500m based on his times at 3000m and 5000m, etc. All of the results of these calculations are given in Table 1.

Table 2 reports the prediction error (in terms of the difference between the actual time achieved and each of the predicted times in Table 1, expressed as a percentage of the actual time achieved).

Table 2: Prediction error in Table 1

<table>
<thead>
<tr>
<th></th>
<th>( d_1 )</th>
<th>( d_2 )</th>
<th>( d_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coe</td>
<td>-0.69%</td>
<td>0.38%</td>
<td>-1.05%</td>
</tr>
<tr>
<td>El Gerrouj</td>
<td>-1.36%</td>
<td>0.54%</td>
<td>-0.93%</td>
</tr>
<tr>
<td>Gebreselassie 1</td>
<td>0.88%</td>
<td>-0.49%</td>
<td>1.09%</td>
</tr>
<tr>
<td>Gebreselassie 2</td>
<td>0.41%</td>
<td>-0.49%</td>
<td>0.40%</td>
</tr>
</tbody>
</table>

Note: the distance columns are as for Table 1.
or negative), especially considering that we are talking about long distances here. This happens because these three distances (5000m, 10,000m and half marathon) are extremely similar in nature, leading to the athlete performing largely as expected in each relative to the others. It is a testament to the fact that the methodology of prediction works best when applied to distances that are by-and-large of a similar nature.

All in all, Table 2 points to the predictions in Table 1 being reasonably accurate; the predictions are generally within one percent of what is actually achieved. And of course a good deal of the prediction error might be able to be explained by exogenous factors such as different track surfaces, weather conditions, and the degree of competition on the day.

**A Thought Experiment**

Here is an interesting question for you. Which athlete out of Sebastian Coe, Steve Ovett, Hicham El Gerrouj, Steve Cram, Nouredinne Morcelli, Noah Ngeny and Said Aouita would have run the fastest time in a race over 1200m, and what would that time have been? For this experiment, it is important that we only use objective information on times that each athlete actually did achieve at different distances, and not performances that we consider an athlete, hypothetically, should have been able to achieve. Table 3 has information (according to Wikipedia) on these athletes:

<table>
<thead>
<tr>
<th>800m</th>
<th>1000m</th>
<th>1500m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coe</td>
<td>1:41.73</td>
<td>2:12.18</td>
</tr>
<tr>
<td>Ovett</td>
<td>1:44.09</td>
<td></td>
</tr>
<tr>
<td>Morcelli</td>
<td>1:44.79</td>
<td>2:13.73</td>
</tr>
<tr>
<td>Aouita</td>
<td>1:43.86</td>
<td></td>
</tr>
<tr>
<td>Cram</td>
<td>1:42.88</td>
<td></td>
</tr>
<tr>
<td>Ngeny</td>
<td>1:44.49</td>
<td>2:11.96</td>
</tr>
<tr>
<td>El Gerrouj</td>
<td>1:47.18</td>
<td>2:16.85</td>
</tr>
</tbody>
</table>

Let’s first find out their expected 1200m time using only the 800m and 1500m times as a reference. On this basis, they end up with the following numbers: Coe 2:42.38, Ovett 2:44.18, Morcelli 2:42.81, Aouita 2:43.40, Cram 2:42.97, Ngeny 2:43.10, and El Gerrouj 2:43.32. However, if instead of using Ngeny’s 800m time, we use his 1000m time, he ends up with 2:42.04.

Thus, the ranking when we limit ourselves to keeping the 1200m as an intermediate distance between the reference points is:

1. Noah Ngeny, 2:42.04
2. Sebastian Coe, 2:42.38
3. Nouredinne Morcelli, 2:42.81
4. Steve Cram, 2:42.97
5. Hicham El Gerrouj, 2:43.32
6. Said Aouita, 2:43.40
7. Steve Ovett, 2:44.18

Naturally, El Gerrouj would almost certainly have headed the list if he had only run a few 800m races when in the peak of his career. Indeed, in order to have gone to the number 1 slot, he would only have had to run 800m in 1:45.12, a time that most observers would feel he was easily capable of. But since I only want to use objective, and not subjective estimates, I cannot use this kind of argument to move El Gerrouj up on the list. But wait, there is still a surprise in store for us. El Gerrouj did run a fantastic 4:44.79 over 2000m, and Morcelli achieved 4:47.88 over that distance. We can then ask, what time at 1200m is consistent with each of their 1500m times and their 2000m times? That is, we can extrapolate downwards to find their 1200m predictions. The answer is that the formula predicts a fantastic time of 2:40.07 for El Gerrouj over 1200m, and an only marginally slower 2:40.58 for Morcelli! However, since we also know that extrapolating outside of the range given by our input data is likely to be a little less precise than predicting within the range, I enter both El Gerrouj and Morcelli into my final ranking with a *, but at least I get them into the places they rightly deserve on the list.
Conclusion

In this paper I have explored the option of predicting an athlete’s best potential time at one distance, given only objective data on performances that have actually been achieved by the same athlete at two other distances. The methodology is quite robust to the distances chosen, although it should be used with care in some circumstances (e.g. extrapolating over very large ranges, extrapolating outside of an athlete’s natural range of competence, or extrapolating based only on times in pure sprint events). By way of example, I have shown that the methodology is accurate (to approximately 1% or less).

The methodology has been explained in terms of 100% efforts at all distances, that is, we can find out the maximum potential capability of the athlete at one distance given their maximum capabilities at two other distances. However, we may also use the technique to find out what time an athlete should run when only at, say, 80% (or indeed any other effort level less than 100%) of maximum speed, by simply using the performances at two other distances at the same (80%) effort level. In that way, we can easily adapt the methodology to suit coaches who need to know what times to set their athletes for interval training at given effort levels.

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REFERENCES

1. The answer is disappointed. This athlete should have been capable of 8:03 over 3000m.
2. In fact, a little algebra suffices to show that the average time, \( t \), is always less than (i.e. faster than) the average pace predictor, \( pxd \), whenever it holds that the pace at the longer distance is higher (i.e. slower) than the pace at the shorter distance, something that we should always expect. That actual realised performances seem to always fall between the two boundaries cannot of course be proved mathematically, but our examples are persuasive for it tending to hold true generally.
3. I am not the only one to wonder about this. See the blog thread on http://www.letsrun.com/forum/flat_read.php?thread=2509407&page=0
4. A blank cell indicates that no personal best for the distance is available.
5. Coe, Morcelli and El Gerrouj all end up with slower 1200m estimates when we use their 1000m time instead of their 800m time.
6. The fastest 1200m on record is 2:44.75, run by El Gerrouj en route to a 2:26.96 1500m in Rieti 2002. See http://trackandfieldnews.com/archive/at_1200_enroute_m.html
An Objective and Individualised Method of Predicting Performances in Running Events
A Biomechanical Analysis of World-Class Senior and Junior Race Walkers

by Brian Hanley

ABSTRACT

The purpose of this study was to conduct a biomechanical analysis of all 15 medallists at the 25th IAAF World Race Walking Cup in Saransk, Russia. Each of the medallists was videoed during the faster second half of the race. Two cameras were placed alongside the course and 3D analysis of the video data conducted in order to measure the most important variables in race walking. As expected, stride length correlated with velocity, and data on individual athletes emphasised the importance of this variable. However, longer strides were negatively associated with stride frequency, and so a balance between these two fundamental variables is advisable. The athletes adhered very closely to the race walking rule with regard to having a straightened knee at first contact; however, they were closer to the threshold of visibly losing contact. While there was little variation between athletes in terms of hip and knee angles, there were larger variations found within the measurements of shoulder and elbow angles. Coaches and athletes should be mindful that race walking is a whole-body activity and inefficient movements should be identified and corrected as appropriate.

AUTHOR

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Introduction

Race walking is part of the athletics programme at the Olympic Games and all other major athletics championships. Championship competitions are held over 20km for men and women, and 50km for men only. Races for junior men and women (under 20 years of age) are held over 10km. The IAAF World Race Walking Cup is a biennial event intended primarily as a team competition between IAAF member nations; however, athletes also compete as individuals. The World Cup is seen as a measure of each competing nation’s depth of talent. As nations are allowed up to five entries per senior race, the participating numbers are relatively high compared with the more prestigious World Championships and Olympic Games. This results in an overall greater depth in talent as strong nations can enter more athletes than in the more exclusive championship races, and thus the World Cup is a highly regarded competition amongst the leading race walking nations.
While it is very useful to measure biomechanical variables across large groups of athletes,\textsuperscript{4,5} it is equally valuable to focus on performances of the very best athletes in understanding the determinants of fast race walking. The aim of this study was to analyse the top three finishers in each race at the 25\textsuperscript{th} World Race Walking Cup held in Saransk, Russia, in May 2012.

**Methods**

Two Canon digital camcorders (50 Hz) were placed at the side of the course at approximately 45° and 135° to the plane of motion respectively. The reference volume used was 5.2m long, 2m wide, and 2m high; this ensured data collection of at least three successive strides and provided a calibration reference for 3D-DLT. The cameras were set up at approximately the 500m point of the 2km lap. The 20km men and women were analysed as they passed through 14.5km, while the 50km men were analysed as they passed 28.5km. Both sets of junior athletes were analysed as they passed through 6.5km.

The top three finishers in all five races were analysed and their results are reproduced here. The video data were analysed using motion analysis software (SIMI, Munich). Variables and gait events of interest were defined as follows:

- **Velocity** – the average horizontal velocity during one complete gait cycle,
- **Stride length** – the distance the body travelled between a specific phase on one leg and the same phase on the other leg,
- **Stride length difference** – the difference in length between right-to-left and left-to-right strides,
- **Stride frequency** – the number of strides taken per second, measured in hertz (Hz),
• Contact – the first visible point during stance where the athlete’s foot clearly makes contact with the ground,
• Toe-off – the last visible point during stance before the athlete’s foot clearly loses contact with the ground,
• Midstance – the point where the athlete’s foot was directly below their body’s centre of mass, used to determine the ‘vertical upright position’ (IAAF rule 230.1).

DE LEVA’s 6 body segment parameter models were used to obtain centre of mass data as these have been found to be most suitable for analysis of elite race walking 7. Data for the left and right sides of the body have been averaged wherever appropriate (i.e. for knee angles). Details of each athlete analysed are included in Table 1. Pearson’s product moment correlation coefficient was used to find associations using all 15 athletes as a single group of world-class athletes.

Results and Discussion

The key race walking performance parameters for each analysed athlete are shown for each event in Table 2. The velocities recorded were those measured at the particular distance of analysis and might differ slightly from the average velocity for the entire race. Indeed, all five gold medallists recorded negative splits in that their second half of the race (when they were analysed) was faster than the first. It can be seen that the six fastest walkers competed in either the senior men’s 20km or the junior men’s 10km races.

Race walking velocity is the product of stride length and stride frequency 4, both of which are shown in Table 2. As shown in Figure 1, velocity was correlated with stride length ($r = 0.85, p < .001$) when taking all 15 analysed athletes into account, although velocity was not found to correlate with stride frequency ($r = –0.31, p = .256$).

Table 1: Participants, ages (yrs), performances and other notable successes

<table>
<thead>
<tr>
<th>Place</th>
<th>Athlete</th>
<th>Age</th>
<th>Time</th>
<th>Additional comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20km Senior Women</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Elena Lashmanova (RUS)</td>
<td>20</td>
<td>1:27:38</td>
<td>2012 Olympic Champion</td>
</tr>
<tr>
<td>2</td>
<td>Olga Kaniskina (RUS)</td>
<td>27</td>
<td>1:28:33</td>
<td>2008 Olympic Champion</td>
</tr>
<tr>
<td>3</td>
<td>María José Poves (ESP)</td>
<td>34</td>
<td>1:29:10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20km Senior Men</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Zhen Wang (CHN)</td>
<td>20</td>
<td>1:19:13</td>
<td>2012 Olympic bronze medallist</td>
</tr>
<tr>
<td>2</td>
<td>Andrey Krivov (RUS)</td>
<td>26</td>
<td>1:19:27</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Vladimir Kanaykin (RUS)</td>
<td>27</td>
<td>1:19:43</td>
<td>2011 World Champs silver medallist</td>
</tr>
<tr>
<td></td>
<td>50km Senior Men</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Sergey Kirdyapkin (RUS)</td>
<td>31</td>
<td>3:38:08</td>
<td>2012 Olympic Champion</td>
</tr>
<tr>
<td>2</td>
<td>Igor Erokhin (RUS)</td>
<td>25</td>
<td>3:38:10</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Jared Tallent (AUS)</td>
<td>27</td>
<td>3:40:32</td>
<td>2008 / 2012 Olympic silver medallist</td>
</tr>
<tr>
<td></td>
<td>10km Junior Women</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Sandra Arenas (COL)</td>
<td>18</td>
<td>45:57</td>
<td>2012 World Junior bronze medallist</td>
</tr>
<tr>
<td>2</td>
<td>Alejandra Ortega (MEX)</td>
<td>17</td>
<td>46:00</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Nadezhda Leontyeva (RUS)</td>
<td>18</td>
<td>46:02</td>
<td>2012 World Junior silver medallist</td>
</tr>
<tr>
<td></td>
<td>10km Junior Men</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Eider Arévalo (COL)</td>
<td>19</td>
<td>41:17</td>
<td>2012 World Junior Champion</td>
</tr>
<tr>
<td>2</td>
<td>Alexander Ivanov (RUS)</td>
<td>17</td>
<td>41:42</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Jesús Tadeo Vega (MEX)</td>
<td>17</td>
<td>41:56</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2: Key race walking performance parameters

<table>
<thead>
<tr>
<th>Athlete</th>
<th>Velocity (km/hr)</th>
<th>Stride length (m)</th>
<th>Stride length difference (m)</th>
<th>Stride frequency (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>20km Senior Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lashmanova</td>
<td>14.53</td>
<td>1.21</td>
<td>0.02</td>
<td>3.34</td>
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<tr>
<td>Kaniskina</td>
<td>13.20</td>
<td>1.08</td>
<td>0.02</td>
<td>3.39</td>
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<tr>
<td>Poves</td>
<td>13.38</td>
<td>1.06</td>
<td>0.05</td>
<td>3.49</td>
</tr>
<tr>
<td><strong>20km Senior Men</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Wang</td>
<td>15.31</td>
<td>1.27</td>
<td>0.02</td>
<td>3.35</td>
</tr>
<tr>
<td>Krivov</td>
<td>14.79</td>
<td>1.35</td>
<td>0.02</td>
<td>3.03</td>
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<tr>
<td>Kanaykin</td>
<td>15.49</td>
<td>1.31</td>
<td>0.05</td>
<td>3.30</td>
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<tr>
<td><strong>50km Senior Men</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kirdyapkin</td>
<td>14.10</td>
<td>1.16</td>
<td>0.02</td>
<td>3.39</td>
</tr>
<tr>
<td>Erokhin</td>
<td>13.92</td>
<td>1.16</td>
<td>0.00</td>
<td>3.32</td>
</tr>
<tr>
<td>Tallent</td>
<td>13.66</td>
<td>1.11</td>
<td>0.04</td>
<td>3.42</td>
</tr>
<tr>
<td><strong>10km Junior Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arenas</td>
<td>14.27</td>
<td>1.16</td>
<td>0.05</td>
<td>3.41</td>
</tr>
<tr>
<td>Ortega</td>
<td>14.11</td>
<td>1.17</td>
<td>0.00</td>
<td>3.36</td>
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<tr>
<td>Leontyeva</td>
<td>14.00</td>
<td>1.12</td>
<td>0.00</td>
<td>3.48</td>
</tr>
<tr>
<td><strong>10km Junior Men</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arévalo</td>
<td>15.78</td>
<td>1.23</td>
<td>0.01</td>
<td>3.55</td>
</tr>
<tr>
<td>Ivanov</td>
<td>15.28</td>
<td>1.36</td>
<td>0.01</td>
<td>3.13</td>
</tr>
<tr>
<td>Vega</td>
<td>14.92</td>
<td>1.30</td>
<td>0.04</td>
<td>3.20</td>
</tr>
</tbody>
</table>

*Figure 1: The relationship between velocity and stride length for all 15 participants*
Stride length and stride frequency were found to be negatively correlated with one another, in that athletes with longer strides were found to have lower stride frequencies ($r = -0.76$, $p = .001$). Stride length differences varied throughout the group, with some athletes having equally long strides while others had up to 5cm difference. These differences might be indicative of imbalances between left and right sides of the body and could be measured (e.g. by coaches) at various distances during training to establish how frequently such differences occur, what effect they might have, and if changes occur with fatigue.

Elena Lashmanova won the women’s 20km event in a time of 1:27:38, more than two and a half minutes slower than the world record time she set 3 months later when winning at the Olympic Games in London. This slower time (and those of other athletes) was partly due to the difficult weather conditions in Saransk (e.g. a temperature of 30°C was recorded at both the beginning and end of the women’s 20km race). The runner-up to Lashmanova in both Saransk and London was the 2008 Olympic and three-time World Champion Olga Kaniskina. Lashmanova was by far the fastest of the three medallists at the instance of analysis: her higher race walking velocity was due to a much longer stride length (13cm longer than Kaniskina’s and 15cm longer than that of bronze medallist, María José Poves). By contrast, Lashmanova had the lowest stride frequency and highlighted the significance of stride length in elite performances as shown by the correlations above.

The importance of stride length in fast race walking was also shown in the results found for the 20km men, as the two fastest men at this point (Zhen Wang and Vladimir Kanaykin) had relatively long strides. However, the negative relationship between stride length and stride frequency was underlined by the data found for Andrey Krivov who had the longest stride of this trio (and the second-longest of the 15 athletes) but by far the lowest stride frequency of all analysed athletes. Interestingly, the longest strides measured in the whole sample (1.36m) were obtained for Alexander Ivanov in the junior men’s race, who had the second-lowest stride frequency. The average stride frequency of all 15 athletes was 3.34 Hz (which equates to 200 strides per minute) and this is a useful guide for coaches who wish to develop their athletes to world-level.

In the men’s 50km race, walking velocity is of course lower compared with the shorter 20km race as the athletes attempt to balance a competitive pace with the need to delay and withstand fatigue. It was informative that the 3 medallists’ lower walking velocities (approximately 1.3 km/hr slower than the 20km medallists) were achieved with shorter strides rather than lower stride frequencies and this again suggests that there could be an optimal range of stride frequencies in elite race walking. The 50km gold medalist, Sergey Kirdyapkin, became Olympic Champion in London three months after the World Cup, having twice won over the same distance at the IAAF World Championships in Athletics (2005 and 2009). His technique can be therefore seen as an excellent model in terms of balancing stride length and stride frequency.

In addition to Kirdyapkin, the other eight senior medallists at the World Cup went on to compete at the Olympic Games in London. The two junior gold medallists (Eider Arévalo and Sandra Arenas) also completed in the Olympic 20km events, finishing 20th and 32nd respectively.

It is worth noting that 2012 was Lashmanova’s first year out of junior competition. The transition to senior competition can be difficult even for elite junior race walkers because of the doubling of distance, but an efficient race walking technique with a sound biomechanical basis can make this transition easier. In Saransk, the analysed walking velocities of the medallists in both junior races were similar to those of their senior 20km counterparts, and it can be seen that in general their stride lengths and stride frequencies matched closely those of the older athletes. It can of course take much
longer for junior athletes to become successful senior athletes but an important component to emphasise during all young athletes’ development is correct race walking technique.

Stride frequency is dependent on the duration of both contact time and flight time. The values for both these variables are shown in Table 3 along with the percentage of time per stride spent in contact with the ground. Very brief flight times are not visible to the human eye and explain why there were few red cards written for loss of contact (IAAF rule 230.1) for the 15 athletes. However, there were more red cards amongst the faster athletes (e.g. 20km senior men) as the walkers got closer to the threshold of visibly losing contact. Short contact times have been previously shown to be hugely important in faster race walking⁶ and the results found for these 15 elite athletes indicate near-optimal values.

Table 4 shows the averages of the hip and knee joint angles at both contact and toe-off. The small standard deviations reported for each group indicate that variation between athletes was small for both joints at first contact, although there were slightly larger variations at toe-off. The small ranges found during this part of the gait cycle are undoubtedly a consequence of the rule that requires a straightened knee at first contact with the ground until the ‘vertical upright position’ (IAAF rule 230.1). These elite race walkers adhered to the rule very well; on average, the athletes were found to have fully extended their knees at first contact, and indeed further hyperextension of the knee occurred until the vertical upright position (midstance) where the average knee angle was 192° (± 4).

In contrast with the lower limb angles, there were much larger variations in the upper limb joint angles measured in this sample of athletes (Table 5). The shoulder angles at contact indicate the amount of shoulder hyperextension occurring on the same side as the heel striking the ground (and are typical of the high elbow drive associated with race walking technique) while the shoulder angles at toe-off indicate

| Table 3: Temporal data (mean ± SD) and total red cards (loss of contact) |
|-------------------------|-------------|-------------|-----------------|-----------------|
|                         | Contact time (sec) | Flight time (sec) | Contact time (%) | Red cards (~) |
| 20km Senior Women       | 0.26 (± .00)      | 0.03 (± .01)    | 88.7 (± 3.6)     | 0              |
| 20km Senior Men         | 0.26 (± .02)      | 0.05 (± .01)    | 84.7 (± 4.1)     | 2              |
| 50km Senior Men         | 0.26 (± .00)      | 0.04 (± .00)    | 86.7 (± 0.0)     | 0              |
| 10km Junior Women       | 0.25 (± .01)      | 0.04 (± .00)    | 86.3 (± 0.5)     | 3              |
| 10km Junior Men         | 0.26 (± .02)      | 0.04 (± .00)    | 86.6 (± 0.9)     | 1              |

| Table 4: Lower limb joint angles for each group of athletes (mean ± SD) |
|-------------------------|-------------|-------------|-------------|-------------|
|                         | Hip joint   | Knee joint  |
|                         | Contact (°) | Toe-off (°) | Contact (°) | Toe-off (°) |
| 20km Senior Women       | 165 (± 2)   | 196 (± 2)   | 184 (± 1)   | 161 (± 1)   |
| 20km Senior Men         | 170 (± 2)   | 190 (± 2)   | 186 (± 2)   | 153 (± 6)   |
| 50km Senior Men         | 170 (± 1)   | 191 (± 3)   | 184 (± 2)   | 164 (± 4)   |
| 10km Junior Women       | 171 (± 1)   | 196 (± 4)   | 183 (± 2)   | 164 (± 8)   |
| 10km Junior Men         | 170 (± 3)   | 190 (± 3)   | 181 (± 4)   | 159 (± 4)   |
Table 5: Upper limb joint angles for each group of athletes (mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>Shoulder Joint</th>
<th></th>
<th>Elbow Joint</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contact (°)</td>
<td>Toe-off (°)</td>
<td>Contact (°)</td>
<td>Toe-off (°)</td>
</tr>
<tr>
<td>20km Senior Women</td>
<td>70 (± 11)</td>
<td>44 (± 13)</td>
<td>80 (± 28)</td>
<td>68 (± 26)</td>
</tr>
<tr>
<td>20km Senior Men</td>
<td>65 (± 14)</td>
<td>39 (± 7)</td>
<td>84 (± 12)</td>
<td>75 (± 17)</td>
</tr>
<tr>
<td>50km Senior Men</td>
<td>55 (± 8)</td>
<td>40 (± 8)</td>
<td>81 (± 7)</td>
<td>65 (± 9)</td>
</tr>
<tr>
<td>10km Junior Women</td>
<td>58 (± 7)</td>
<td>42 (± 11)</td>
<td>82 (± 10)</td>
<td>75 (± 7)</td>
</tr>
<tr>
<td>10km Junior Men</td>
<td>65 (± 7)</td>
<td>39 (± 7)</td>
<td>77 (± 14)</td>
<td>65 (± 13)</td>
</tr>
</tbody>
</table>

Flexion (the arm is in front of the body). Adding the two values together gives the total range of motion of the shoulder, and it can therefore be seen that the shoulder’s overall range during a single stride was approximately 100°. Slightly higher ranges were found for the women’s 20km athletes (114°) whereas the lowest values were found in the 50km medallists (95°).

Most race walkers hold their elbows in whatever position feels comfortable but the best angle might not be adopted naturally. While the overall average elbow angle at contact was 81°, there were very large variations found in all groups, and in particular amongst the 20km women. This was due to one medallist (Lashmanova) having the largest elbow angle of all 15 athletes (109°) and another (Poves) having the smallest (53°). The comparable large variations for the elbow joint at toe-off were also caused by such large discrepancies between athletes. The fact that world-class race walkers can differ so greatly in appearance shows that there is little effect of the race walking rule on the arm’s movements (as there is on the legs) and that there is not just one successful technique. Race walkers generally hold and move their arms in balancing the movement of the legs but coaches should consistently observe their athletes in order to ascertain if arm swing is helping or hindering the legs’ rhythm.

Conclusion

Selecting the very best athletes for analysis is useful when the aim is to identify the most important variables in successful race walking. The majority of the 15 medallists analysed in this study were closely matched in terms of stride frequency and so the greater importance of stride length to race walking velocity was evident. However, athletes should note that there is a limit on how much stride length can be increased before stride frequency is reduced to detrimental levels. Furthermore, increases in stride length might be achieved through longer flight times, which can lead to disqualification. The athletes analysed in this study were some of the world’s best and had the ability and prior training to achieve long strides at high frequencies while maintaining legal race walking technique. Coaches and athletes should note that every race walker’s technique is different (as emphasised by the variations in upper limb joint angles) and each individual’s strengths and weaknesses need to be identified to achieve their own optimal race walking technique.

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REFERENCES


Introduction

Injury is a cause of concern for all athletes - from amateurs at the recreational and grass roots levels to the elite professionals taking part in the IAAF World Championships in Athletics and the Olympic Games. The practice of athletics involves a certain risk of injuries that might lead to missed training and/or competition for athletes\(^1\)\(^2\)\(^3\) and could also impact everyday life away from the

Epidemiology of Track and Field Injuries

by Pascal Edouard and Juan-Manuel Alonso

ABSTRACT

Injury is a cause of concern for all athletes - from amateurs at the recreational and grass roots levels to the elite professionals taking part in the IAAF World Championships in Athletics and the Olympic Games. Preventive measures, focused on the most relevant injuries (high frequency and/or severity), should be implemented in the preparation of the athlete with the aim of reducing future risk and/or severity of injury. Epidemiological data make it possible to identify and highlight the most relevant injuries, and thereby develop appropriate prevention strategies. The authors survey the existing literature focusing their attention on data linked to 1) injuries over the course of a season, 2) injuries at major championships and 3) injuries in young athletes. In addition to identifying the variations in injury risk in elite athletes by discipline and age, they point out that the data shows increased injury risk for young athletes. After calling for increased knowledge of injury incidence and characteristic in youth athletes, they conclude with identification of the main injury prevention strategies found in the literature.

AUTHORS

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Juan-Manuel Alonso, MD, PhD, is the Chair of the Medical and Anti-doping Commission IAAF. He recently begun to work as Sports and Exercise Physician at ASPETAR, Qatar Orthopedics and Sports Medicine Hospital. He has been the Head Physician in the Royal Spanish Athletics Federation (Real Federación Española de Atletismo, RFEA), from 1996 to 2013.
The ultimate aim for health professionals working with athletes must be to increase safety in the sport. Prevention is always better than treatment. Preventive measures, focused on the most relevant track and field related injuries (high frequency and/or severity), should be implemented in the preparation of the athlete with the aim of reducing future risk and/or severity of injury. Therefore, epidemiological data are very important. They make it possible to identify and highlight the most relevant injuries, and they help to develop prevention strategies adapted to the injury mechanisms and risk factors, following the four-step sequence of sports injury prevention described by van Mechelen et al.

This purpose of this article is to draw on the existing literature to describe the incidence and characteristics of athletics injuries occurring over the course of an athletics season and during top-level competitions in order to determine the priority of injury preventive measures.

**Injury During an Athletics Season**

The current knowledge of injury risk during an athletics season is based on few studies with different methods of injury surveillance, which makes comparison between them and conclusion difficult. However, we can say that according to the available studies the prevalence of injuries is from 3.1 to 169.8 per 100 athletes per year. This represents a high injury risk. In the course of a season most injuries occur during training (60 to 91%) compared with those during competition (9 to 30%). This finding is consistent with the fact that most of the time during a season is spent in training rather than competition.

Due to the differences in physical and technical constraints, injury risk varies between athletics disciplines. The characteristics of injuries also vary between disciplines, according to the biomechanical and technical movements, the implements used, the duration of practice and the training workload. For example, a higher acute injury risk is reported in explosive events (sprint, hurdles and jumps) and a higher chronic injury risk is reported in middle- or long-distance runs. In Table 1 we can also see that thigh injuries and especially hamstring strains are frequent in sprints and hurdles, Achilles tendinopathy in explosive events (jumps/sprints/hurdles) or in middle- and long-distance events, ankle sprains and back pain in the pole vault, severe head and spinal cord trauma also in the pole vault, chronic knee lesions (patellar cartilage lesions, iliotibial syndrome, patellar tendinopathy...) and stress fractures in middle- and long-distance runs.

In general, most injuries in athletes are to the lower limbs (from 60 to 100%), because the lower limbs are critical to performance in every event. Musculo-tendinous lesions are frequent in explosive events (sprints, jumps), and are often due to indirect force on the muscle-tendon junction, which is often the weakest point.

However, lower back injuries are also common (12%), especially in jumps, throws and combined events. The technical skills required for pole vault and javelin throw for example (including intense musculoskeletal contortion) put athletes at risk of lumbar strain. Moreover, all track and field events require a good back and abdomen sheathing in order to optimally transmit the force of the lower limbs for performance.

Upper limbs injuries are also reported frequently, with shoulder injury representing the main injury in throwers (70%), and in combined events athletes.
Among the risk factors of athletics injury, a previous history of injury is a predisposing factor to re-injury\textsuperscript{15,22}. Injury prevalence has been reported to be lower when training is supervised by coach\textsuperscript{13} and when athletes have mastered the technical skills\textsuperscript{15}. The gender, age, number of years of practice, and level of practice, are discussed but currently are not determined as risk factors\textsuperscript{1,2,12,13,15-18,25}.

### Injuries During Major Championships

The rigorous method developed by the International Olympic Committee (IOC)\textsuperscript{26} and validated by the IAAF for track and field injury surveillance\textsuperscript{2} facilitated obtaining relevant data on injury incidence and characteristics during major athletics competitions\textsuperscript{2,3,8,25}. From these studies, it can be said that 10-14\% of athletes incur an injury during a top-level championships. During the two most recent IAAF World Championships in Athletics (2009 and 2011), injury incidence was 135 per 1000 registered athletes\textsuperscript{3,25}. About half of these injuries were expected to result in time-loss from training or competition (47 to 64\% of registered athletes)\textsuperscript{2,3,8,25}.

During major championships, male athletes suffer more injuries than female athletes\textsuperscript{2,3,25}. The influence of age on injury risk remains unclear; at the 2009 IAAF World Championships in Athletics in Berlin, most injuries occurred to athletes between 26 to 30 years of age\textsuperscript{25}, but two years later at the same event in Daegu most injuries were to athletes more than 30 years old\textsuperscript{3}.

The risk of injury at a major championship varies substantially between the disciplines with athletes competing in combined events, steeplechase and middle- and long-distance runs having the highest risk\textsuperscript{2,3,25}. In these disciplines, although the intensity of exercise is lower than other events, the time spent in training and/or in competition is longer and overuse

### Table 1: Main injuries (higher risks) among different athletics disciplines

<table>
<thead>
<tr>
<th>Disciplines</th>
<th>Causes</th>
<th>Types</th>
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<tbody>
<tr>
<td><strong>Sprints and hurdles</strong></td>
<td>Acute</td>
<td>Thigh injuries (hamstring strains)</td>
</tr>
<tr>
<td></td>
<td>Overuse</td>
<td>Achilles tendinopathy</td>
</tr>
<tr>
<td><strong>Jumps</strong></td>
<td>Overuse</td>
<td>Achilles tendinopathy, Patellar tendinopathy</td>
</tr>
<tr>
<td><em>Pole vault</em></td>
<td>Acute</td>
<td>Ankle sprains</td>
</tr>
<tr>
<td></td>
<td>Overuse</td>
<td>Back pain</td>
</tr>
<tr>
<td></td>
<td>Major injuries</td>
<td>Severe head and spinal cord trauma</td>
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<td><strong>Throws</strong></td>
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<td>Shoulder and elbow injuries</td>
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<tr>
<td></td>
<td>Overuse</td>
<td>Back pain</td>
</tr>
<tr>
<td><strong>Middle- and long-distance</strong></td>
<td>Overuse</td>
<td>Achilles tendinopathy</td>
</tr>
<tr>
<td></td>
<td>Overuse</td>
<td>Knee chronic lesions (patellar cartilage lesions)</td>
</tr>
<tr>
<td></td>
<td>Overuse</td>
<td>Iliotibial syndrome</td>
</tr>
<tr>
<td></td>
<td>Overuse</td>
<td>Stress fractures</td>
</tr>
</tbody>
</table>


might have a facilitating influence. Although the combined events are practised by a fewer number of athletes than most of the other disciplines, higher injury and time-loss injury risks have been reported in this event\textsuperscript{2,3,5,25,27}.

The majority of injuries are caused by overuse\textsuperscript{1-3,25,28}. The most common diagnoses are thigh strain (14-17%) and hamstring strain (16%), and 46% of these cases leading to time-loss from sport\textsuperscript{2,3,25}. Other common injuries are lower leg strain (5-9%), ankle sprain (3-6%), and trunk muscle cramps (6%)\textsuperscript{2,3,25}. The characteristics of injuries varies between female and male athletes; their locations are shown in Figure 1 and Figure 2, respectively.

**Injuries in Young Athletes**

To our knowledge, few data are available regarding injury risk in youth athletes\textsuperscript{18}. From what data is available we can see that higher injury risk has been reported in this age population than in adult athletes\textsuperscript{5,29}. Injuries to young athletes can sometimes lead to drop out from the sport and/or long-term or even permanent damage of developing tissues and affected structures in this age population\textsuperscript{5,6,18}.

One possible factor in the increased injury risk for young athletes could be the relatively immature musculoskeletal systems of youth athletes.

Increasing the knowledge of injury incidence and characteristic in youth athletes is a priority in order to improve injury prevention programmes and ensure young people can practice track athletics with long-term benefits.

**Injury Prevention Strategies**

One approach suggested in the literature is for prevention strategies to be focused on the most common injuries. Hamstring strain represents the main injury during training and competition periods\textsuperscript{1,3}. Specific studies have suggested that hamstring mechanics during sprinting\textsuperscript{30}, strength imbalances\textsuperscript{20}, flexibility, fatigue, age, ethnicity (particular racial or ana-
Epidemiology of Track and Field Injuries

Injuries in Athletics

Incidence
Athletes have a moderate to high risk of injury compared to other sports.

Characteristics
- Higher risk of injury in training.
- Overuse is the most common cause of injury.
- Lower limbs represent close to 80% of injuries in athletics.
- Thigh strain, mainly hamstring strain, is the most frequent injury.
- Ankle sprain is also a common injury.

Risk factors
- Males seem to have a higher risk of injury than females.
- Athletes over 26 seem to have a higher risk of injury in competition.
- History and severity of a previous injury is a predisposing factor to re-injury.
- Low mastery of technical skills and/or no supervision by coach.
- Combined events athletes have a higher risk of injury in competition.

Figure 1: Injury location in female athletes during IAAF World Championships in Athletics

Figure 2: Injury location in male athletes during IAAF World Championships in Athletics
Epidemiology of Track and Field Injuries

Ankle sprain is also a common injury in athletes\(^3,15,17\). Severity of previous injury has been reported as a major risk factor\(^33\). Deficits in ankle joint positional sense, in feet-forward neuromuscular control, in postural stability and in strength, have been described to be associated with chronic ankle instability, ankle pain and risk of repetitive ankle sprain\(^34,35\).

Given their severity, stress fractures should be monitored and not be neglected\(^12,19,30,37\).

A second approach suggested in the literature is for prevention strategies to be focused on the disciplines with higher injury risk, such as combined events, middle- and long-distance running, pole vault and hurdles\(^2,3,5,15,17,25,27\). The biomechanical and/or metabolic demands of these events need to be better understood to direct injury prevention strategies\(^3,27\). For highly technical disciplines (pole vault, hurdles), mastery of movements and some vigilance seem to appear as a suggested element of injury prevention\(^15,21\).

With reference to injuries at major championships, the literature shows that overuse injuries are the most common\(^2,3,25\). Precociously treating acute injuries, eliminating periods of overtraining, and improving preventative strengthening and recovery programmes could be relevant prevention strategies\(^5\). Appropriate and rigorous treatment and rehabilitation of the first episode of injury is also fundamental in order to prevent recurrence of injury which represents a common cause of injury and an important risk factor of injury\(^12,15,31,33\).

Finally, it is suggested that the management of injuries that need a long-term healing process should be optimised by including maintenance of cardio-respiratory and musculo-tendinous capabilities in order to prevent detraining and anticipate the return to sport\(^1,11\).

Conclusions

Track and field musculoskeletal injuries are common and may lead to absence from training and competition. The epidemiology is summarised in Table 2.

According to the existing literature, preventive interventions should focus on overuse injuries, adequate rehabilitation of previous injuries, hamstring strains, ankle sprains, and optimised technical mastery.

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Reaction Time and Performance in the Short Sprints

by Giorgos P. Paradisis

ABSTRACT

Even though reaction time values are very small, they could differentiate final performance in short sprint races, where the margin of victory is often measured in thousandths of a second. The aim of this study was to examine the role of reaction time in performance in sprints at the elite level. Data on 60m and 100m races staged in the world’s most important competitions from 1996 to 2012, including the IAAF World Indoor Championships, the IAAF World Championships in Athletics (outdoors) and the Olympic Games were gathered from official published results. The times of 565 60m athletes (334 men and 231 females) and 1,533 100m athletes (866 males and 667 female) were analysed. The results showed no significant differences in reaction time between men and women in the 60m, whereas reaction times were shorter for men in the 100m. The analysis revealed an important association between reaction time and performance in the 60m but not in the 100m. The author recommends that athletes, both men and women, and coaches who are looking for success in the 100m should emphasise parameters of their training strategy other than improving reaction time as the means to improve overall performance.

AUTHOR

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Introduction

Reaction time in athletics has been defined as the time that elapses between the firing of the starter’s gun and the moment that the athlete exerts a pre-determined amount of force on the starting blocks. MERO & KOMI divided reaction time into pre-motor time (the time from the gun signal until the onset of activity in the skeletal muscles) and motor time, (the delay between the onset of electrical activity and the force production by the muscles). There are claims that, even though reaction time values are very small, they could differentiate final performance in the short sprint races, such as the 60m and the 100m, where the margin of victory is often measured in thousandths of a second.

MARTIN & BUONCRISTIANI reported the reaction times $171 \pm 26$ ms and $179 \pm 27$ ms for men and women respectively for the 1994 European Athletics Championships 100m races. MORAVEC et al. analysed the reaction time for the 100m finals at the 1987 IAAF World Cham-
pionships in Athletics (175 ± 45 ms and 196 ± 35 ms for men (n = 8) and women (n = 8) respectively) and concluded that there was no significant correlation between reaction time and final performance. Similar results reported by BRÜGGE-MANN & GLAD, who analysed the reaction times in the 100m races at the 1988 Olympic Games (153 ± 21 ms and 152 ± 16 ms for men and women respectively). However, MARTIN & BUONCRISTIANI analysed the reaction times of 206 men and 191 women in the 100m (1993 IAAF World Championships in Athletics and 1994 European Athletics Championships) and found significant relationship between reaction time and final performance (P<0.001), but they did not provide any correlation coefficient.

In the case of the 60m, there are no data regarding the correlation between reaction time and performance. Therefore, in order to have a conclusive answer to this issue further research is needed.

The aim of this study was to examine the relationship between reaction time and final performance in elite sprinters in both the 60m and 100m in order to compare men and women and to determine if a short reaction time provides such an advantage that the mastering of techniques to minimise it should be emphasised in training.

**Methods**

In order to examine the relationship between reaction time and final performance data on sprint races staged in the world’s most important competitions from 1996 – 2012, including the IAAF World Indoor Championships, the IAAF World Championships in Athletics (outdoors) and the Olympic Games were gathered from the official published results. The IAAF approved the timing systems used in all the events studied. The times of 565 60m athletes (334 men and 231 females) and 1,533 100m athletes (866 males and 667 female) were analysed (Table 1). The data analysed for both the performance (time of 60m and 100m) and reaction time were obtained from the electronic timing systems at the corresponding events and the best performance of each athlete was included for analysis.

**Table 1: Number of participants in the competitions studied**

<table>
<thead>
<tr>
<th>Event</th>
<th>Men</th>
<th>Women</th>
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</thead>
<tbody>
<tr>
<td>OG Atlanta 1996</td>
<td>104</td>
<td>49</td>
</tr>
<tr>
<td>OG Sidney 2000</td>
<td>95</td>
<td>80</td>
</tr>
<tr>
<td>OG Athens 2004</td>
<td>80</td>
<td>57</td>
</tr>
<tr>
<td>OG Beijing 2008</td>
<td>79</td>
<td>82</td>
</tr>
<tr>
<td>IAAF WCA Seville 1999</td>
<td>74</td>
<td>49</td>
</tr>
<tr>
<td>IAAF WCA Edmonton 2001</td>
<td>77</td>
<td>53</td>
</tr>
<tr>
<td>IAAF WCA Paris 2003</td>
<td>72</td>
<td>56</td>
</tr>
<tr>
<td>IAAF WCA Helsinki 2005</td>
<td>58</td>
<td>55</td>
</tr>
<tr>
<td>IAAF WCA Osaka 2007</td>
<td>66</td>
<td>70</td>
</tr>
<tr>
<td>IAAF WCA Berlin 2009</td>
<td>89</td>
<td>60</td>
</tr>
<tr>
<td>IAAF WCA Daegu 2011</td>
<td>72</td>
<td>56</td>
</tr>
<tr>
<td>IAAF Indoor WC Birmingham 2003</td>
<td>56</td>
<td>32</td>
</tr>
<tr>
<td>IAAF Indoor WC Budapest 2004</td>
<td>58</td>
<td>35</td>
</tr>
<tr>
<td>IAAF Indoor WC Moscow 2006</td>
<td>54</td>
<td>33</td>
</tr>
<tr>
<td>IAAF Indoor WC Valencia 2008</td>
<td>57</td>
<td>35</td>
</tr>
<tr>
<td>IAAF Indoor WC Doha 2010</td>
<td>52</td>
<td>34</td>
</tr>
<tr>
<td>IAAF Indoor WC Istanbul 2012</td>
<td>57</td>
<td>62</td>
</tr>
</tbody>
</table>
An independent t-test was used to examine differences between the sexes and a Pearson correlation coefficient was used to establish any significant relationship between the time performance and reaction time. The significance level for the tests was set at \( P < 0.05 \).

## Results

The overall mean reaction time and final performance for the 60m races studied was 185 ± 64 ms and 6.90 ± 0.30 sec respectively for men and 189 ± 59 ms and 7.52 ± 0.42 sec respectively for women (Table 2). The statistical analysis revealed no significant differences in reaction time between men and women. Further analysis of each competition examining the differences in sex in terms of the mean of all the participants in each competition (M_CompT) and in terms of the mean of the participants in the finals (M_FinalT) revealed no significant differences except for the 2010 IAAF World Indoor Championships, where M_CompT of men showed lower reaction times (\( P < 0.05 \)) and at the 2012 IAAF World Indoor Championships, where M_FinalT of men produced slower reaction times compared to women (Table 2). On the other hand performance in 60m was statistically faster for men than in women when the sample was analysed overall, as M_CompT and as M_FinalT (Table 2).

The overall mean reaction time and final performance for the 100m races studied was 166 ± 29 ms and 10.59 ± 0.55 sec respectively for men and 178 ± 35 ms and 11.85 ± 0.85 sec respectively for women (Table 3).

The statistical analysis revealed significant differences in reaction times between men and women (\( P < 0.05 \)). Further analysis of each competition examining the differences in sex in terms of M_CompT and in terms of M_FinalT revealed that in seven out of eleven competitions the M_CompT of men showed shorter reaction times than women (Table 3), whereas in only three competitions M_FinalT of men showed shorter reaction times (in the 2008 Olympic Games, 2003 IAAF World Championships in Athletics and 2009 IAAF World Championships in Athletics). On the other hand performance in the 100m was statistically faster for men than for women when the sample was analysed overall, as M_CompT and as M_FinalT (Table 3).

The progression of the 60m performances and the reaction times in terms of the best performance of the competition (B_FinalT), M_COMPT and M_FINALT from 2003 to 2012 are shown in Figure 1 and Figure 2 for men and in Figure 3 and Figure 4 for women. Analyzing Figure 1 and Figure 3 it is clear that even though BPC and M_FINALT for men and women were constant throughout the years, the M_COMPT in the 60m has worsened. In term of reaction time, both BPC and M_COMPT reaction times worsened throughout the years, whereas M_FINALT remains constant.

### Table 2: Reaction time and final time in the 60m races at the IAAF World Indoor Championships (mean ± SD)

<table>
<thead>
<tr>
<th>Event</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RT (ms)</td>
<td>Time (sec)</td>
</tr>
<tr>
<td>IAAF Indoor WC Birmingham 2003</td>
<td>153 ± 24</td>
<td>6.84 ± 0.28*</td>
</tr>
<tr>
<td>IAAF Indoor WC Budapest 2004</td>
<td>150 ± 23</td>
<td>6.81 ± 0.23*</td>
</tr>
<tr>
<td>IAAF Indoor WC Moscow 2006</td>
<td>176 ± 50</td>
<td>6.83 ± 0.23*</td>
</tr>
<tr>
<td>IAAF Indoor WC Valencia 2008</td>
<td>207 ± 66</td>
<td>6.93 ± 0.31*</td>
</tr>
<tr>
<td>IAAF Indoor WC Doha 2010</td>
<td>181 ± 47*</td>
<td>6.92 ± 0.33*</td>
</tr>
<tr>
<td>IAAF Indoor WC Istanbul 2012</td>
<td>240 ± 89</td>
<td>7.06 ± 0.37*</td>
</tr>
</tbody>
</table>

\* = Significantly shorter than women, as determined by Student’s T-test for independent samples (\( P < 0.05 \))
Table 3: Reaction time and final time in the 100m races at the Olympic Games and IAAF World Championships in Athletics (mean ± SD)

<table>
<thead>
<tr>
<th>Event</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RT (ms)</td>
<td>Time (sec)</td>
</tr>
<tr>
<td>OG Atlanta 1996</td>
<td>171 ± 21</td>
<td>10.55 ± 0.21*</td>
</tr>
<tr>
<td>OG Sidney 2000</td>
<td>193 ± 36*</td>
<td>10.56 ± 0.38*</td>
</tr>
<tr>
<td>OG Athens 2004</td>
<td>164 ± 24*</td>
<td>10.50 ± 0.44*</td>
</tr>
<tr>
<td>OG Beijing 2008</td>
<td>162 ± 20*</td>
<td>10.54 ± 0.51*</td>
</tr>
<tr>
<td>IAAF Outdoor WC Seville 1999</td>
<td>154 ± 39</td>
<td>10.51 ± 0.51*</td>
</tr>
<tr>
<td>IAAF Outdoor WC Edmonton 2001</td>
<td>165 ± 20</td>
<td>10.60 ± 0.65*</td>
</tr>
<tr>
<td>IAAF Outdoor WC Paris 2003</td>
<td>158 ± 28*</td>
<td>10.58 ± 0.49*</td>
</tr>
<tr>
<td>IAAF Outdoor WC Helsinki 2005</td>
<td>154 ± 23*</td>
<td>10.62 ± 0.56*</td>
</tr>
<tr>
<td>IAAF Outdoor WC Osaka 2007</td>
<td>159 ± 19*</td>
<td>10.70 ± 0.67*</td>
</tr>
<tr>
<td>IAAF Outdoor WC Berlin 2009</td>
<td>155 ± 20*</td>
<td>10.62 ± 0.56*</td>
</tr>
<tr>
<td>IAAF Outdoor WC Daegu 2011</td>
<td>177 ± 27</td>
<td>10.77 ± 0.81*</td>
</tr>
</tbody>
</table>

* = Significantly shorter than women, as determined by Student’s T-test for independent samples (P < 0.05)

The progressions of the 100m performance and reaction time in terms of BPC, M_COMPT and M_FINALT from 1996 until 2011 are shown in Figure 5 and Figure 6 for men and in Figure 7 and Figure 8 for women. Analysing Figure 5 and Figure 6 it can be seen that all three indices for both reaction time and 100m performance for men show fluctuations, and during the last years they have worsened. However, in term of women, the M_COMPT has shown an improving trend over the last years, even though BPC and M_FINALT have worsened (Figure 7). Finally, reaction time progression in the women’s 100m has shown very large fluctuation throughout the years (Figure 8).
Figure 2: Progression of men’s 60m reaction times in terms of the best performance of the competition (B_FinalT), mean of all the participants of the competition (M_CompT) and mean of the participants in the finals (M_FinalT)

Figure 3: Progression of women’s 60m performances in terms of the best performance of the competition (B_FinalT), mean of all the participants of the competition (M_CompT) and mean of the participants in the finals (M_FinalT)

Figure 4: Progression of women’s 60m reaction times in terms of the best performance of the competition (B_FinalT), mean of all the participants of the competition (M_CompT) and mean of the participants in the finals (M_FinalT)
Reaction Time and Performance in the Short Sprints

Figure 5: Progression of men’s 100m performances in terms of the best performance of the competition (B_FinalT), mean of all the participants of the competition (M_CompT) and mean of the participants in the finals (M_FinalT).

Figure 6: Progression of men’s 100m reaction times in terms of the best performance of the competition (B_FinalRT), mean of all the participants of the competition (M_CompRT) and mean of the participants in the finals (M_FinalRT).

Figure 7: Progression of women’s 100m performances in terms of the best performance of the competition (B_FinalT), mean of all the participants of the competition (M_CompT) and mean of the participants in the finals (M_FinalT).
The correlation coefficient between reaction time and performance in the 60m races overall was $r = 0.450$, $P < 0.05$: for the men it was $r = 0.550$, $P < 0.05$ ($y = 2.642x + 6.411$) and for the women it was $r = 0.601$, $P < 0.05$ ($y = 4.288x + 6.706$). The correlation coefficients for each of the championships studied appear in Table 4.

The correlation coefficient between reaction time and performance in the 100m races overall was $r = 0.393$: $P < 0.05$, for the men it was $r = 0.349$, $P < 0.05$ ($y = 6.546x + 9.503$) and for the women it was $r = 0.351$, $P < 0.05$ ($y = 8.564x + 10.315$). The correlation coefficients for each of the championships studied appear in Table 5.

Table 4: Correlation coefficients between the reaction time and performance in 60m races ($^* = P < 0.05$)

<table>
<thead>
<tr>
<th>Event</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAAF Indoor WC Birmingham 2003</td>
<td>0.212</td>
<td>-0.009</td>
</tr>
<tr>
<td>IAAF Indoor WC Budapest 2004</td>
<td>0.312*</td>
<td>0.236</td>
</tr>
<tr>
<td>IAAF Indoor WC Moscow 2006</td>
<td>0.462*</td>
<td>0.459*</td>
</tr>
<tr>
<td>IAAF Indoor WC Valencia 2008</td>
<td>0.646*</td>
<td>0.637*</td>
</tr>
<tr>
<td>IAAF Indoor WC Doha 2010</td>
<td>0.445*</td>
<td>0.702*</td>
</tr>
<tr>
<td>IAAF Indoor WC Istanbul 2012</td>
<td>0.615*</td>
<td>0.597*</td>
</tr>
</tbody>
</table>

Table 5. Correlation coefficients between the reaction time and performance in 100m races ($^* = P < 0.05$)

<table>
<thead>
<tr>
<th>Event</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>OG Atlanta 1996</td>
<td>0.348*</td>
<td>0.248</td>
</tr>
<tr>
<td>OG Sidney 2000</td>
<td>0.276*</td>
<td>0.406*</td>
</tr>
<tr>
<td>OG Athens 2004</td>
<td>0.527*</td>
<td>0.471*</td>
</tr>
<tr>
<td>OG Beijing 2008</td>
<td>0.433*</td>
<td>0.614*</td>
</tr>
<tr>
<td>IAAF WCA Seville 1999</td>
<td>0.409*</td>
<td>0.406*</td>
</tr>
<tr>
<td>IAAF WCA Edmonton 2001</td>
<td>0.539*</td>
<td>0.711*</td>
</tr>
<tr>
<td>IAAF WCA Paris 2003</td>
<td>0.414*</td>
<td>0.378*</td>
</tr>
<tr>
<td>IAAF WCA Helsinki 2005</td>
<td>0.429*</td>
<td>0.582*</td>
</tr>
<tr>
<td>IAAF WCA Osaka 2007</td>
<td>0.434*</td>
<td>0.314*</td>
</tr>
<tr>
<td>IAAF WCA Berlin 2009</td>
<td>0.341*</td>
<td>0.409*</td>
</tr>
<tr>
<td>IAAF WCA Daegu 2011</td>
<td>0.538*</td>
<td>0.401*</td>
</tr>
</tbody>
</table>
Sex differences

It is a common belief that men have shorter reaction times than women\(^4\). Data from studies that examined sex differences in reaction time in response to auditory stimulus in large populations (1,265 and 7,130 accordingly), support the difference in reaction times in favour of men\(^7,8\). However, others\(^9,10\) using small populations (140 and 22 accordingly), did not identify any sex differences in reaction time, even though WINTER & BROOKES\(^10\) did find differences in the Electromechanical Delay (the time interval between the change in EMG and movement). The biological reason for the sex difference in reaction time is not known, but it has been hypothesised that either neurological\(^8\), or mechanical factors are responsible\(^10\).

Interestingly, the results of this study revealed that there was significant difference in reaction time between the men’s and women’s 60m races at only two of the events studied even though overall performance for 60m was significantly faster for in men (P < 0.05). This approximation of parity in reaction time between the sexes is rather unexpected.

In contrast, in the 100m races studied the men did have significantly shorter reaction times than the women, as well as better overall performances (P < 0.05). BABIC & DELALIJA\(^4\) showed that reaction times of women in the 100m were statistically longer than those of men at the 2004 Olympic Games. MORAVEC et al.\(^5\) reported trends of longer reaction times for the women 100m runners at the 1987 IAAF World Championships in Athletics, but these were not statistically significant. In the 1988 Olympic Games, the men’s reaction times did not differ from that of women’s; in fact, M_FINALT of women showed shorter values\(^6\). MARTIN & BUONCRISTIANI\(^3\) reported a trend for shorter men’s reaction times compared to women’s in both 1993 IAAF World Championships in Athletics and the 1994 European Athletics Championships but, again, these trends were not significantly different.

Discussion

General trends

The analysis of the progression of the 60m for men and women revealed that even though the best performance in the finals remained about the same over the years the average values for the competitions of both reaction time and final time showed increasing trends. This is rather surprising, as one would expect better performance as a result of improved training knowledge and methods. Similar results can be observed in the 100m progression for both men and women. However, further research is needed in order to identify any physiological or/and sociological parameters that could explain this observation.
To summarise, although there is conflicting data from the literature about the 60m, the data regarding the reaction time in the 100m supports the general belief regarding sex differences.

**Reaction time and final performance**

The results of this study showed that there is a significant association between reaction time and final performance; however the correlation coefficient between reaction time and performance in 60m races is greater in women than men. It looks like reaction time is an important factor in the final performance in the 60m at the elite level.

In contrast, the association between reaction time and final performance in the 100m is rather small except in some isolate cases (Table 5), supporting previous findings. It looks like reaction time does not play an important role in final performance in 100m races at the elite level.

**Conclusions**

The results of this study revealed no significant differences in reaction time between elite men and women in the 60m, whereas reaction times are significantly shorter for elite men in the 100m.

Additionally, the analysis revealed important associations between reaction time and final performance in the 60m but not in the 100m. Therefore, athletes, both men and women, and their coaches who are looking for success in the 100m should emphasise parameters of their training strategy other than improving reaction time as the means to improve overall performance.

**REFERENCES**


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Coaching

contents

- Congress Report – The North America, Central America and Caribbean Track and Field Coaches Association Congress
- Conference Report – The International Festival of Athletics Coaching
Eighty-three coaches and experts turned out for the 22nd Congress of the North America, Central America, and Caribbean Track & Field Coaches’ Association (NACACTFCA) in Nassau, Bahamas, 4-7 October, 2012.

Honouring the Congress with their participation in the Opening Ceremony were Bahamian personalities Daniel Johnson, the Minister of Sport and Culture, Mike Sands, Bahamas Association of Athletics Associations (BAAA) President, and the legendary sprinter Pauline Davis-Thompson, who is now an IAAF Council member and a member of the IAAF Coaches’ Commission. Also in attendance was longtime NACACTFCA supporter Neville McCook, the North America, Central America and Caribbean Athletics Association President, who, sadly, has since passed away.

World-class sprints and jumps coach Frans Bosch (NED), was the Congress keynote speaker and the line-up of distinguished presenters included Orlando Meneses (MEX), Bradley Cooper (BAH), Peter Thompson (GBR), Jim Denison (USA), and Wolfgang Ritzdorf (GER). The main theme for the Congress was “New Frontiers in Athletics Training” and the common threads that recurred regularly throughout the various presentations included 1) the need to simplify cues and teaching models to improve athlete understanding, 2) development of athlete autonomy, responsibility and control in both training and competition and 3) the notion that the role of the coach is not necessarily to teach technique and competitive skills, but to enable the athlete to develop and own those themselves!

The following sections give highlights from the main presentations.

Positive Running
Frans Bosch (NED)

Addressing high velocity running, Bosch who now works as a performance consultant and is noted for his book “Running, Biomechanics and Exercise Physiology Applied in Practice”, which he co-authored with Ronald Klomp, provided an excellent presentation of the need to re-examine how we think about sprinting.

His main point was that maximum strength is not the limiting factor in running velocity – there is plenty of force available - but the right force is needed in a short time and in the proper direction. “Strength training”, he said, “is not the holy grail!” He focused instead on ground reaction forces and his “whip from the hip” concept, which means pushing the foot into the ground on contact. The simultaneous hip, knee, and ankle extension applies force to the ground earlier in the stance, using the rectus femoris before the hamstring. Although there is a need for specific strength development of the pertinent muscular systems, traditional power training through Olympic lifts introduces too much muscle slack and is probably not very effective for speed / power training unless the movement is modified to remove the counter movement and slack. Indeed, the counter-
movement causes slack in many exercises, including jumps and hops, and thus should be avoided in specific strength and power training.

Bosch talked at length about “Positive Running,” where pelvic posture, big pendulum vs. small pendulum, forward hip rotation at toe-off, reduced scissors action, casting the foot in front of the hip, and “the most difficult moment in the running cycle - reversing the pendulum” - are all important. Positive running helps muscles and tendons work in the optimum length. He stressed that the knee should not travel behind the pelvis and that athletes need to keep the free hip higher than the hip on the stance side – an excellent cue to watch. At toe-off, the stance shoulder is lower and the free hip should be higher. Overhead stick and jump rope and dumbbell runs can help athletes organise their own system to develop this.

He also noted that control of anterior-posterior pelvic rotation is crucial for hamstring function. At high velocities, large quantities of energy are transported from one leg to the other leg by elastic stretch as many as 4-5 times per second. A functional hamstring wants to stop knee extension and wants to assist hip extension and the isometric condition in the hamstring is controlled by pelvic rotation in the sagittal plane. In addition, at higher velocities there is less vertical oscillation and shorter ground contact. More force is produced in a shorter time, and this goes hand in hand with the pelvic rotation and hamstring function. He said the iliopsoas is crucial in hamstring loading - there is no such thing as an overactive iliopsoas. He recommends training the hamstrings with maximum strength exercises in the lengthened state – prone trunk raises with weights are done with the single leg.

Strength, Flexibility, and Balance: Discus Specifics Made Easy
Bradley Cooper (BAH)

Cooper, a former NCAA Champion at Florida State University and the national record holder in the discus who works with athletes of all levels in his native Bahamas, explained his general approach to training discus throwers.

Starting with the point that technical skill plus physical capability equals the basic performance, he said he uses a multi-lateral programme with various methods including sprints, jumps, and throws and circuit training for developing speed, strength, and coordination. Weight room exercises like cleans and bench press are not over-emphasised at the expense of the special strength exercises of throwing different weight discs and other weighted implements such as balls, puds, and plates. Some of the testing he uses includes the Max Jones Quadathlon, a 60m speed test, and the vertical jump.

Technical development is centred on balance drills, phantom or ghost drills, and South African and full throws. Balance and rhythm are the essential principles of the throw, and Cooper emphasises low to high, slow to fast, and hips before arms with young throwers.

He concluded by discussing tactical development and mental training for big competitions based on his own experiences as well as those of his athletes.

Development of the Hurdles
Orlando Meneses (MEX)

Meneses, originally from Cuba, has been living in Mexico where he has successfully developed hurdlers at various levels. He was was gracious enough to fill in for the Cuban hurdle coach Santiago Antunez, who was unable to make the Congress at the last minute, and used his presentation described the training and technical considerations he applies with his athletes. He provided a solid overview of the methodology of periodised training, pedagogy of teaching and motor learning, and teaching progressions for the hurdles at different stages of development.
Designing More Effective Training Sessions

Peter Thompson (USA)

Previously the Senior Education Manager in the IAAF Member Services Department, Thompson is now based in Oregon, USA. His presentation covered his programme of New Interval Training for middle and long distance runners and how its inclusion can result in more effective sessions, even for sprinters and hurdlers and jumpers.

He outlined the historical development of interval training, noting that many coaches and athletes still confuse repetition training with interval training – interval training may use repetitions, but repetition running is not in and of itself interval training! He referred to the research of Brooks in 1988, which dispelled the “lactic acid” myth and promoted the idea that oxidation of lactate is an important energy source during high-level running! He explained lactate dynamics training (LTD), which promotes utilisation and clearance of lactate so that it is optimally used around the body, and is accomplished by use of varied running rhythms so that lactate is alternately increased and reduced, with fartlek as the classic example.

Thompson said that in interval training, the training effect is in the interval. His programme is a form of LTD where the athlete runs a “roll on recovery” to develop a “synergistic relationship between the aerobic and lactate systems,” while “improving awareness for running rhythms and paces.” The “roll on recovery” as a principle and a skill is supported with science, analogous evidence, and case studies involving his own runners and those of coaches who have utilised the programme.

He presented methods of introducing and utilising his New Interval Training in any programme, and noted that with time the system can develop and become more detailed as the athletes develop a feel for the rhythms and using the roll on recoveries. Finally, he pointed out that through this programme, athletes develop a responsibility for their own rhythms and recoveries, leading to greater ownership of their own training.

Positive Coaching: Ethical Planning for Athletics

Jim Denison (USA)

Dr Denison is an Associate Professor in the Faculty of Physical Education and Recreation at the University of Alberta and the Director of the Canadian Athletics Coaching Centre in Edmonton, Canada. In his presentation he discussed coaching ethics and developing autonomy in athletes through training and competition.

Beginning with the notion that while “ethics” in coaching usually invokes thoughts of doping or inappropriate relationships with athletes, he pointed out that it is in fact a larger issue when put into the framework of doing what is for the long-term good of the athlete and person. He detailed the traditional approach to coaching, planning, control of space, time, and movement, summarising that the usual goal is that every aspect of training is measured and supervised, maximum efficiency in use of time and space is the aim, and “each stage of development is subject to meticulous control and intervention.

“The question,” he asked, “is what do we do with Foucault’s analysis that 18 studies show that too much coaching control and not enough athlete ownership creates problems? Can athletic coaches reduce the disciplining and docile-making effects of their training plans by the way they organise various spatial, temporal, and movement elements?”

After giving some examples of situations involving coaching ethics and some suggestions for ways to include athletes in the process, Denison opened up to questions from the audience. The discussion included what it means to be “coachable” – does this mean a docile, robotic athlete who is dependent and often lacks the individual will to compete for him or herself? The notion that athletes are a problem
if they question and do not blindly follow everything the coach throws at them comes under the microscope when we think about the athlete's role in the whole process! He challenged the audience to consider if coaches “are teaching athletes to be independent and even allowing them to question and take the initiative to ask for more or question why things are not done differently?”

**Analysis of the Jumping Events: Summer Olympics 2012**

Wolfgang Ritzdorf (GER)

A lecturer at the German Sport University and General Manager of the IAAF World High Jump Centre in Cologne, Germany, Dr Ritzdorf used his presentation to review the jumping events at the recent Olympic Games in London and evaluate performances.

He started by detailing the poor performances in most of the preliminary rounds, the especially poor results in the men’s high jump and women’s vault finals and the good results in the men’s pole vault and women’s high jump finals. Comparisons were made with personal bests, season bests, and national records in the finals of each event. He noted that the Olympics were far from the best result for most athletes, with less than 10% achieving a season best in London.

After highlighting the individual disasters of top athletes in Olympic Games and World Championship results from 1996 to the present, Ritzdorf questioned why - given the improved resources, money, tracks, equipment, knowledge, technology, etc of today - jumpers are not at the general performance levels of the late 1980s and early 1990s, acknowledging that the less controlled doping of that era was a factor.
His suggestions for improving the situation included federations and other organisations providing more support and encouragement of athletics in society at all levels. But, he said, the main burden may need to be on coaches and their role in the preparation and empowerment of the athlete over the long term. This would include better understanding and individualisation of volume, intensity and density in training, making the “technical model” fit the athlete, and better physical and psychological preparation for competition. He then offered practical ideas in each of these areas.

Additional Points

The NACACTFCA would like to thank our sponsor, Nordic Sport CEO Dennis Österberg, who was present for the Congress and treated the lecturers and members of the NACACTFCA board to his annual appreciation dinner.

Special thanks to Dianne Woodside and the Bahamian Coaches Association for their organisation and hospitality, and for putting on a great Congress and Junkanoo!

Finally, we take this opportunity to announce that 23rd NACACTFCA Congress will be held in Curaçao October 3-6, 2013. The theme will be “The Road to Rio: Trends and Preparation for the Next Olympiad.” Presenters will include Art Venegas (USA), Ismael Lopez (TRI), Joe Vigil (USA), and Wendell Prince (CUR). Go to www.nacactfca.org for more information, Technical Bulletins, and electronic articles of past presentations.

Reported by Richie Mercado

Richie Mercado is Secretary the NACACTFCA. He can be contacted at rmercado@sjs.org.
The International Festival of Athletics Coaching

Glasgow, Scotland

More than 350 participants from 26 nations were treated to an impressive line-up of speakers, including the coaches behind five London 2012 Olympic gold medals and two Paralympic gold medals, at the fifth edition of the International Festival of Athletics Coaching (IFAC) in Glasgow, Scotland, from 26 to 28 October 2012.

In addition to the four keynote presentations and various seminars staged at Glasgow’s Marriott Hotel, the programme included a range of extended practical workshops, which took place at city’s premier sport facility, the Emirates Arena.

Staged under the auspices of the European Athletic Coaches Association and scottishathletics the event was supported by European Athletics, Glasgow Life, the Dallas Trust, SeeGlasgow and sportscotland.

Keynote Presentation

Jama Aden (SOM)

The Somali-born Aden is now based in Qatar, where he works with endurance athletes from several countries including the 2012 Olympic 1500m champion Taoufik Makhloufi from Algeria and Qatari Hamza Driouch, winner of the 1500m gold at the 2012 IAAF World Junior Championships. Summarising his coaching experiences, Aden, who was named the 2008 IAAF Middle Distance Coach of the Year, emphasised the need to plan individualised programmes that fit each athlete’s strengths and addresses their weaknesses. He then discussed in detail the importance of
testing, competition opportunities and recovery. A particularly strong image used by Aden was the analogy of the tight-rope: finding the right balance between over supporting an athlete, too much slack, and pushing an athlete too far, too much tension.

**Keynote Presentation**

**Frank Dick (GBR)**

Dick, the President of EACA and a member of the IAAF Coaches Commission, used his presentation to conduct a debrief of the athletics events at the London 2012 Olympic Games. After discussing strengths and weakness of the various competitions, he said that in many events it is becoming increasing apparent that the athletes seem ill prepared for the rounds format of a major championship. This is particularly noticeable in the middle- and long-distance events, where athletes have become comfortable with the one-off, paced races and seem to lack racing competencies. With this conclusion, Dick presented an analysis on how athletes delivered on the day at the Games, finding that generally European athletes were not as effective as those from the USA or Jamaica. He concluded with recommendations that coach education better address the issue of delivering performance on the day.

**Keynote Presentation**

**Sharon Hannan (AUS)**

Hannan is the long-term coach to sprint hurdler Sally Pearson, Australia’s golden girl from London 2012. Her presentation described both how Person’s talent was spotted and carefully developed and her own journey of development as a coach. She said she did not come into coaching with an athletics background, but got involved because her daughter wanted to take part in athletics. With her first coaching qualification under her belt, Hannan admitted that she became hooked and was driven by a thirst for knowledge, a desire to understand and attention to detail. Paraphrasing Albert Einstein, she shared her belief that once we find our limits, we should strive to go beyond them!

**Keynote Presentation**

**Toni Minichiello (GBR)**

Minichiello started the long journey to Olympic glory with Jessica Ennis over 14 year ago, not far from the ‘10 years - 10,000 hour rule’ referred to by many experts in the area of talent development. His presentation, entitled ‘Staying the Course,’ emphasised the importance of remaining true to goals and targets. Ennis had a turbulent journey to her Olympic title and Minichiello painted a picture of how a coach’s attitude and confidence in the ‘master plan’ can help the athlete overcome adversity and doubts. He explained how his role as a coach evolved: from teacher to coach to mentor, advisor and support. Points covered included the importance of planning and, perhaps more importantly in his view, taking time to reflect on plans.

**Practical Workshops & Seminars**

Following the success of the practical workshops at IFAC 2011, the 2012 edition of the conference held an extensive programme of
practical workshops to support learning. The workshop leaders included Sharon Hannan, Jama Aden, Damien Inocencio, Stephen Maguire, Peter Hannan, Stan Madiri, Vern Gambetta, Suren Ghazaryan, Marcin Góra.

In addition, there were interactive seminars on sport science and training methodology given by Judy Murray, Frans Bosch, Dr. Yannis Pitsiladis, Tony Stanger and Dave Sunderland.

The 2013 edition of the International Festival of Athletics Coaching will take place in Glasgow on 25-27 October 2013. Among the confirmed keynote speakers is Boris Verkhovsky, Director of Acrobatic Performance and Coaching at the World famous Cirque de Soleil.

Registration is now open for IFAC 2013 at www.ifacscotland.co.uk.

Reported by Jamie Bowie
Development

Dynamics of Medal Shares at the IAAF World Championships Athletics - A Statistical Analysis
by Dimitrios Souls, Athanasios Tsiokanos, Vasilios Voutselas and Frank Dick

Building the Next Generation – Resurrecting the Hammer Throw in the USA
by G. Martin Bingisser
Dynamics of Medal Shares at the IAAF World Championships Athletics - A Statistical Analysis

by Dimitrios Soulas, Athanasios Tsiokanos, Vasilios Voutselas and Frank Dick

ABSTRACT

Sport is a social phenomenon in which performances and high achievement reflect the overall achievements of a society. The aim of this study was to make a longitudinal analysis of high achievement in athletics, expressed in medals won at the IAAF World Championships in Athletics, in order to provide a basis for future work to better understand the factors that contribute to national sporting success and to help develop elite sport training and support systems. The medals won by all countries that participated in the championships from 1983 to 2011 were grouped by continent, gender and type of medal (gold, silver, bronze) and descriptive statistics was conducted. These are detailed in individual sections for each continent. Among the findings are that the combined men’s and women’s shares of the total medals won by continent are: Europe 50.85%, the Americas 29%, Africa 13.57%, Asia 4.71% and Oceania to 1.87%. However, between the 1983 and 2011 editions of the championships there was a significant decline in Europe’s share, which is offset by increases mainly from the America’s and Africa. The authors conclude with a recommendation for deeper and multidisciplinary analysis of all the trends identified.

AUTHORS

Dimitrios Soulas, PhD, is an Associate Professor at The Department of Physical Education and Sport Science in Trikala, University of Thessaly, Greece. A former athlete, he has coached hundreds of middle and long distance runners over the last thirty-five years.

Athanasios Tsiokanos, PhD, is an Associate Professor in Sport Biomechanics at the Department of Physical Education and Sport Science and the Lab Director of the Center of Research and Evaluation of Human Performance at the University of Thessaly, Greece.

Vasilios Voutselas, PhD, is a teacher at the Department of Physical Education and Sport Science, University of Thessaly, Greece.

Frank Dick OBE is the President of the European Athletics Coaches Association, and a member of the IAAF Coaches’ Commission.
Introduction

Achievement in high-performance sport is a multi-factorial phenomenon that is connected with the cumulative effects of socio-economic, technological and scientific (biomechanical, biochemical, exercise-physiological, sport-psychological) factors, accompanied by the most effective elite sport training and support systems. Expression of high achievement, especially in athletics, can be in world records or in the medals won at the Olympic Games and IAAF World Championships in Athletics.

In the literature there are some studies examining the development of world records in particular sports and disciplines\(^1,2,3,5\) or the medal achievements at a local level\(^6\). However, to date there are no studies dealing with dynamic evolution of performances in athletics as a whole, by continent or otherwise. Such information would provide a valuable basis for future work to better understand the factors that contribute to national sporting success and for developing the requisite systems. For this reason, the aim of the present study was to make a longitudinal analysis of medal achievements at the biennial IAAF World Championships in Athletics.

Methods

The medals won by all countries that have participated in the 13 IAAF World Championships in Athletics from 1983 (the first edition of the event) through 2011 were used as material for the study. This data was obtained from the official website of the International Association of Athletics Federations (IAAF)\(^6\). Additional information obtained from Wikipedia\(^7\) was also used. The medals were grouped by continent, by gender and by type of medal (gold, silver, bronze). Descriptive statistical analysis was conducted using the SPSS 15 program.

For the purposes of the analysis we made the following methodological compromises:

- the medals of the former Soviet Union were included in the total of Russia,
- medals of the former East and West Germany were included in the total of Germany,
- the medals of the former Czechoslovakia were included in the total of the Czech Republic,
- the medals of North America, Central America, South America and the Caribbean are combined into one group - the Americas (this grouping is consistent with that used by the International Olympic Committee).

Results and Discussion

Europe - Overview

From 1983 to 2011, Europe won a total of 896 medals at the IAAF World Championships in Athletics. The distribution of medals per championship, per medal category (gold, silver, bronze), per men and women, as well as the combined total for men and women, is shown in Table 1.

Figure 1 shows the general trend of all Europe’s medals (men and women together) from 1983 to 2011. There is a downward trend from 88 medals in 1983 and 92 medals (maximum) in 1987 to 52 medals (minimum) in 2011. The same downward trend is noticed for gold medals (from 30 in 1983 to 16 in 2011), for silver medals (from 29 in 1983 to 18 in 2011, but with more variations in the declining line) and for bronze medals (from 29 in 1983 to 18 in 2011).

On average (all championships included) Europe’s medal total consists of 29.80% gold, 35.04% silver and 35.16% bronze. Variability exists in relation to time in all three categories of medals: gold (23.68 to 36.23 %), silver (29.69 to 39.68%) and bronze (31.88 to 42.19%). The percentage contribution of each category to the total number of medals is 34.09% for the gold in 1983 vs. 30.77% in 2011, for the silver 32.95 vs. 34.62% and for the bronze 32.95 vs. 34.62% respectively.
Table 1: Detail of Europe’s medals at the IAAF World Championships in Athletics 1983 to 2011

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Figure 1: Distribution of Europe’s IAAF World Championships in Athletics medals by year
Europe – Men’s medals
Europe’s men have won 417 medals, 46.54% of all Europe’s medals. This percentage was 48.86% in 1983 vs. 48.08% in 2011.

There is a downward trend from 43 men’s medals in 1983 to 25 medals (minimum) in 2011. The same downward trend is noticed for the men’s gold medals (from 15 in 1983 to 8 in 2011), for the men’s silver medals (from 14 in 1983 to 9 in 2011) and for the men’s bronze medals (from 14 in 1983 to 8 in 2011).

Europe – Women’s medals
Europe’s women have won 479 medals, 53.46% of the total of all Europe’s medals. This percentage was 51.14% in 1983 vs. 51.92% in 2011.

There is a downward trend from 45 women’s medals in 1983 to 27 (minimum) in 2011. The same downward trend is noticed for the women’s gold medals (from 15 in 1983 to 8 in 2011), for the women’s silver medals (from 15 in 1983 to 9 in 2011) and for the women’s bronze medals (from 15 in 1983 to 10 in 2011).

Europe – Country shares
The countries that have taken the biggest shares of Europe’s medal total are Russia (25.78%), Germany (17.41%), Great Britain & NI (8.48%), Italy (4.46%), France (4.35%), Spain (4.02%), Belarus (4.02%), Poland (3.57%), Ukraine (3.35%), Czech Republic (3.24%), Romania (2.34%) and Finland (2.12%). A rising trend can be seen for Russia, Great Britain and Poland.

The Americas

Americas – Overview
From 1983 to 2011, the Americas won a total of 511 medals at the IAAF World Championships in Athletics. The distribution of medals per championship, per medal category (gold, silver, bronze), per men and women as well as the combined total for men and women, is shown in Table 2.

Figure 2 shows the general trend of all of the Americas’ medals (men and women together) from 1983 to 2011. There is an upward trend from 31 in 1983 and 27 (minimum) in 1987 to 51 (maximum) in 2009 and 48 in 2011. The same upward trend is noticed for gold medals (from 10 in 1983 to 18 in 2011), for silver medals (from 12 in 1983 to 19 in 2009 and 15 in 2011, but with more variations in the rising line) and for bronze medals (from 9 in 1983 to 15 in 2011).

On average (all championships included) the America’s medal total consists of 37.77% gold, 32.48% silver and 29.75% bronze. Variability exists in relation to time in all three categories of medals: gold (30.56 to 47.06%), silver (18.52 to 41.30%) and bronze (17.39 to 44.44%). The percentage contribution of each category to the total number of medals is for the gold 32.26% in 1983 vs. 37.50% in 2011, for the silver 38.71 vs. 31.25% and for the bronze 29.03 vs. 31.25% respectively.

The Americas – Men’s medals
The Americas’ men have won 300 medals, 58.71% of all the Americas’ medals. This percentage was 67.74% in 1983 vs. 56.25% in 2011.

There is an upward trend from 21 men’s medals in 1983 to 27 (minimum) in 2011. The same upward trend is noticed for the men’s gold medals (from 8 in 1983 to 10 in 2011), for the men’s silver medals (from 5 in 1983 to 9 in 2011) and for the men’s bronze medals (from 8 in 1983 to 9 in 2011).

The Americas – Women’s medals
The Americas’ women have won 211 medals, 41.29% of all the Americas’ medals. This percentage was 32.26% in 1983 vs. 43.75% in 2011.

There is an upward trend from 10 women’s medals in 1983 to 21 medals in 2011. The same upward trend is noticed for the women’s gold medals (from 2 in 1983 to 8 in 2011), for the women’s silver medals (from 4 in 1983 to 7 in 2011) and for the women’s bronze medals (from 4 in 1983 to 6 in 2011).
Table 2: Detail of the America’s medals at the IAAF World Championships in Athletics 1983 to 2011

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Figure 2: Distribution of the America’s IAAF World Championships in Athletics medals by year
The Americas – Country shares

The countries that have taken the biggest shares of the America’s medal total are the United States of America (53.82%), Jamaica (17.42%), Cuba (9.78%), the Bahamas (3.72%) and Canada (3.52%). A rising trend can be seen for the United States and Jamaica.

Africa

Africa - Overview

From 1983 to 2011, Africa won a total of 239 medals at the IAAF World Championships in Athletics. The distribution of medals per championship, per medal category (gold, silver, bronze), per men and women as well as the combined total for men and women, is shown in Table 3.

Figure 3 shows the general trend of all Africa’s medals (men and women together) from 1983 to 2011. There is an upward trend from 3 medals in 1983 (minimum) to 30 medals (maximum) in 2011. An upward trend is also noticed for gold medals (from 0 in 1983 to 9 in 2011, but with more variations in the rising line), for silver medals (from 1 in 1983 to 10 in 2011, but with more variations in the rising line) and for bronze medals (from 2 in 1983 to 11 in 2011).

On average (all championships included) Africa’s medal total consists of 35.98% gold, 35.57% silver and 28.45% bronze. Variability exists in relation to time in all three categories of medals: gold (0 to 71.43%), silver (25 to 45.45%) and bronze (0 to 66.67%). The percentage contribution of each category to the total number of medals is 0% for the gold in 1983 vs. 30% in 2011, for the silver 33.33% vs. 33.33% and for the bronze 66.67 vs. 36.67% respectively.

Africa – Men’s medals

Africa’s men have won 159 medals, 66.53% of all Africa’s medals. This percentage was 100% in 1983 vs. 50% in 2011.

There is an upward trend from 3 men’s medals in 1983 to 15 medals in 2011. An upward trend is also noticed for the men’s gold medals (from 0 in 1983 to 5 in 2011), for the men’s silver medals (from 1 in 1983 to 5 in 2011) and for the men’s bronze medals (from 2 in 1983 to 5 in 2011).

Africa – Women’s medals

Africa’s women have won 80 medals, 33.47% of the total of all Africa’s medals. This percentage was 0% in 1983 vs. 50% in 2011.

There is an absolute upward trend from 0 women’s medals in 1983 to 15 medals in 2011. An upward trend is also noticed for the women’s gold medals (from 0 in 1983 to 4 in 2011), for the women’s silver medals (from 0 in 1983 to 5 in 2011) and for the women’s bronze medals (from 0 in 1983 to 6 in 2011).

Africa – Country shares

The countries that have taken the biggest shares of Africa’s medal total are Kenya (33.47%), Ethiopia (22.59%), Morocco (11.30%) and South Africa (7.11%). A rising trend can be seen for Ethiopia and Kenya.

ASIA

Asia - Overview

From 1983 to 2011, Asia won a total of 83 medals at the IAAF World Championships in Athletics. The distribution of medals per championship, per medal category (gold, silver, bronze), per men and women, as well as the combined total for men and women, is shown in Table 4 (see next page).

Figure 4 shows the general trend of all Asia’s medals (men and women together) from 1983 to 2011. There is an upward trend from 1 medal in 1983 to 7 medals in 2011, with three maxima (12 in 1993, 9 in 2003 and 11 in 2009). There are two maxima in the upward line of evolution for gold medals (6 in 1993 and 3 in 2005, 2007, and 2009), an upward trend for silver medals (from 0 in 1983 to 3 in 2011) and a bell-shaped curve describing the dynamics of the bronze medals (maximum of 7 in 2003).
Table 3: Detail of Africa’s medals at the IAAF World Championships in Athletics 1983 to 2011

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Figure 3: Distribution of Africa’s IAAF World Championships in Athletics medals by year
On the average (all championships included) Asia’s medal total consists of 31.33% gold, 28.92% silver and 39.75% bronze. The percentage contribution of each category to the total number of medals is 0% for the gold in 1983 vs. 28.57% in 2011, for the silver 0% vs. 42.86% and for the bronze 100% vs. 28.57% respectively.

**Asia – Men’s medals**

Asia’s men have won 35 medals, 42.17% of all Asia’s medals. This percentage was 100% in 1983 vs. 42.86% in 2011.

There is an upward trend from 1 men’s medal in 1983 to 5 medals in 2009 and 3 medals in 2011.

**Asia – Women’s medals**

Asia’s women have won 48 medals, 57.83% of all Asia’s medals. This percentage was 0% in 1983 vs. 57.14% in 2011.

There is an upward trend from 0 women’s medals in 1983 to 10 in 1993, followed by a decline until 2011 (4 medals).

**Asia - Country shares**

The countries that have taken the biggest shares of Asia’s medal total are China (37.35%), Japan (25.30%), Bahrain (8.43) and Kazakhstan (7.23%).

**Oceania**

**Oceania - Overview**

From 1983 to 2011, Oceania won a total of 33 medals at the IAAF World Championships in Athletics. The distribution of medals per championship, per medal category (gold, silver, bronze), per men and women, as well as the combined total for men and women, is shown in Table 5.

Figure 5 shows the general trend of all Oceania’s medals (men and women together) from 1983 to 2011. There is an upward trend from 1 medal in 1983 to 5 medals in 1997, followed by a decline until 2003 (1 medal) and then by a rise until 2011 (4 medals).

On average (all championships included) the Oceania medal total consists of 45.46% gold, 21.21% silver and 33.33% bronze.

**Oceania – Men’s medals**

Oceania’s men have won 16 medals, 48.48% of all Oceania’s medals. This percentage was 100% in 1983 vs. 50% in 2011.

The highest number of men’s medals, three, were won in 2001 and 2009.

**Oceania – Women’s medals**

Oceania’s women have won 17 medals, 51.52% of all Oceania’s medals. This percentage was 0% in 1983 vs. 50% in 2011.

The highest number of women’s medals, three, were won in 1997 and 1999.

**Oceania - Country shares**

The countries that have taken the biggest shares of Oceania’s medal total are Australia (84.85%) and New Zealand (15.15%).

**Interaction Among Continents**

The total number of medals won by athletes from all continents, in all editions of the IAAF World Championships in Athletics from 1983 to 2011, amounts to 1,762 (587 gold, 596 silver and 579 bronze).

Europe’s share is 50.85%, the Americas’ 29%, Africa’s 13.57%, Asia’s 4.71% and finally Oceania’s is 1.87% (Figure 6a). Of course, there is variability in each continent’s share depending on time. A comparison between the 1983 and 2011 championships (Figures 6b, Figure 6c) reveals that Europe’s shares are, respectively, 70.96% vs. 36.88%, Americas’ shares are 25% vs. 34.04%, Africa’s shares are 2.42% vs. 21.28%, Asia’s shares are 0.81% vs. 4.96% and Oceania’s shares are 0.81% vs. 2.84%.

Clearly, there is a regressive trend for Europe and a progressive trend for all the other continents, especially the Americas and Africa.
### Table 4: Detail of Asia’s medals at the IAAF World Championships in Athletics 1983 to 2011

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![Figure 4: Distribution of Asia’s IAAF World Championships in Athletics medals by year](image)
Table 5: Detail of Oceania’s medals at the IAAF World Championships in Athletics 1983 to 2011

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Figure 5: Distribution of Oceania’s IAAF World Championships in Athletics medals by year
The share taken by European athletes in 2011 was just over half what it was in 1983 (36.88 vs. 70.96%). This loss is covered mainly by the gains of the America’s and Africa.

If we examine men’s medals and women’s medals separately, some differences are revealed in each continent’s share of the medal total. Regarding men, each continent’s percentage share of the total of the 927 medals won is as follows: Europe 44.98%, the Americas 32.36%, Africa 17.15%, Asia 3.78% and finally Oceania 1.73%. Of course there is variability in these shares depending on time. A comparison between the championships in 1983 and the championships in 2011 reveals that the share taken by Europe’s men is 62.32 vs. 34.72%, by the Americas’ men is 30.43 vs. 37.50%, by Africa’s men 4.35 vs. 20.83%, by Asia’s men 1.45 vs. 4.17% and by Oceania’s men 1.45 vs. 2.78%. There is a clear regressive trend for Europe (a loss of 27.6% in the share) and a progressive trend for all the other continents, especially the Americas (a gain of 7.07%) and Africa (a gain of 16.48%).

Regarding women, each continent’s percentage share of the total of the 835 medals won is as follows: Europe 57.36%, America 25.27%, Africa 9.58%, Asia 5.75% and finally Oceania 2.04%. Again, there is variability depending on time. A comparison between the championships in 1983 and 2011 reveals that the share taken by Europe’s women is 81.82 vs. 39.13%, by the Americas’ women 18.18 vs. 30.43%, by Africa’s women 0 vs. 21.74%, by Asia’s women 0 vs. 5.80% and by Oceania’s women 0 vs. 2.90%. Here too, there is a clear regressive trend for Europe (a loss of 42.69% in the share) and a progressive trend for all the other continents, especially the America’s (a gain of 12.25%) and Africa (a gain of 21.74%).

Figure 6a: Continental shares of the medals from all IAAF World Championships in Athletics
Figure 6b: Continental shares of the medals from the 1983 IAAF World Championships in Athletics

Figure 6c: Continental shares of the medals from the 2011 IAAF World Championships in Athletics
Conclusions

This study aimed to increase understanding of achievement in athletics, expressed in medals won, based on the analysis of the results of the IAAF World Championships. If we look at the five continents, Europe’s share is 50.85%, the Americas’ 29%, Africa’s 13.57%, Asia’s 4.71% and finally Oceania’s 1.87%. However, from the first to the final Championship, there is a clear decline in the share taken by European athletes, which is compensated by corresponding increases in the shares taken by the athletes from the other continents, mainly the Americas and Africa.

Given that sport is a social phenomenon in which performances and high achievement reflect the overall achievements of a society, the interpretation of the above-mentioned trends in elite level athletics deserves deeper and multidisciplinary analysis.

References


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Building the Next Generation
Resurrecting the Hammer Throw in the USA

by G. Martin Bingisser

ABSTRACT

After dominating the hammer throw in the first six editions of the Olympic Games, the USA experienced a decline both in terms of international results and domestic participation. Medals at the top level became relatively scarce (one gold, one silver and four bronzes at the Olympics over more than 90 years) and the event all but disappeared from school and youth competitions. However, since the 1990s grassroots participation has been revived due to a number of factors and actions, including the personal efforts of the 1956 Olympic Champion Harold Connolly. The growth in the number of youth hammer throwers has been at least 400% in the last twenty years and the number of elite performers over 65m has increased at least fivefold. At the junior level, this has translated into international success (three medals, including two golds at the 2008 and 2010 IAAF World Junior Championships). The author, an active hammer thrower himself, draws on statistical analysis and survey results to chart the progress and explain the processes at work in this development. He then provides five practical recommendations on how federations or other organizations in other countries can increase participation in the hammer throw and other similarly affected events.

AUTHOR

G. Martin Bingisser works as an international tax attorney in Zurich, Switzerland. He is a four-time national champion in the hammer (best 67.90m) and currently a member of the Swiss national team. He also operates a personal website (www.mbingisser.com) focused on the hammer throw.

Introduction

or the last third of the twentieth century, European athletes utterly dominated the international hammer throwing scene. But in recent years a number of factors have contributed to a decline of this dominance. Across the Atlantic Ocean, however, an opposing trend can be witnessed. The United States has seen unprecedented growth among hammer throwers over the last decade.

After giving a brief overview of the opposing trends in Europe and America, this case study will 1) isolate and identify the factors that contributed to the growth of American youth and junior hammer throwing, and 2) provide recommendations on how federations or other organizations can increase participation in the hammer throw and other similarly affected events. As the women's hammer throw has only been an Olympic discipline since 2000, much of the statistical data referenced in this study focuses
This decline in European dominance can be primarily attributed to two major factors. First, technical and training advances made in Europe during the 1970s and 1980s slowly began penetrating the other continents and elevated their level of competitive performance. Secondly, at the same time, the depth of European hammer throwing declined. During this period the depth of the international rankings remained virtually unchanged as shown in Figure 2; only the makeup of countries represented altered. This means that not as many Europeans are achieving the same marks as they were thirty years ago.

This decline can also be viewed at a more granular level by examining statistics from individual countries. For example, in Germany only one of the country’s all-time top 15 male throwers has thrown his best since 2000.1 And, as Germany’s southern neighbour Switzerland never has been a hammer throwing powerhouse, the numbers are even bleaker there. The tenth best thrower in Switzerland threw over 58m in the mid-1990s, but for the past few years the tenth best thrower has not broken 45m. and at the 2011 Swiss national championships the bronze medal was won with just 43.98m. At the junior level it has not

European Hammer Throwing: Tradition and Resurgence

European hammer throwing reached its pinnacle in the 1980s. In 1983, the 60 best male hammer throwers in the world all came from European countries. While the continent continues to show dominance in the hammer, in 2010 only 43 of the top 60 throwers in the world were from Europe (Figure 1).

Figure 1: Europeans among the world’s top 60 hammer throwers vs. the rest of the world (ROW) (Statistics compiled by Ian Tempest.)

Figure 2: Results of the world’s 100th best hammer throwing since 1980 (Statistics compiled by Ian Tempest.)
American Hammer Throwing: Tradition and Resurgence

American hammer throwing has also experienced a dominance and decline as we have witnessed recently in Europe. The USA won the first six Olympic gold medals and captured a total of 14 medals in the hammer throw at the first six Olympics. In the following 30 years, it took only four additional medals (one gold, four bronze). Since 1956 its sole medal was silver as the host of the 1996 Olympic Games. During this time it did not win any World Championship medals, or, until 2008, any medals at the IAAF World Junior or IAAF World Youth Championships.

A similar decline also occurred at the youth level. At the start of the twentieth century more than a dozen states included the hammer throw as an official event in high school competition. A century later, only Rhode Island, the country’s smallest state, continued to stage the hammer throw officially at high school competitions.

Beginning in the late 1990s, this trend reversed at both the youth and elite level. While the top tier of American throwers still have not been able to consistently qualify for international finals, their level has improved remarkably. Five of the all-time top ten male throwers threw their personal best since 2000, with two others also throwing their best in the late 1990s.

The growth at the youth level is even more significant. From beginning to elite throwers, the numbers outlined in the findings below show growth of at least 400% at all performance levels in the last twenty years. Some analysis of this data has shown the number of throwers over 50m increased nearly eightfold during this time, and elite throwers over 65m increased at least fivefold. Unlike the senior throwers, juniors have already seen the increase in results translate into international success, taking home three medals (2 gold, 1 silver) from the 2008 and 2010 IAAF World Junior Championships.

Methods

Two main methods were used to analyse the cause of growth in American youth hammer throwing. First, annual national performance lists were compiled to help identify the extent of the growth in different geographic locations. Second, online surveys and follow-up interviews were conducted with youth coaches across the United States to identify what brought new coaches to the sport and how they developed their coaching knowledge.

Statistical analysis

Statistician Bob Gourley has compiled performance lists for the top American high school hammer throwers for decades. Since American youth and junior sports are primarily organised through the school system, this data provides the best overview of youth athletics. While there is no age limit, boys normally attend high school until their 18th or 19th year and throw a 12 pound (5.45 kg) implement.

For this analysis, Gourley provided year-end performance lists for the twenty year period from 1992 to 2011 identifying all high school throwers that had surpassed 150-feet (45.72m) during the course of the season. This information was then parsed and sorted by performance level, the number of states represented, and the depth of results in each state.

Surveys and interviews

After conducting the statistical analysis, feedback was solicited from youth coaches (and self-coached youth athletes) via an online survey, including both open- and closed-ended questions. In addition to identifying information such as name, location, number
of years coaching both hammer and athletics, and number of youth hammer throwers in their training group, the following substantive questions were asked:

- Where did you first hear that the hammer throw was a youth sport with many opportunities available?
- What made you decide to start coaching the hammer throw?
- What is the primary motivation for you and your athletes?
- What are the biggest obstacles that you think the hammer throw must overcome to grow further at the youth level?
- How did you learn to coach the hammer throw?

Links to the survey were posted on the four most popular hammer throwing-related websites in the United States reaching an estimated 3,000 weekly fans, athletes, and coaches. In addition, Gourley distributed the link to the survey directly to his mailing list of more than 100 youth hammer coaches. In total, 51 survey responses representing feedback from 16 different states were received. The majority of the responses came from youth coaches, while eight responses came from self-coached youth athletes.

**Findings and Discussion**

Analysis of the data showed that four main elements contributed to the rise of youth hammer throwing over the last 10-15 years in the USA. First, publicity for the event was a key driver in increasing the profile of the event at the youth level. Second, an increased number of competitions allowed new athletes in new locations to try the sport. Third, coaching programmes and initiatives ensured that new coaches came to the event and beginning coaches could find the resources to learn about it. Finally, additional programmes helped make sure that athletes then had all the resources they needed to develop into better throwers. The following sections outline the findings related to each of these areas of development.

Publicity: The rise of the internet brings the hammer throw to new people

It is no coincidence that the rise of the hammer throw in America has correlated almost directly to the rise in popularity of the Internet. Gourley has long compiled a list of national rankings, drawing on his connections with coaches across the country to source his data. As the internet developed, it became easier for him to distribute this list via email to anyone that requested. In 1995, John Dye founded the regional youth track and field website Dyestat and began posting national rankings for other events in 1997. Gourley’s national rankings were also posted on Dyestat soon after.

1956 Olympic Champion Harold Connolly founded Hammethrow.org near the end of the century as a way for him to post resources and information about the event, including technical articles and explanations. Then, in 2000, HSHammer.com was founded to not only provide easy access to Gourley’s rankings, but also as an outlet to post news, results, and additional information about youth hammer throwing.

The proliferation of hammer throwing information online gave the event a boost in several ways. First, it helped train coaches. The vast majority (72.5%) of the respondents to the coaches’ survey stated that they used Internet resources to further their coaching education.
Also, coaches that did not already know the hammer throw existed as a youth event listed the Internet as the second most popular way they learned that competition opportunities existed. Only a personal introduction to the event ranked higher. In this way the Internet allowed athletes and coaches to see that the hammer throw actually existed as a youth event, find where they could compete locally, connect with other throwers nearby, and easily measure themselves against their competitors nationwide. In an event where throwers are often geographically isolated, these factors provided a strong boost by creating a close-knit hammer throwing community.

**Increased opportunities: Fast, consistent growth triggered by geographic expansion**

From the mid-1990s to the mid-2000s, the number of competitions outside of Rhode Island also increased substantially. Thanks to the lobbying efforts by Connolly, the hammer throw was gradually included in the Junior Olympic programme of the national athletics federation (USATF), in which youth athletes compete as members of athletics clubs during the summer season that takes place after the school year is finished. Prior to 1999, the event was not included at any level of the multi-tiered programme. After gaining exhibition status, it was added to competitions at the national, regional, and local levels. This provided opportunities for throwers in every state to watch and compete in it. Simultaneously, the small increase in throwers encouraged high school competitions to add the hammer throw as an event. It is no coincidence that this period of growth in competitions coincided with a strong growth in participation and performance levels.

The statistical analysis of Gourley’s data showed that the growth in the number of hammer throwers and the improvement in their results has been extremely fast and relatively consistent over the past two decades at both intermediate and advanced levels. The number of throwers over 150-feet (45.72m), 50m, 55m, 60m, and 65m was measured each year, and

![Figure 3: Historical development of American hammer throwing and shot put results (Data provided by Bob Gourley (Hammer) and Jack Shepard (Shot Put).)
was modest growth in Rhode Island, much of it occurred in the 1990s and the numbers have since slightly regressed, causing a negative correlation between the number of American hammer throwers and the number of Rhode Island throwers over the past decade. Further, the number of Rhode Islanders throwing over 45.72m was identical in both 1994 and 2010, showing the relative stability of their performance level.

The growth outside of Rhode Island, on the other hand, has a near perfect 0.98 correlation to the growth across the United States over the past two decades. As shown in Figure 5, during the 1992-1993 season no throwers from outside of Rhode Island threw over 45.72m. In comparison, the last three seasons (2008-2011) have seen an average of 74 throwers from outside of Rhode Island better that mark from an average of 19 other states each year. Non-Rhode Island throwers now comprise nearly three-quarters of those athletes over 50m.

Over the last few years the number of competitions has levelled off, yet performances continue to improve outside of Rhode Island. This is likely due to one of two factors: 1) the fact that these competitions have grown in popularity since being initially introduced or 2) that the athletes and coaches who started the sport because of these new competitions have improved as they gained experience.
disseminate information proved to be an inexpensive and easy method to reach a large audience. As mentioned above, Harold Connolly is the most significant individual in the American youth hammer throwing resurgence. In addition to his lobbying efforts, he produced a short manual for hammer throwers and coaches, which he gave away at free clinics across the country and distributed, along with additional information, through his website. He also mailed free printed copies to those who requested it. Many of the coaches cited this manual as a key source of learning about the event, including coaches who already knew the hammer. He also organised coaching clinics across the country and an annual elite hammer coaching clinic at the US Olympic Training Center. All of these activities worked to increase both the number and competence of coaches.

**Developing Athletes: Facilities and governing body support remain big issues**

There was also an effort in the final area of athlete development. By nature, athlete development must be done on a more local level and therefore it is more difficult for this to be
coordinated nationally. Connolly began raising money to expose the top young talents to new ideas beginning in the early 2000s. After organising training camps for elite junior throwers and their coaches, he then sent two high school champions to train and learn from top coaches in Hungary in 2004. After that he instituted an annual youth grant programme that helped reimburse training expenses incurred by other talented throwers. Numerous coaches also worked hands-on with their athletes to develop them further. However, in the survey, this was the area where most coaches felt work still needed to be done.

In their survey responses, coaches listed that the major obstacles facing the hammer throw as the same ones that faced the event two decades ago. The top response given by more than a third of respondents pointed to the lack of hammer throw training facilities as the largest obstacle. The second most popular theme, cited by more than a quarter of respondents, was that further growth is being prevented by the failure of state high school federations and other governing bodies to sanction the hammer throw as an official event.

Both of these issues are prevalent across the globe at both youth and elite levels. Facilities can be expensive to build and current facilities are also being lost as participation decreases for the hammer throw and other throwing events.

Conclusion and Recommendations

The unprecedented growth of hammer throwing in the USA, particularly among young throwers, was due to a unique combination of factors that might not necessarily exist elsewhere. But nevertheless, lessons can be learned from their success and these principles can be applied to not only other countries, but also other events seeking to increase participation. Namely, national federations and other organisations looking to improve an event’s participation and results can focus their efforts on the following:

1. Publicise - Utilising the Internet as a means of promoting the event will give it exposure both within the throwing community and to the athletics community at large. The use of existing federation websites and other independent websites should be leveraged first to tap into existing audiences. Social media can also be used to develop an event-specific community.

2. Increase Opportunities - Increase the number of youth competitive opportunities. Federations can help in this regard by ensuring that the hammer throw is included in more competitions for youth throwers, and preferably at a visible time and location. The hammer throw has been excluded from the Diamond League, and similar exclusion issues also exist on the national level. For example, in Switzerland the hammer throw is only included as an event in the top division of the Swiss Club Championships. Since every club needs to be represented in each event, by including the hammer throw all clubs would encourage new athletes to try, and potentially like, the hammer throw. Similar measures could also be considered in other countries to increase participation in the hammer throw and other events by exposing new athletes to the sport.

3. Strengthen Coaching - Use outreach efforts to make sure that current and former athletes continue to stay involved in the sport as coaches as these individuals are most likely to support growth in the event. The fact that most coaches in the USA were already very familiar with the hammer throw and opportunities for youth throwers means that the best strategy for recruiting hammer throw coaches is to target former throwers that have drifted away from the sport. In Switzerland, for example, only two of the all-time top 20 hammer throwers are currently active as coaches (and one of these coaches is still currently training). Throwers often lose contact with the sport as they focus on their careers, family, etc. Retaining these individuals will likely be more profit-
able than recruiting new coaches to learn the hammer throw and also should serve as a model for other events.

4. Provide Educational Support - This applies to coaches and athletes. Utilise low costs means such as the Internet. This model can likely be replicated even more successfully in other countries since the vast majority of coaching information available online for all events is in English. If federations developed similar manuals in the local language, it would increase resources available to the many coaches who are not proficient in English.

5. Develop Athletes - Assist local clubs and cities in retaining appropriate training facilities and building new training facilitates. National federations should assist local clubs in defending current facilities from being converted to other uses. Additional financial grants can also be used to help cover training expenses of young talents and provide a motivational goal.

The beauty of this approach to developing an event is that success breeds more success because the cycle never ends. As athletes begin to succeed in the event, they will generate more publicity, thus beginning the cycle again at a new higher level.

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REFERENCES


2. Historical Olympic medalists information is available from Hammerthrow.org at: http://hammerthrow.org/what-is-the-hammer/the-olympics/olympic-medalists/

3. Historical Olympic medalists information is available from Hammerthrow.org at: http://hammerthrow.org/what-is-the-hammer/the-olympics/olympic-medalists/


5. A full version of the survey is best viewed online since it offers interactive features. See http://www.mbingisser.com/2012/03/us-youth-hammer-throw-survey/

**Introduction**

This bibliography is an update of the “Children’s and youths’ athletics” bibliography published in NSA 3/2008. It includes 79 articles published between 2006 and 2012 and is divided into the following chapters:

- The IAAF’s position on children’s and youths’ athletics;
- Publications dealing with the topic of modified athletics (“fun in athletics”);
- Publications about training aspects in children’s and youths’ athletics in general and about strength training in particular;
- Publications dealing with talent selection, identification, and development in general and in specific events;
- Publications dealing with the physical and motor development of children and youths;
- Publications dealing with psychological aspects of children’s and youths’ athletics;
- Publications dealing with medical aspects of children’s and youths’ athletics.
- General

The following articles deserve particular attention:

Basic information about the IAAF’s Kid’s Athletics program is provided by WEST (2009, Ch. 1 of this bibliography). Kid’s Athletics is a team athletics program that has been developed by the IAAF to avoid early specialisation and events are therefore not scale models of adult’s competitions. Kid’s Athletics is based on three age groupings: Group 1 – children 7-8 years; group 2 – children 9-10 years; group 3 – children 11-12 years. Teams are mixed and generally comprise 10 members and most events are conducted in some relay format. Events are sprinting and running, throwing and jumping. Scoring is designed to keep the event outcome unpredictable and give participants a feeling that they can actually be a winner. The program is based on meeting the following requirements: a) to offer children attractive athletics; b) to offer children accessible athletics; c) to offer children instructive athletics. Kid’s Athletics is intended to bring excitement into playing athletics. The most important objectives are: 1. That a large number of children can be active at the same time. 2. That varied and basic athletic forms of movement are experienced. 3. That not only stronger or faster children make a contribution to a good result.

Further information about the IAAF’s Kid’s Athletics program is provided by GOZZOLI, SI-MOHAMED, and EL-HEBIL (2006, Ch. 1).

The concept of fun in athletics, which is the basis of Kid’s Athletics is also dealt with by WENSOR (2008, Ch. 2). He holds that if athletics training is not fun, a young athlete isn’t going to improve much over the course of a season. Nor will they continue turning up to training year after year. Therefore, making training “fun” should be a high priority for each coach of young athletes.

Under the headline “Training for young athletes”, NUNN-CEARNS, G. (2010, Ch. 3)
new studies in athletics · no. 1./2.2013

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training and the too low training load, which is a consequence of this reluctance. At least, on an international level it has been known and accepted for decades that the often mentioned arguments leading to caution or restraint are not applicable. The current state of knowledge on the topic of “strength training for children” can be summarized in three main points: 1. Strength training with children is possible and worthwhile. 2. It is safe if properly conducted. 3. It is an essential part of training from both the point of view of health and performance.

Brooks (2009, Ch. 4) sums up her statements about the biology of athletic talent in seven key points: 1. Body structure is genetically determined. Talent identification and detection theory assumes that if we know the physique typical of successful performers we can match an individual’s physique to the appropriate sport. 2. While external body dimensions can give you some clues as to the athletic potential of a youngster, the genetic capacity of internal body structures are equally important. Unlike the external body structure that remains fixed once the individual matures, internal structures can fluctuate in size and speed of operation according to energy needs. 3. The upper limit of athletic performance is set by two built in design parameters. One is the structural design parameter that sets the upper limit of athletic performance due to how large the structure can grow. The other is the functional design parameter that limits athletic performance due to the structure’s maximum speed of operation according to energy needs. 4. The size of internal body structures is related to the intensity of the training stimulus. The size of the structure will almost always match current energy demand, but there is an uppersize limit that is dictated by genetics beyond which the training stimulus will no longer cause additional growth. 5. The overall athletic performance of an athlete at any specific stage in their development is set by the upper limit of both the functional design parameter and the structural design parameter. Talent identification and detection theory assumes that natural capacity before training is related to maximal performance potential, and additional

In another article, Nunn-Cearns (2011, Ch. 3) points out that when young athletes go through a growth spurt they are likely to lose some of their coordination and will need to develop certain skills again. It is also known that at this stage there could be some growth issues which may lead to injury. All this should be taken into account in children’s and youth training. This should lead to: 1. Abandonment of plyometrics; 2. always professional diagnosis; 3. encouragement of other events; 4. encouragement of stretching; 5. encouragement of a body weight/resistance training program; 6. a modified training week with alternative training – swimming, bike, pilates.

According to Oltmanns and Zawieja (2011, Ch. 3) adolescents of today demonstrate increasingly less physical fitness and a poor performance status. The low fitness level is also due to the reluctance to early strength training and the too low training load, which is a consequence of this reluctance. At least, on an international level it has been known and accepted for decades that the often mentioned arguments leading to caution or restraint are not applicable. The current state of knowledge on the topic of “strength training for children” can be summarized in three main points: 1. Strength training with children is possible and worthwhile. 2. It is safe if properly conducted. 3. It is an essential part of training from both the point of view of health and performance.

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The talent identification at Qatar’s ASPIRE Academy is described by Peltola et al. (2008, Ch. 4). The ASPIRE Academy for Sports Excellence is Qatar’s visionary programme for discovering and developing the best young sporting talent from the region and around the world. The objective is to turn young sporting talents into winners at the highest levels of international competition. ASPIRE’s Talent Identification Programme works in close coordination with Qatar’s Ministry of Education, the Supreme Council of Education and the Qatar National Olympic Committee to find students who have exceptional athletic talent and offer them a scholarship to ASPIRE. It comprises a three-phase structure (Bronze, Silver and Gold), each phase with specific aims and tests.

Buns, M. (2011, Ch. 5) emphasizes that children are no small adults. Children have different proportions and composition. They have relatively larger heads, shorter extremities, and smaller torsos than adults. Children and adults handle heat and oxygen production differently during training. Children have higher resting heart rates than adults; at rest, children’s hearts are working harder than adults’ hearts. Anaerobic power is also lower in children than in adults and they have a lower haemoglobin concentration in the blood. This means that children can do less work than adults. Children become more fit as a result of fitness training but the responses to training tend to be lower in children than in adults. Weight training for children is a controversial topic. For prepubescent children, the gains are small. Therefore, the time might better be spent doing something else. As children are growing, there is risk of injury. The bodies of girls and boys are more alike than different during childhood: however, differences emerge during puberty that give males a performance advantage in certain activities. Prior to puberty, boys and girls are very similar in height and weight. Therefore, they can work together.

The parents’ responsibility for the development of young athletes is the topic of Dempster’s (2010, Ch. 6) article. He points out that in the
USA 40 million kids participate in sport annually. 70% retire at age 13. The number one reason they give is that it is no longer fun, that the adults are too involved and demanding. Against this background, DEMPSTER has developed 12 guidelines that should be considered by the parents of young athletes.

“Energy systems and the developing athlete” is another article by DEMPSTER (2008, Ch. 7) included in this bibliography. Therein he holds that the energy systems in physically immature youngsters are underdeveloped. Children are constantly growing and developing so thereby utilizing energy in copious amounts and in an inefficient and irregular manner in comparison to their adult counterparts. Indeed the anaerobic lactate energy system will not fully mature until well into the 20s. This means that physically youngsters are not yet capable of many of the high intensity lactic based physical sessions but seem to be like sponges when it comes to learning the skills and movements required by all sports movement patterns. Huge gains are made if development is focussed in this direction. Psychologically, this enables the young athlete to retain an appetite for the process rather than, as in too many cases, many feeling that they have had enough by the age of 17, with the best years of their careers ahead of them.

The risk of the Youth Olympic Games is dealt with by DIGEL (2008, Ch. 8). He holds that although the decision to create a Youth Olympic Games creates opportunities for the International Olympic Committee (IOC) and the international sport federations to promote positive values in a sustainable way, the organisation and staging of the Games also entails serious risks of creating unintended and undesirable side effects that could threaten the success of the event or even lead to the self-destruction of the current sports system. Among those issues examined are 1) the practical implications of trying to integrate value educational activities with high-performance sport competition, 2) the exacerbation of negative trends in international sport such as doping and over-commercialisation, 3) the difficulties of designing the competition programme of the Games and limiting the number of participants, 4) issues related to the mass media and hosting cities, and 5) the long-term effects on the senior Olympic Games and international sports. Accepting that the Games will take place, the author recommends that the organisers find creative concepts to address the issues raised and that research be conducted so that lessons for preparation of future editions can be learned.

This bibliography, which, of course, does not acclaim to be complete, has been compiled by using

- SPOLIT, the sports literature database of the Federal Institute of Sport Science (BISp) in Cologne, Germany (www.bisp-datenbanken.de, free access), and
- SPORTdiscus, the database of the Sport Research and Information Centre in Ottawa, Canada (www.sirc.ca, no free access).

In addition, some of the articles come from the private library of the author.

Readers interested in obtaining one or more articles from this bibliography should contact Dr. Jürgen Schiffer, e-mail: j.schiffer@dshs-koeln.de.

Bibliography

IAAF Kids’ Athletics


In the spring of 2001, the “IAAF Kids’ Athletics” Working Group took the initiative and developed an event concept for children which featured a distinct departure from the adult model of athletics. The concept was henceforth labelled, “IAAF Kids’ Athletics”. Then, in 2005, the IAAF created a global athletics policy for youth from 7-15 years
old. This policy has two objectives: 1. to make athletics the most practiced individual event in schools in the whole world; 2. to enable children from federations and others to prepare for their future in athletics in the most efficient way. The approach hinges on forms of competitions that are appropriate to all age categories and to the institutions that implement this programme. These competitions are the organising structures for the children’s practice of athletics – training of athletes, education of coaches, judges, etc. “IAAF Kids’ Athletics” is intended to bring excitement into playing athletics. New events and innovative organisation will enable children to discover basic activities: sprinting, endurance running, jumping, throwing/putting in just about any place. The athletics games will provide children with the opportunity to make the most of the beneficial practice of athletics, in terms of health, education, and self-fulfilment.

IAAF
IAAF Team Athletics Championships: A team event for 13-15 year olds

The IAAF proposes a new type of competition to be carried out as a championship for young athletes of 13-15 years (boys and girls). This type of meeting is: 1. A continuation of Kids’ Athletics which is proposed to children of 7-12 years; 2. a tool which is put at the disposal of Schools and Federations to develop Athletics among 13-15 year-old athletes; 3. a preparatory phase for young athletes for future regional, national or even world wide championships in their category in Schools and Federations. The proposal is structured as following: 1. Championship formula; 2. form of competition, team ranking; 3. technical events and conditioning tests; 4. practical and technical requirements.

West, T.
Kid’s Athletics
Modern Athlete and Coach, Adelaide, 47, (2009), 1, pp. 11-13

Kid’s Athletics is a team athletics program that has been developed by the IAAF to avoid early specialisation and events are therefore not scale models of adult’s competitions. It is based on three age groupings: Group 1 – children 7-8 years; Group 2 – children 9-10 years; Group 3 – children 11-12 years. Teams are mixed and generally comprise 10 members and most events are conducted in some relay format. Events are sprinting and running, throwing and jumping. Scoring is designed to keep the event outcome unpredictable and give participants a feeling that they can actually win the event they participate in. The program that was developed was based on meeting the following requirements: a) to offer children attractive athletics; b) to offer children accessible athletics; c) to offer children instructive athletics. Kid’s Athletics is intended to bring excitement into playing athletics. The most important objectives are: 1. That a large number of children can be active at the same time. 2. That varied and basic athletic forms of movement are experienced. 3. That not only stronger or faster children make a contribution to a good result.

Publications dealing with the topic of modified athletics (“fun in athletics”)

Brand, W. H.
Ein Bewegungsgarten für Groß und Klein [A movement garden for younger and older children]
Leichtathletiktraining, Münster, 21 (2010), 6, pp. 36-39

If more children and young people, and even recreational athletes shall be recruited for organized athletics, new ways are needed. According to author, the aim must be to offer athletics so attractively that the movement actions cause pleasure. This can be achieved if in addition to conventional facilities also supposedly unsuitable facilities are used. In Bremen, for example, a movement garden has been created. Here, the children are given the opportunity to experience diversity of movement, to develop movement solutions and to act intelligently when moving. In the movement garden, the children experience athletics exclusively in a playful way. Nevertheless, the children are very successful at regional sport festivals. In school, too, they are among the best. The example of the movement garden shows that athletics, which is a sport emphasizing basic movements, should reach both great talents and people who are not very ambitious.
Hücklekemkes, J.  
Bloß keine Strafrunde! Eine für Leichtathleten angepasste Form der beliebten Wintersportart Biathlon belebt das Hallentraining  
[Please, no penalty lap! A form of the popular winter biathlon adapted for track-and-field athletes makes indoor training more attractive]

Leichtathletiktraining, Münster, 21 (2010), 4, pp. 17-21

Indoor training during the fall and winter is often not very variable and therefore boring. This is why the contents of this training should be offered in a varied way. Biathlon relays are an ideal way to make the indoor training more interesting and exciting. The author presents a competition course consisting of five different throwing stations, varied running, climbing, crawling and jumping sections with integrated penalty laps. The relays can be conducted with children between 8 and 15 years of age.

Katzenbogner, H.  
Wettspiele – Höhepunkte in der Kinderleichtathletik. Teil 1  
[Competitive games – highlights of children’s athletics. Part 1]

Leichtathletiktraining, Münster, 21 (2010), 6, pp. 15-21

Young boys and girls are highly motivated when they learn new movements, practice in a varied way and can put their skills to the test in a variety of situations. Therefore, a greatly reduced exercise and competition programme does not meet the child’s mentality and sooner or later causes them to leave athletics and seek new challenges. As children experience their environment very emotionally, the children’s emotions when designing lessons and the organization of events must be included in the consideration. Playful trials of strength and competitiveness are important features of children’s leisure activities. Competitive games are very useful to give children the chance to live out these preferences.

Katzenbogner, H.  
Wettspiele – Höhepunkte in der Kinderleichtathletik. Teil 2  
[Competitive games – highlights of children’s athletics. Part 2]

Leichtathletiktraining, Münster, 21 (2010), 7, pp. 26-32

The traditional competition rules have already been supplemented for school classes by competition recommendations such as biathlon relays. This is beneficial for the versatile motor development during childhood and promotes children’s natural urge for movement. When playing in nature, children often demonstrate playful trials of strength. They have the natural need to compare themselves with others. This rivalry must be utilized in the motor development of children and in competitions. Various forms of competitive games that include basic elements from the fields of running, jumping and throwing are particularly suitable in this context. However, these competitions not only allow recognizing one’s own abilities, but also experiencing success (or failure) in the community. In this way, competitive games can also contribute to the development of social abilities.

Knoblauch, S.; Sjögrehn, S.  
Gepardenstaffel, Tigersprung und Co: Der Niedersächsische Leichtathletik-Verband eröffnete mit den „Dschungelspielen“ die neue Hannoversche Kinderliga  
[Cheetah Relay, Tiger Jump, and Co.: The Lower Saxony Association of Athletics Federation has opened the new Hanoverian Little League with the „jungle games“]

Leichtathletiktraining, Münster, 20 (2009), 6, pp. 12-15

In 2009, the new Hanoverian Children’s League of the Lower Saxony Athletics Federation (NLV) was opened. It is based on the “Cologne Little League” existing since 2000. In March 2009, the kick-off event for a child-friendly competition series took place in the Sports Performance Center in Hanover under the name “Jungle Games”. The “Jungle games” are designed for the C and D age categories. They are only for mixed teams of eight boys and girls. According to the “Jungle Games” motto, the individual competition stations were given names like “Cheetah Relay”, “Tiger Jump”, or “Spider Web” and were decorated with animal images. The entire event was accompanied by music. All participating children received, regardless of their results, creatively designed certificates and jelly animals to nibble.

Lütgeharm, R.  
Abwechslungsreiche Spielformen für Groß und Klein  
[Varied playing forms for young and old]

Leichtathletiktraining, Münster, 23, (2012), 9+10, pp. 36-37

Small games are characterized by joyful actions emanating from a particular game idea. They are also referred to as “free” games that stand aloof
Movement, games and sport play a crucial role in the development of children. They affect not only their physical but also their mental, emotional and social maturity. Only when children move around a lot, can they develop in an age-appropriate way. During childhood physical activity does not only lead to a development and strengthening of the bones, tendons and muscles, but the perceptual skills are also improved. Particularly, the orientation in space, body awareness, coordination ability and sense of balance are challenged. Furthermore, dealing with one’s own body in sports and games contributes to a positive self-perception and thus also supports the development of self-awareness. To move and to have fun, children do not need professional sports equipment and facilities. Especially for little children simple items such as plastic bottles, cloths, balloons, or balls, tires, cones, gymnastic benches, boxes, ropes, etc., are completely sufficient to create forms of movement and play.

Schubert, R. Bewegungshits für Kinder [Movement hits for kids]
Leichtathletiktraining, Münster, 22, (2011), 12, pp. 14-17

Movement, games and sport play an important role in the development of children. They affect not only their physical but also their mental, emotional and social maturity. Only when children move around a lot, can they develop in an age-appropriate way. During childhood physical activity does not only lead to a development and strengthening of the bones, tendons and muscles, but the perceptual skills are also improved. Particularly, the orientation in space, body awareness, coordination ability and sense of balance are challenged. Furthermore, dealing with one’s own body in sports and games contributes to a positive self-perception and thus also supports the development of self-awareness. To move and to have fun, children do not need professional sports equipment and facilities. Especially for little children simple items such as plastic bottles, cloths, balloons, or balls, tires, cones, gymnastic benches, boxes, ropes, etc., are completely sufficient to create forms of movement and play.

Sjörehn, S. Gepardenstaffel, Tigersprung und Co. Teil 2 [Cheetah Relay, Tiger Jump, and Co. Part 2]
Leichtathletiktraining, Münster, 21 (2010), 1, pp. 20-25

The success of Children’s Little League is based on two main points: 1. A child-friendly orientation of the entire competition including the selection and design of the stations up to the tight organization, so that no long pauses occur, and 2. the organization of a framework programme for the athletes and the presenters with the chance of winning alluring prizes so that the sport of athletics is presented to the children in an attractive way. In this paper the author describes the individual stations of the “Jungle Games” and presents detailed information on their implementation.

Ullrich, D.; Deister, D. Kinder sind für Wettkämpfe – Wettkämpfe für Kinder [Children favour competitions – competitions are ideal for children]
Leichtathletiktraining, Münster, 22, (2011), 9+10, pp. 4-7

With the new competition system of the DLV (German Athletics Federation) for children, athletics shall be made versatile, varied and purposeful in order to on a long-time basis introduce children to “big” athletics. Since the training contents are controlled by the competition options, the DLV has installed a “specialization brake” in the new “Competition System 2012” for the 6-11-year-old children. This means that in contrast to the previous narrow canon of disciplines, the organizers now have the freedom to choose, depending on the age range, a certain number of disciplines from a total of 11 fields of movement.

Vonstein, W. Kommentar zur Notwendigkeit alternativer Wettkämpfe für Kinder [Comment on the need for alternative events for children]
Leichtathletiktraining, Münster, 21 (2010), 7, p. 33

The IAAF “Kid’s Athletics” program was developed at the beginning of the new century and disseminated in the IAAF Regional Centers. “IAAF Kid’s Athletics” is recognized worldwide as the right approach to introducing children to child-suitable and versatile athletics. However, in Germany, the temptation to respond to the needs of children and to develop their skills effectively is resisted. Instead, one probably still hopes still for a return of the “good old days” when athlet-
ics was played as a basic sport. The author encourages all coaches, instructors and clubs to massively rethink on the “lower” level to offer children’s athletics in an attractive way through appropriate competitions or attractive games.

Wensor, D.
Fun tops the charts
Modern Athlete and Coach, Adelaide, 46, (2008), 3, pp. 7-8
If athletics training isn’t fun, a young athlete isn’t going to improve much over the course of a season. Nor will they continue turning up to training year after year. Therefore, making training “fun” should be a high priority for a coach of young athletes. If one asks young athletes what will be fun, normally the following items will be mentioned:
1. Being challenged;
2. achieving personal bests;
3. measures and times;
4. games;
5. relays;
6. fun activities;
7. learning and improving;
8. setting goals and reaching them;
9. friends;
10. variety.

Wensor, D.
Games that kids love
The author describes three of his all-time favourite athletics games that over many years have been guaranteed hits with groups of young athletes in a range of coaching clinic situations:
1. Hurdles – “Hurdles Shuttle Relay”;
2. High Jump – “Escape from the Space Monsters”;

Publications about training aspects in children’s and youths’ athletics in general and about strength training in particular

Ebbets, R.
Skills and drills
Track Coach, Mountain View, (2009), 189, pp. 6034-6039
The author raises the question of what to do if one wants to introduce 7 to 8-year-old children with no previous sport experience to the sport of athletics. For these children, a methodology is suitable that is based on the basic skills of running, jumping and throwing already established in the kindergarten. In addition, such a program should lead the children to elementary training concepts and furthermore convey to them more abstract skills such as teamwork, communication and discipline. The author presents a corresponding “Pre-Junior Olympic” program of six weeks duration with one training session each week.

Eberle, F.
Handlungsfeld Werfen [The “throwing” field of action]
Leichtathletiktraining, Münster, 21 (2010), 2+3, pp. 58-63
Although throwing is a natural form of movement, today’s children have only limited experience in throwing because they spend more time in front of the TV or computer than playing (and thus throwing) outdoors. Therefore, children must be offered a large and varied field of action, where they can throw, put and hurl different devices. In basic throwing training, the following priorities or components should be included:
1 The social component: from a social perspective, catching is also a part of basic throwing training. The ability to learn, the willingness to perform, the willingness to make an effort, and the ability to concentrate are also important aspects of this psycho-social area of experience.
2 Motor component: This relates to movement experiences that develop the physical and coordinative elements of throwing. These include powerful, fast, and accurate rolling, throwing, putting and hurling in different directions and from different positions.
3 Material component: Children should experiment with as many different throwing devices as possible.

Eberle, F.; Eisinger, S.; Voigt, A.
The authors present a four-step exercise concept for introducing children to endurance running. Using an eight-week graded plan, the children are first motivated for endurance running. During the first four weeks, the focus of the exercise concept is on developing the feel for pace. In addition to this, the children shall find their individual (slightly fatiguing) pace of running that makes them feel well. At the end of the eight weeks of training, the children shall be able to run 20-30 minutes without a break, and especially without symptoms of severe fatigue.
Hatfield, I.  
**Distance running and the young athlete**  
*Modern Athlete and Coach, Adelaide, 46, (2008), 3, pp. 5-6*  
The author presents training sessions for 11- and 14-year-old middle-distance runners. For 11-year-old runners two training sessions per week are sufficient, however, if they are more experienced with extra training years, a third session is appropriate. At this age some strength building exercises could be given to the athlete. Basic exercises such as push ups, running arms, sit ups, and other body-weight exercises especially to target the abdominal and lower back region (core strength) are appropriate. An important issue to stress is that the exercises will help prevent injury. The training sessions are a speed, an endurance, and a games & activities session. For 14-year-old athletes three training sessions per week are appropriate. In addition to the speed and endurance session, these young athletes perform a speed-strength session. This session includes hill runs, fartlek runs and interval runs.

Knowles, D.  
**Discus and the young athlete**  
Using the example of the Australian discus thrower Dani Samuels (World Champion in 2009) the author illustrates the importance of technique, balance and coordination as well as a motivating training environment when learning and refining the discus throw.

Loprinzi, P. D.; Cardinal, B. J.; Karp, J. R.; Brodowicz, G. R.  
**Group training in adolescent runners: influence on VO2max and 5-km race performance**  
The aims of this study were to (a) examine the interrelationships between training intensity, VO2max, and race performance in adolescent cross-country runners and (b) determine if adolescent runners participating in a group cross-country training program differ in the amount of training time at various intensities. In this study, 7 adolescent runners performed a laboratory-based VO2max test before and after a 9-week high-school cross-country season. Heart rate (HR) and ventilatory threshold (VT) were used to identify 3 training zones for each runner based on the HR at ventilator threshold (HRVT): zone 1: >15 b/min below HRVT; zone 2: between zone 1 and HRVT; zone 3: >HRVT. During each training session throughout the season, HR was measured to quantify the amount of training time in each of these 3 intensity zones. Results showed that the time in each of the 3 zones was not significantly associated with 5-km race performance. Zone 3 training time was positively associated with postseason VO2max (r = 0.73, p = 0.06); VO2max was significantly inversely associated with 5-km race performance (r = -0.77, p = 0.04). Each week, the amount of training time at, above, and below the VT was significantly different among the participants even though the training prescription for the group was standardized. The results suggest that, among adolescent cross-country runners, training above the VT may be important in increasing VO2max and ultimately, race performance. Given the between-participant differences in the amount of training time in each HR zone, coaches should apply individual, rather than group, training programs.

Martínez-López, E. J.; Benito-Martínez, E.; Hita-Contreras, F.; Lara-Sánchez, A.; Martinez-Amat, A.  
**Effects of electrostimulation and plyometric training program combination on jump height in teenage athletes**  
The purpose of this study was to examine the effects of eight-week (2 days/week) training periods of plyometric exercises (PT) and neuromuscular electrostimulation (EMS) on jump height in young athletes. Squat jump (SJ), counter movement jump (CMJ) and drop jump (DJ) were performed to assess the effects of the training protocols. 98 athletes (100 & 200m and 100m & 110m hurdles) voluntarily took part in this study, 51 males (52%) and 47 females (48%), 17.91 ± 1.42 years old, and 5.16 ± 2.56 years of training experience. The participants were randomly assigned to four different groups according to the frequency and the timing of the stimulation. Analysis of covariance was used to analyze the effects of every training program on jump height.
Our findings suggest that compared to control (Plyometrics (PT) only), the combination of 150Hz EMS + PT simultaneously combined in an 8 week (2 days/week) training program, we could observe significant jump height improvements in the different types of strength: explosive, explosive-elastic, and explosive-elastic-reactive. The combination of PT after < 85 Hz EMS did not show any jump height significant increase in sprinters. In conclusion, an eight week training program (with just two days per week) of EMS combined with plyometric exercises has proven useful for the improvement of every kind of vertical jump ability required for sprint and hurdles disciplines in teenage athletes.

Nunn-Cearns, G.  
Teaching kids to skip  
Skipping is an inexpensive exercise coaches can get athletes to do at home without too much supervision. It is a particularly good exercise to do when the weather outside is horrible, or parents are not able to take their son/daughter to an organised training session. It is a great cardiovascular workout for them. It is an activity that can be used for coordination, agility, balance and timing, involving both arm and leg activities. Skipping has a lot going for it. Another big plus about skipping is the cost is minimal – all you need is a place to jump (not a hard surface if possible), a good rope and a good pair of shoes. The right rope is important. It should be heavy enough to develop a steady rhythm and long enough for the ends to reach your armpits when you stand an the centre of the rope. A lot of young children can’t skip because they just don’t do it anymore. Kids are much happier to sit in front of a computer or TV. So, the first step one will need to take is to teach young athletes how to skip.

Nunn-Cearns, G.  
Training for young athletes  
Modern Athlete and Coach, Adelaide, 49, (2011), 2, pp. 5-6  
In this article, the author explains her thoughts on the development of young athletes in sprinting and the importance of an overall development. It should be emphasised that, at an early age, it is extremely important to have a large variety of activities to help develop an athlete’s coordination and a many-sided development in their general physical capabilities. During this introduction to Track and Field, athletes from the age of 10 to 15 years need a multi-sided development of their general physical characteristics. Activities used during this initial stage could include uphill runs, stair running and hopping, runs in the sand and runs over small hurdles alternated with sessions under normal conditions. All are great activities for developing a general fitness level and tend to guide the coach as to the deficiencies of the young athlete – whether it be stability, basic body strength or flexibility to name a few. The young athletes should also be introduced to learning the basic elements of relays and minor games that ask the athlete to change their running speed and direction continually. Drills encouraging basic movement patterns and stability should also be kept in mind. In mentioning this, the words of Kelvin Giles, discussing the “physical literacy of movement” comes to mind. In a presentation delivered at the National Congress in 2005, Giles discussed the movements required for event technique demand certain physical qualities. When discussing running, he mentioned the qualities were ankle, hip and hamstring range along with multi joint strength in single leg stance. Put simply, there are things coaches MUST do in the development of sprinters. The musts are: 1. Functional strength – not necessarily the weight an athlete can lift, but the amount of strength the athlete uses in the execution of their activity. 2. Structural stability – the ability for the body to move efficiently as a series of levers. 3. Structural Flexibility – ability to take advantage of range of motion. Larger, stronger muscles will produce force and stabilise joint actions which will allow the athlete to support technical development.

Nunn-Cearns, G.  
Young athletes are not miniature adults  
Modern Athlete and Coach, Adelaide, 49, (2011), 2, pp. 5-6  
It is well known when young athletes go through a growth spurt they are likely to lose some of their coordination and will need to develop certain skills again. It is also known that at this stage there could be some growth issues which may lead to injury. All this should be taken into
account in children’s and youth training. This should lead to: 1. Abandonment of plyometrics; 2. always professional diagnosis; 3. encouragement of other events; 4. encouragement of stretching; 5. encouragement of a body weight/resistance training program so the athletes can feel satisfied with their commitment to training; 6. a modified training week with alternative training – swimming, bike, pilates.

O’Reilly, L.

The Kenyan way: In touch with nature

Modern Athlete and Coach, Adelaide, 48, (2010), 2, pp. 9-11

The author recommends to introduce children and youths to middle- and long-distance running through cross-country running. Cross-country running leads to the general development of basic endurance in a stimulating environment. In addition to this, the individual athlete in cross-country running is always the member of a team, too. This leads to a social learning experience. Relay runs over additional obstacles and varying distances are an additional motivating factor.

Oltmanns, K.; Zawieja, M.

Kinder lernen Krafttraining [Children learn strength training]

Leichtathletiktraining, Münster, 22 (2011), 8, pp. 14-20

Adolescents of today demonstrate increasingly less physical fitness and a poor performance status. According to the author, the low fitness level is also due to the reluctance to early strength training and the too low training load, which is a consequence of this reluctance. At least, on an international level it has been known and accepted for decades that the often mentioned arguments leading to caution or restraint are not applicable. The current state of knowledge on the topic of “strength training for children” can be summarized in three main points: 1. Strength training with children is possible and worthwhile. 2. It is safe if properly conducted. 3. It is an essential part of training from both the point of view of health and performance.

Poulos, N.; Kuitunen, S.; Buchheit, M.

Effect of preload squatting on sprint performance in adolescent athletes


Training methods and warm-up practices aimed at developing high levels of muscular power have recently received significant attention from researchers and applied practitioners. One such method utilises a combination of resistance training and sports-specific movement. The purpose of this study was to investigate the effects of different intensity resistance exercises (i.e., 65, 75 or 85% 1-repetition maximum back squat) conducted over multiple sets prior to a 50m sprint in highly trained adolescent track and field athletes. A secondary purpose was to investigate whether the athletes’ 1-repetition maximum back squat has an impact on the responses observed. The results suggest that performing heavy load resistance exercises (HRE) prior to the sprint start has no significant effect on 50m sprint performance in highly trained adolescent track and field athletes, even when conducted over multiple sets. The results also suggest that practitioners may wish to consider improving a relative 1-repetition maximum back squat in already trained adolescent athletes in order to improve maximal sprinting speed. The data also suggests that there might be at least positive time saving benefits in performing HRE prior to sprinting over multiple sets utilizing the protocols provided.

Schrader, A.

Laufen mit Kindern [Running with children]

Leichtathletiktraining, Münster, 21 (2010), 9+10, pp. 36-37

Regardless of the specific contents of individual lessons, the most important effect of children’s athletics is in general that the children have fun and that they enjoy practicing. However, when hearing the word “endurance training” most children think that this means the stupid running of laps at a slow pace. Therefore, endurance running must be offered to children in a varied way in order to avoid boredom. This means that for example additional tasks are integrated or different forms of organization are used. The following possibilities are available to motivate children for endurance running: 1. Running in partner or group form; 2. Running according to music; 3. Using equipment and additional tasks (orienteer- runs, etc.); 4. Changes of terrain; 5. little material incentives such as certificates, badges, etc.
Warren, D.
Warming up the crowd: ideas for warming up groups of young athletes

The warm up that a coach uses with young athletes at the beginning of a practice session should be different to what is used for older, more experienced athletes. Whilst a warm up for young athletes certainly has value in achieving the often-cited goals of raising body temperature and heart rate, preparing the muscles and joints for the activity to follow, and helping to prevent injury, the most important role of the warm up for this age group is to set the mood and pace for the session that is to follow and to enthuse the athletes. The coach wants to capture the participants' attention and to get the participants "on side". The warm up is also an ideal time to develop general movement skills and athletic qualities in young athletes. Therefore the coach should plan and conduct a warm up that 1. is fun, 2. is very active, and 3. contains a wide range of movements and physical challenges. This can be achieved in a variety of ways but games and fun activities should dominate the warm up of young athletes. The time the warm up takes can be adjusted to suit the circumstances. A sample warm up (for athletes up to the age of 10 years) is presented.

Wensor, D.
Teach kids discus in 30 minutes
Modern Athlete and Coach, Adelaide, 48 (2010), 1, pp. 5-7

In this article, the author outlines the process that he uses to teach young athletes a basic, safe, working model technique within thirty to forty minutes.

Wensor, D.
Teach kids long jump in 30 minutes
Modern Athlete and Coach, Adelaide, 48 (2010), 3, pp. 8-10

In this article, the author outlines how he teaches young athletes a basic Long Jump technique in a 30 minute session. During such a session, the aim is to get a beginner to the point where they are able to run at speed, take off accurately from one foot, and perform a safe landing in the sand pit on two feet.

Wensor, D.
The 30 minute working model
Modern Athlete and Coach, Adelaide, 47 (2009), 3, pp. 5-7

The author believes that a basic working model for most athletics events can be taught in 30-40 minutes. Over the years, for each event, he has developed a series of steps to quickly and reliably take beginners to a point where they can perform a basic, safe, working model technique within thirty to forty minutes. In this article, he outlines the process that he uses to teach young athletes to functional shot putters in a very limited time.
Coaching with clarity is vital in this situation. Realistically, one coaching session will usually not result in a ‘textbook’ technique, but will produce happy young learners who at least possess the minimum skills required to participate safely in the event. In this particular article, the author features a ‘30 minute working model’ for hurdles.

West, T.
Middle distance running and the young athlete – how young/old before it gets hard?
Modern Athlete and Coach, Adelaide, 46 (2008), 4, pp. 8-11

The weekly training volume of young middle-distance runners should be as follows: 10 years: 20 km; 11 years: 30 km; 12 years: 40 km; 13 years: 50 km; 14 years: 60 km; 15 years: 70 km; 16 years: 80 km; 17 years: 90 km; 18 years: 100 km; 19 years: 110 km; 20 years: 120 km. With 10- to 11-year-old runners 80% of the training sessions should be endurance-oriented. Interval training, too, should be a part of the training of 10- to 12-year-old runners. If a 12 year old has a personal best time for the 200 of 31 seconds, they will be capable of running 8 x 200 in 35 sec with 200 jog recovery in 2 min. An athlete of this age, and running at an intensity of 80-85%, a recovery ratio of 4:1 is recommended. A good rule of thumb in deciding the pace is to take the best 100 or 200 time of the athlete and add 10%, and then add another second. Too hard for this 12 year old would be 8 x 200 in 35 sec mit 30 sec recovery or 8 x 200 m in 31 sec with 2 minutes recovery. Basic principles of the middle-distance training of young athletes are: 1. The bulk of training is endurance based. 2. Young athletes should not train like adults. 3. Training should be interesting, varied, and challenging.

Publications dealing with talent selection, identification, and development in general and in specific events

Brooks, C. M.
Biology of athletic talent
Modern Athlete and Coach, Adelaide, 47 (2009), 1, pp. 7-10

The author sums up her statements about the biology of athletic talent in seven key points: 1. Body structure is genetically determined. Talent identification and detection theory assumes that if we know the physique typical of successful performers we can match an individual’s physique to the appropriate sport. 2. While external body dimensions can give you some clues as to the athletic potential of a youngster, the genetic capacity of internal body structures are equally important. Unlike the external body structure that remains fixed once the individual matures, internal structures can fluctuate in size and speed of operation according to energy needs. We use this adaptation feature of internal structures to improve athletic capacity. 3. The upper limit of athletic performance is set by two built in design parameters. One is the structural design parameter that sets the upper limit of athletic performance due to how large the structure can grow. The other is the functional design parameter that limits athletic performance due to the structure’s maximum speed of operation. The analogy is similar to a factory: A single employee has a varying level of production capacity according to the needs of the factory, but there is an upper limit to how fast this individual employee can work. However, the entire factory can raise overall production output by increasing the number of staff. 4. The size of internal body structures is related to the intensity of the training stimulus. The size of the structure will almost always match current energy demand, but there is an uppersize limit that is dictated by genetics beyond which the training stimulus will no longer cause additional growth. 5. The overall athletic performance of an athlete at any specific stage in their development is set by the upper limit of both the functional design parameter and the structural design parameter. Talent identification and detection theory assumes that natural capacity before training is related to maximal performance potential, and additional structural growth will always occur. However, testing cannot predict the upper limit to structural growth and, thus cannot predict the upper limit to performance capacity. 6. Whenever the body is building structural capacity the general rule of thumb is that it usually takes around 4-6 weeks for the building process to occur. After that an increase in training stimulus will stimulate more growth over the ensuing 4-6 weeks. This cycle can continue up to the genetic limit for growth. 7. Good athletic genetics does not guarantee an elite athletic performance – it’s just the essential starting point.
Brown, E.

**Talent ID for multi events**

*Modern Athlete and Coach, Adelaide, 49 (2011), 1, pp. 9-1*

The question is often asked: How do I identify young athletes who are potentially capable of being great heptathletes or decathletes? Identifying whether athletes have the talent or not requires the mach to look at some of the following attributes: 1. Little Athletics is the first area that talent ID should occur. Most of our greatest multi eventers have progressed through this area simply because it gives young athletes the opportunity to try most events in Track and Field. 2. Most multi-event athletes will demonstrate promising talent in two or three events and be above average in a number of others even from a very young age. 3. Height is an asset with good decathletes averaging around 1.88m while the women will be about 1.70m. However, there are always exceptions to the rule. It is a good idea to delve into the sporting background of the parents and grandparents to better understand the likely future makeup of the young athletes. 4. Speed is an essential factor. It is a bonus if this is an inherited gift compared to having to work hard in this area. This can be determined by fast arm and fast leg speed. As there are nine speed and power events, and one endurance event in the decathlon, and six and one in the heptathlon, speed and power is a must to succeed. 5. Mental toughness always comes to the surface in these events because of the long years and hours of training to get to the top. It is a long hard road with no short cuts. 6. Determination, dedication and a will to win must make up the personality of multi-eventers. 7. An aggressive and positive type of nature is yet another vital component in determining the profile of these athletes. These are vital attributes as the athlete may need to recover from disappointment. They need to quickly put a bad event to the side and get up and go again a short time later. 8. A tall lean body shape is also a great asset to have. Strength without too much bulk is essential because of the nature of the events. Too much bulk carried around over two days will affect the result and too little will affect the power events. Therefore there is an important balance to be attained between both to last the two days of competition, and achieve the best possible outcome. 9. It is also noted that coaching patience and long term parental support are musts to succeed. 10. While the athletes are young it is a good time to try as many events as possible just to see if there are any “hidden” talents. If you have a young sprinter who may not have previously thrown, you may want to observe their arm speed as a guide towards proceeding further. Their technique may not be good, but if the implement comes out of the hand at high speed this will indicate that they have the speed and power to consider multi events. 11. Standing long jumps, vertical jump tests, overhead shot and above average speed are other tests to indicate potential, but at the end of the day they need most of the attributes mentioned above. 12. It is important at a young age to have a gradual technical input into all events as they normally take many years to master. Starting multi events at 15 or 16 years will delay any outstanding scores for five to eight years, until they can cement their technical skills in events they have not done before.

Heine, K.

**Echte Feste des Schulsports: Bei Schulwettkämpfen können Talente gefunden und für den Vereinssport gewonnen werden**

*[True festivals of school sport: At school competitions talents can be found and won for club sports]*

*Leichtathletiktraining, Münster, 21 (2010), 6, pp. 10-14*

The author describes the structure of the German Federal Youth Games, which were held for the first time in 1951 and in 2001 were amended to the current conditions and requirements. The concept of the “new” Federal Youth Games starts from the recognition that young people have very different ways to play sports. Moreover, the goal is to systematically introduce younger children to the basic sports of gymnastics, swimming and athletics. In doing so, early specialization and a too rigid set of rules are avoided. Therefore, in addition to the traditional sport-specific competition (gymnastics, swimming or athletics), an all-around competition has been included in the programme. This competition is of a versatile character. The multi-discipline competition encompasses the three basic sports. The schools or clubs can decide on their own which of the three alternatives they offer. To give especially the younger children the opportunity to take part in the Federal Youth Games and to avoid early specialization, since 2001, the priority for the youngest participants has been on the versatile competition. As far as athletics is concerned, this
competition consists of “running fast”, “jumping far or high”, “throw or putting for distance”, and “running continuously”. Measuring tape and stopwatch play only a minor role. Through this competition the child-oriented training approaches of the German Athletics Federation have become a part of the competition concept of schools.

Henriksen, K.; Stambulova, N.; Roessler, K. K. Successful talent development in track and field: considering the role of environment

Track and field includes a number of high-intensity disciplines with many demanding practices and represents a motivational challenge for talented athletes aiming to make a successful transition to the senior elite level. Based on a holistic ecological approach, this study presents an analysis of a particular athletic talent development environment, the IFK Växjö Track and Field Club, and examines key factors behind its successful history of creating top-level athletes. The research takes the form of a case study. Data was collected from multiple perspectives (in-depth interviews with administrators, coaches and athletes), from multiple situations (observation of training, competitions and meetings) and from the analysis of documents. The environment was characterized by a high degree of cohesion, by the organization of athletes and coaches into groups and teams, and by the important role given to elite athletes. A strong organizational culture, characterized by values of open co-operation, by a focus on performance process and by a whole-person approach, provided an important basis for the environment’s success. The holistic ecological approach encourages practitioners to broaden their focus beyond the individual in their efforts to help talented junior athletes make a successful transition to the elite senior level.

Ijzerman, J.; Damen, T.; Koens, G.; Collée, T. Improving talent identification and development in young distance runners
New Studies in Athletics, Aachen, 23 (2008), 3, pp. 35-48

Talent selection can be made by scientific methods or by coach selection. In many cases, coaches use a competition-ranking based method. Why selected athletes have performed in a certain way in the selection process or the ‘pros and cons’ of the choices made for their development are seldom considered. Many young athletes continue in an event despite the fact that they don’t have the best characteristics for success in that discipline. Only after a dropout due to injuries or lack of motivation is it realised that mistakes might have been made in the decision to place an athlete in an event or event group. The main purpose of this study was to identify ways to reduce or eliminate health risks associated with athletic training by ensuring the best possible choice of athletic discipline. The authors also wanted to use testing and monitoring to learn more about the athletes’ natural development, their training characteristics, their health and psychological status, and their future possibilities. The aim was to provide a conclusion as to what extent each athlete was suited for a particular athletic event and general recommendations for future work in the area of talent selection.

Killing, W.; Rinder, J. Langfristig Sprungtalente entwickeln! Der DLV-Rahmentrainingsplan „Aufbautraining Sprung“ ist betont praxisnah gestaltet [The long-term development of talented young jumpers! The framework build-up training plan for the Jump of the German Athletics Federation is deliberately kept very close to practice]
Leichtathletiktraining, Münster, 20 (2009), 4, pp. 9-13

The framework training plans („Rahmentrainingspläne“ = RTP) of the German Athletics Federation for all discipline blocks are currently in the revision process. In this paper, the authors give an overview of the structure and content of the new RTP for youth athletics in the “Jump” discipline group. In contrast to the previous RTP, the new editions dealing with build-up training deliberately place the emphasis on youth training. As far as the exercise selection and the load organisation is concerned, in the recommendations for training a youth-adequate training is presented which still leaves room for later training stages. For build-up training, the RTP “Jump” is mainly oriented to training with young people aged between 15 and 19 years. During the build-up phase, training starts with a block-specific basic training, which then becomes increasingly discipline-specific.
After completion of the junior class (U20), a discipline-specific follow-up and high-performance training is conducted during junior and adult age. This means that ideally the young athletes have already completed a sound basic training for several years and thus have set the basis for a more specific build-up training.

Launder, A.
*Recruiting: a critical aspect of coaching*
*Modern Athlete and Coach, Adelaide, 47 (2009), 2, pp. 17-18*

Much of the success of the German track and field program can be attributed to their very efficient system of talent identification and the allocation of youngsters to the sporting area in which they are likely to be most successful. In the American college system recruiting talented athletes is often regarded as being of more importance to producing a successful team than the ability to coach them when they arrive. In contrast, the situation in Australia is almost laughable and coaches may have to accept the fact that they have to be grateful for any youngsters who choose to show up with an interest in the sport. Given the continuing proliferation of sporting opportunities for youngsters in Australia, with many sports offering coaching and competition for five year olds, it is clear that the aggressive approach must be adopted. Every coach in Australia should make it a goal to bring at least five athletes into the sport every year. To do this they must attend school athletics meetings at every possible opportunity and where this is not possible, they must carefully scrutinise results sheets. Obviously personal contact and observation at the competition is by far the best. After the competition, the coach must talk with them and if at all possible with their teachers and parents. Field tests, or control tests, cannot only confirm potential but they can in a very objective manner show parents and athletes just how good they are.

May, R.
*Vielseitige Voraussetzungen schaffen [Creating manysided prerequisites]*
*Leichtathletiktraining, Münster, 18 (Juli 2008), 7, pp. 16-20*

The author presents the organizational structure of the junior training (basic training) at the German GutsMuths sports grammar school in Jena. In addition to the material and personnel prerequisites, he describes contents and methodological structure of the training of 12- to 15-year-old pupils in athletics. At the GutsMuths sport grammar school, general and specific training contents are used to an equal extent. The general contents include swimming, gymnastics, games, cycling and run & bike, inline skating, endurance running, ABC forms, general jumping, general throwing, flexibility training, strengthening and stabilization. In the specific area, the students practice the basic techniques of the sprint, hurdles, high and long jump, ball and javelin throw, the shot put and the rotational throws, pole vault, and horizontal multiple jumps. Hurdling is the main focus within athletics training and is improved using as various forms as possible. The students have two hours of sport three times a week in the morning and four times weekly for up to two hours in the afternoon. The total training volume per week is 12-14 hours. The motto of basic training at the GutsMuths sport grammar school is: “You as a coach can do everything during the sessions as long as you avoid the competitive forms of exercise as much as possible.” Basic training merely sets the stage and is the basis for further training levels. Basic training is considered as a “transition stage” and not as the final stage of training.

Peltola, E.; Hill, M. R.; Price, A.-C.; Simpson, B.
*Talent identification at Qatar’s ASPIRE Academy*
*New Studies in Athletics, Aachen, 23 (2008), 3, pp. 49-52*

The ASPIRE Academy for Sports Excellence is Qatar’s visionary programme for discovering and developing the best young sporting talent from the region and around the world. The objective is to turn young sporting talents into winners at the highest levels of international competition. ASPIRE’s Talent Identification Programme is the foundation of the Academy’s success. It works in close coordination with Qatar’s Ministry of Education, the Supreme Council of Education and the Qatar National Olympic Committee to find students who have exceptional athletic talent and offer them a scholarship to ASPIRE. It comprises a three-phase structure (Bronze, Silver and Gold), each phase with specific aims and tests. The authors, who all work at the academy, provide an overview of the process and a de-
cription of each phase, including the tests and other activities that they use. They conclude by stressing the importance of talent development.

Probst, J.  
**Developing athletes and athletics**  
*Modern Athlete and Coach, Adelaide, 49 (2011), 1, pp. 4-6*

Against the background of the concept of the so-called „Second Pathway“ which was used in the former GDR to recruit young athletes, the author criticizes the Australian method of athlete development. In Australia, the competition system is completely geared towards early developers. It also seems that the emphasis is purely on performance when talents are selected. If a young athlete achieves a certain performance, he/she will enjoy at least some support, regardless of physical and psychological attributes. Those who are late developers but display great aptitude from a psychological point of view and have a passion for the sport more or less narrowly miss out. Australia has a great talent pool, but many might be sick of doing the same sport since they were five years old at exactly the age they should only be starting to hone their skills and perhaps specialise. The author states that for athletics to flourish in Australia a real depth and a real competition at a much higher standard needs to be created, which will kick off a positive cycle. But this requires to change things drastically.

**Publications dealing with the physical and motor development of children and youths**

Buns, M.  
**Coaching kids successfully: 100 years of motor development research**  
*Track Coach, Mountain View (2011), 195, pp. 6229-6233, 6245*

Children are no small adults. Children have different proportions and composition. They have relatively larger heads, shorter extremities, and smaller torsos than adults. Children and adults handle heat and oxygen production differently during training. Children have higher resting heart rates than adults; at rest, children’s hearts are working harder than adults’ hearts. Anaerobic power is also lower in children than in adults and they have a lower haemoglobin concentration in the blood. This means that children can do less work than adults. Children become more fit as a result of fitness training but the responses to training tend to be lower in children than in adults. Weight training for children is a controversial topic. For prepubescent children, the gains are small. Therefore, the time might better be spent doing something else. As children are growing, there is risk of injury. The bodies of girls and boys are more alike than different during childhood; however, differences emerge during puberty that give males a performance advantage in certain activities. Prior to puberty, boys and girls are very similar in height and weight. Therefore, they can work together. Success requires hard work. This means that in training with children the emphasis should be on hard work and practice because this is within their control. No body (nobody) is perfect and effective coaches embrace the uniqueness of each athlete. Coaches can help children understand that a) there is no ideal body shape, b) we are all more alike than different and c) all of us can have healthy bodies. What is also important for children and adolescents to understand is that larger bones and a healthy amount of muscle are good. Their participation in track & field can help by increasing muscle and bone growth, and reducing fat.

Suslov, F.  
**Current problems in the development of young athletes**  
*New Studies in Athletics, Aachen, 23 (2008), 3, pp. 19-25*

Current problems in high-performance athletics call for coaches and other specialists to understand the situation and put pressure on them to identify methodological and organisational solutions. In particular, there is a need to find reserves or new potential for improvement within the system of long-term development that takes beginner athletes to the elite level. The responses to the problem of decreasing talent pools in Russia and most of Europe, which include the naturalisation of proven talent and children from other countries and the acceleration of the long-term training process for young athletes, have biological components. These have not been adequately discussed, even though they have many implications for the athlete development process. The author’s main focus is on the biological maturation of young athletes, for which he gives an overview of the main stages. As there
are inter-individual differences of up three years in the rate of maturation, he argues that athletics training, and even the competition system, must be appropriate to each individual's stage of development, regardless of the chronological age. He also gives a biological perspective and general advice on issues in the areas of sport psychology and talent management.

Publications dealing with psychological aspects of children's and youths' athletics

Dempster, S.
Managing parent power
Modern Athlete and Coach, Adelaide, 48 (2010), 4, pp. 7-8

In the USA, 40 million kids participate in sport annually. 70% retire at age 13. The number one reason they give is hat it is no longer fun, that the adults are too involved and demanding. Against this background the author has developed 12 guidelines that should be considered by the parents of young athletes: 1. Your competitors are your friends. 2. Beat yourself and you can beat anyone. 3. Winning is not necessarily success. 4. Keep it fun at all costs. 5. Whose goal is it anyway? (i.e., the motivation should come from the child not the parents). 6. Your child is not their performance (i.e., children should not be punished for a bad performance). 7. Self-esteem makes the world go round and parents should therefore make their children feel good about themselves. 8. Give your child the gift of failure because failure is a key life skill to acquire for the stepping stone to success. 9. Challenge, don’t threaten, because challenges convey that parents have confidence in their children. 10. Stress the process rather than the outcome. 11. Avoid comparisons. 12. Keep it all in perspective (i.e., the child must know that it will be loved even when it has failed.

Kristiansen, E.; Roberts, G. C.
Young elite athletes and social support: coping with competitive and organizational stress in “Olympic” competition

Elite adolescent sport is a relatively unexplored research field. The purpose of this investigation was to examine how the Norwegian Olympic Youth Team (N = 29) experienced competitive and organizational stress during the European Youth Olympic Festival in July 2007 and how they coped with the stressors. Participants were aged 14-17 and competed in handball, track and field, swimming, and judo. We used a qualitative methodology with interviews and open-ended questionnaires. Qualitative content analyses revealed that the athletes experienced competitive stressors because of the size and importance of the competition, and organizational stressors (e.g., housing, lining up for food, and transportation) exacerbated by the extreme heat during the Festival. The elite competitive experience was novel to all and overwhelming for some of the more “inexperienced” athletes. The athletes used cognitive coping strategies to some extent in addition to relying on different types of social support. The findings revealed the need for social support for adolescent athletes, and underlined the importance of a good coach-athlete relationship in order to perform well and enjoy the competitive experience.

Urycki, Denise; Keenan, Kimberley
Gifts in the moment: a mindful approach to coaching young athletes
Track Coach, Mountain View (2009), 189, pp. 6048-6050

One of the greatest things a coach can do for athletes is to help them become aware of their gifts. To develop this awareness, coach and athlete must be able to see what each moment has to offer. In every moment there is a gift. These gifts are solely for the purpose of teaching the coach valuable lessons or allowing him to influence others. Some precious moments do both. Gifts in the moment (GiTM) are opportunities present everywhere. Mindfulness can be mastered by following these eight coaching GiTM principles: 1. Coaches must be genuine and live consistent with his/her message. 2. Coaches should foster authentic relationships between coach and teammates and should encourage athletes to help themselves and one another. 3. Coaches should anticipate change and encourage flexibility in goals. 4. Coaches should place great emphasis on physical preparation. 5. Coaches should ask their athletes to review
and rehearse the event in his/her mind. 6. Coach should view the sports activity also as „emotional rescue. If the process becomes the goal, the emotional rescue is often more profound. 7. Coaches should have a positive attitude toward spiritual routines. A spiritual routine is a process with meaning and focus that provides comfort and safety. 8. Rest should be seen as an active process. The key to rest is to be able to recognize opportunities for rest and utilize them.

*Publications dealing with medical aspects of children’s and youths’ athletics*


The aim of this study was to examine the physical characteristics and somatotype of junior and senior athletes in relation to sprint start and acceleration performance. Nineteen female junior, 23 male junior, 9 female senior, and 16 male senior sprint athletes performed three maximal 20-m sprints. The starting blocks were instrumented to measure forward propulsion forces. Running velocity was measured by a laser positioned behind the athlete at 1 m height. Anthropometric measures were used to calculate somatotype and skeletal muscle mass. Body composition was estimated by underwater weighing densitometry. Junior and senior athletes were of similar height in both sexes. Male seniors were heavier, had larger limb circumferences, and a higher skeletal muscle mass than male juniors. Only the limb circumferences of the female seniors were larger than those of the female juniors. Female juniors were balanced ectomorphs, while female seniors were situated centrally on the somatochart (2.7–2.2–3.9 vs. 2.6–3.1–3.1; P=0.772, 0.047, and 0.066 respectively). Male juniors were mesomorphic ectomorphs, while male seniors were ectomorphic mesomorphs (1.8–3.3–3.6 vs. 1.6–4.2–2.8; P=0.148, 0.002, and 0.002 respectively). All sprint starts were similar for the junior and senior athletes of both sexes. Senior athletes accelerated more than the junior athletes, which resulted in higher running velocities after 5 m (senior vs. junior: females, 5.51±0.32 vs. 6.01±0.27 m/s, P=0.001; males, 5.85±0.38 vs. 6.13±0.44 m/s, P=0.043). The greater muscularity of senior compared with junior athletes did not result in better sprint start dynamics, but they did accelerate more and ran faster. These results show that late-adolescent boys in particular are still developing their muscularity. The technical complexity of the sprint start and the negative influence of a higher body mass may partly explain the comparable sprint start dynamics of the junior and senior athletes. We suggest that strength training should be combined with sufficient attention to technical skills to allow a positive transfer.


To examine the physiological strain associated with hypoxic high intensity interval training (HHIT), 8 highly trained young runners (age, 18.6 ± 5.3 years) randomly performed, 5 × 3-minute intervals in either normoxic (N, 90% of the velocity associated with VO2max, vVO2max) or hypoxic (H, simulated 2,400-m altitude, 84% of vVO2max) conditions. Cardiorespiratory (ventilation [VE], oxygen consumption [V̇o2], heart rate [HR], oxygen saturation [SpO2]), rating of central perceived exertion (RPEC) responses, changes in neutrophils, erythropoietin (EPO), blood lactate ([La]) and, bicarbonate ([HCO-3]), vagal-related indices of HR variability (natural logarithm of the square root of the mean of the sum of the squares of differences [Ln rMSSD]) and maximal sprint and jump performances were compared after each session. Compared with N, H was associated with similar VE (cohen’s d ± 90% confidence limits, 0.0 ± 0.4, with % chances of higher/similar/lower values of 15/61/24) but at least lower V̇o2 (-0.8 ± 0.4, 0/0/100), HR (-0.4 ± 0.4, 1/21/78), and SpO2 (-1.8 ± 0.4, 0/0/100). Rating of perceived exertion was very likely higher (+0.5 ± 0.4, 92/8/0). Changes in [HCO-3] (-0.6 ± 0.8, 5/13/83), [La] (+0.2 ± 0.4, 52/42/5), and EPO (+0.2 ± 0.4, 55/40/5) were at least possibly greater after H compared with those after N, whereas changes in neutrophils were likely lower (-0.5 ± 0.7, 4/15/81). Changes in 20-m sprint time (+0.20 Nr. 97: Youth Athletics
± 0.23, 49/50/1) were possibly lower after H. There was no clear difference in the changes in Ln rMSSD (+0.2 ± 1.7, 48/18/34) and jump (+0.3 ± 0.9, 60/25/15). In conclusion, although perceived as harder, HHIT is not associated with an exaggerated physiological stress in highly trained young athletes. The present results also confirm that HHIT may not be optimal for training both the cardiorespiratory and neuromuscular determinants of running performance in this population.

Dempster, S.
Energy systems and the developing athlete
Modern Athlete and Coach, Adelaide, 46 (2008), 4, pp. 12-16

Energy systems in physically immature youngsters are underdeveloped. Children are constantly growing and developing so thereby utilizing energy in copious amounts and in an inefficient and irregular manner in comparison to their adult counterparts. Indeed the anaerobic lactate energy system will not fully mature until well into the 20s. This means that physically youngsters are not yet capable of many of the high intensity lactic based physical sessions but seem to be like sponges when it comes to learning the skills and movements required by all sports movement patterns. Huge gains are made if development is focussed in this direction. Psychologically, this enables the young athlete to retain an appetite for the process rather than, as in too many cases, many feeling that they have had enough by the age of 17, with the best years of their careers ahead of them.

Dencker, M.; Svensson, J.; El-Naaman, B.; Bugge, A.; Andersen, L.B.
Importance of epoch length and registration time on accelerometer measurements in younger children
The Journal of Sports Medicine and Physical Fitness, Turin, 52 (2012), 2, pp. 115-121

AIM: The aim of this study was to investigate the effect of epoch length on accumulation of minutes of physical activity per day over a spectrum of intensities, and the effect that selection of number of hours of acceptable registration required per day had on number of days that were considered acceptable. METHODS: Participants were 696 children (369 boys and 327 girls) aged 6.7±0.4 yrs, from a population-based cohort. Physical activity was assessed by the Actigraph accelerometer for four days. RESULTS: Main findings were that epoch length had a profound impact on accumulation of minutes of physical activity per day for higher intensities, whereas it had no effect on mean counts per minute. The chosen number of hours for an acceptable registration per day heavily influenced the number of days that were considered acceptable. CONCLUSION: The findings in the present investigation should be taken into consideration when planning objective measurements of daily physical activity in younger children, and highlight the need for setting international recommendations for physical activity measurements with accelerometers, if different studies are to be comparable.

Edouard, P.; Samozino, P.; Escudier, G.; Baldini, A.; Morin, J.-B.
Injuries in youth and National Combined Events Championships

In major track and field competitions, the most risky discipline is the combined event. Therefore, we aimed to record and analyze the incidence and characteristics of sports injuries incurred during the Youth and National Combined Events Championships. During the French Athletics Combined Events Championships in 2010, all newly occurred injuries were prospectively recorded by the local organising committee of physicians and physiotherapists working in the medical centres at the stadium, in order to determine incidence and characteristics of newly occurred injuries. In total, 51 injuries and 9 time-loss injuries were reported among 107 registered athletes, resulting in an incidence of 477 injuries and 84 time-loss injuries per 1000 registered athletes. Approximately 72% of injuries affected lower limbs and 60% were caused by overuse. Thigh strain (17.6%) was the most common diagnosis. 14 dropouts were recorded, 8 were caused by an injury (57.1%). During the National and Youth Combined Events Championships, over one third of the registered athletes incurred an injury, with an injury incidence higher than in international elite track and field competitions. Interestingly, this higher injury risk concerned the younger population affecting immature musculoskeletal structures. In combined events, preventive interventions should mainly focus on overuse and thigh injuries.
Georgilopoulos, P.
**The young athlete: injury and performance perspectives**
*Modern Athlete and Coach, Adelaide, 48 (2010), 4, pp. 19-21*

The increasing trend towards childhood obesity linked to poor nutrition and inactivity is well documented and is regrettably, a rapidly escalating statistic in Australia. What is generally overlooked however, is the widening chasm between the increasingly inactive majority and the elite minority of children and adolescents who are performing increasingly more intense training and competitive loads to achieve ever higher performance standards. Performance benchmarks are constantly creeping upward and as a consequence, so are the training and competition demands that need to be met to satisfy these targets. Anecdotal evidence exists to suggest gradual anthropometric increases over time in young athletes in terms of height, body mass and muscularity. Girls achieve physical maturity generally much earlier than boys with many 15 year olds very capably competing with senior female athletes. By comparison, boys tend to develop later than girls and are generally not considered capable of competing with senior men until 19 or 20 years of age. The degree of muscular development that continues beyond skeletal maturity in males often precludes, young male athletes from being competitive with senior males in events requiring power. Even so, just as senior athletes continue to push performance and training boundaries, so do their junior counterparts. The dilemma that this poses for the young athlete is that skeletally they are still undergoing growth with the resultant nutritional and coordination issues that this entails. Growth plates can become dislodged or fuse earlier than the normal maturation process would allow and, most commonly, the insertional points of powerful muscular groups such as the hamstrings, quadriceps and calves can cause traction trauma to immature bone leading to common conditions such as Scheuermann’s and Sever’s disease, Osgood Schlatter’s and ischial apophysitis amongst others.

Poynton, E.
**Junior heel pain**
*Modern Athlete and Coach, Adelaide, 48 (2010), 2, pp. 13-14*

Foot and ankle musculoskeletal complaints are the second most common reason for medical consultations by young athletes. Severs Disease is a frequent cause of heel pain in the immature athlete. It occurs more often in boys and is bilateral 60% of the time. However with girls participation in more strenuous sports the boy to girl ratio is slowly equalising. The typical age range is between 8-15 years with the peak average age being between 10-11 years. A child who is suffering from severs disease tends to complain of activity related pain and will grasp the whole heel if requested to show the painful site. Initially the pain is a low grade, dull ache which typically occurs with activity, after rest or after prolonged exercise. Pain tends to increase with activity and improved with rest. Due to the nature of Track and Field disciplines (running, jumping and plyometrics), high impact and propulsion activity tends to produce the greatest pain; however simply walking may produce pain in severe cases. The initiator of Severs disease will vary from child to child. Often the child has just begun a sporting program or increased a current activity load. Constructive management to settle the symptoms is the primary treatment aim of Severs disease. In the long term Severs disease is self limiting as the child will eventually ‘grow out of it’ due to the growth plates closing once the foot is fully grown around the age of 14-15 years. It will usually settle within six to twelve months from initial presentation and have no long term effects on an athlete’s future injury worries.

Rousanoglou, E. N.; Boudolos, K. D.
**Angle specificity of the knee extensor age-related profile in young female athletes**
*International Journal of Sports Medicine, Stuttgart, 29 (2008), 1, pp. 66-69*

The angle specificity of the knee extensor age-related profile was examined in young females (13-19 yr). Twenty-one track & field jumpers, 20 volleyball players and 20 non-active females were separated into the youngest and the oldest age categories, based on the official competitive age categories. The maximum knee extensor isometric torque (T MAX) was measured at 9 knee angles. The relationships between T MAX at the peak of the torque-angle curve and at the other knee angles (angle-angle relationships) were expressed by R2 (%). Statistics included two-way ANOVA for age category differences.
and curve fitting to R2 joint angle trend lines. Differences between age categories were significant for the volleyball players and the non-active females (p<0.05). Age category had an angle specific impact on angle-angle relationships in the athletes, with the youngest ones demonstrating greater R2 decrease at the more extended, or more flexed, knee angles. Significant quadratic R2 joint angle trend lines were found in all track & field jumpers (p<0.05) and, in the youngest only volleyball players (p<0.05), but not in the non-active females (p>0.05). In conclusion, the knee extensor profiles of young female athletes show an age-related angle specificity that should be accounted for when treating athletes within the age range examined.

General

Digel, H.
The risk of the Youth Olympic Games
New Studies in Athletics, Aachen, 23 (2008), 3, pp. 53-58

The decision to create a Youth Olympic Games, with the first edition to be held in Singapore in 2010, creates opportunities for the International Olympic Committee (IOC) and the international sport federations to promote positive values in a sustainable way. However, the organisation and staging of the Games entails serious risks of creating unintended and undesirable side effects that could threaten the success of the event or even lead to the self-destruction of the current sports system. Among those issues examined are 1) the practical implications of trying to integrate value educational activities with high-performance sport competition, 2) the exacerbation of negative trends in international sport such as doping and over-commercialisation, 3) the difficulties of designing the competition programme of the Games and limiting the number of participants, 4) issues related to the mass media and hosting cities, and 5) the long-term effects an the senior Olympic Games and international sports. Accepting that the Games will take place, the author recommends that the organisers find creative concepts to address the issues raised and that research be conducted so that lessons for preparation of future editions can be learned.

Ebbets, R.
Children and sport
Track Coach, Mountain View (2011), 194, pp. 6204-6210

Introduction: With the growing concern over the health status of children in the United States, a solution offered by popular media and educational theorists alike is to promote the participation of youth in some form of regular exercise. Objective: It is the objective of this paper to discuss the opportunities and challenges that arise when athletic opportunities for children shift from youth-led recreation to highly structured activities. Discussion: Some generally accepted components of athletic participation will be explored. Points to be discussed include: biomotor skill development, the age of specialization, volume and intensity, psychological factors, the role of winning and injuries and illnesses. Conclusion: It is important for the coach or consulting physician to strive to be continuously aware of the demands of a sport’s demands and allow for a fuller more factually based discussion regarding the best path for the proper preparation and training for the young athlete.

Ebbets, R.
Interview with Rainer Martens
Track Coach, Mountain View (2012), 200, pp. 6383-6386, 6393

In this interview with the American sport psychologist Rainer Martens, the founder of Human Kinetics publisher, the following aspects are addressed among others: 1. The importance of self-esteem for the development of children; 2. social values which are of significance in education; 3. the disadvantages of the system of talent promotion in the former countries of the Soviet Bloc; 4. the significance of fun in sports and of winning; 5. the role of tests in talent selection and promotion; 6. the value of sports for personality development; 7. the role of the parents for the sports activity of children; 8. the significance of sports psychology for sport beginners; 9. the importance of listening for coaches.
Since the cultural shift of the 1980's, American children experienced a complete lifestyle change compared to their parents. The technology age has forced the majority of activities inside and reduced the physical activities on school grounds across the nation, as well as the time spent playing outside at home. Structured physical training programs which burn calories and build endurance, strength, speed, power, coordination, flexibility, and kinesthetic awareness have been greatly reduced. The fast food revolution has greatly changed the nutritional habits of the American family. Children are having a difficult time managing calories and fueling their bodies with the daily nutritional requirements the body needs for good growth and restoration. America now faces a health crisis because of the technological revolution. In 2002, America spent $40 billion dollars fighting obesity. In 2008, $147 billion dollars were spent, and the Center for Disease Control estimates that $344 billion will be spent by 2018, greatly adding to the health care crises America is facing. In addition statistics show that 1 in 3 children born after 2000 will develop Type 2 diabetes. Against this background, parents, teachers, and coaches should get back to the basics of physical training and nutrition and look at the sport of track & field. Not for the potential to receive an athletic scholarship to college, or what the sport will offer at the professional sport level, but what the sport can do to help keep the child from becoming a victim of the obesity or fighting Type 2 diabetes for life. The Run For The Dream Project was formed to help meet the needs of youth participating in the sport of track & field.

The focus of the conference, which was staged by European Athletics and the Norwegian athletics federation, Norges Fri-idrettsforbund (NFIF) and received additional support from the IMF Regional Development Centre in Moscow, was on ways the sport can attract and retain young people. Among the strong line-up of featured speakers were representatives of the IAAF and the United Nations Educational, Scientific and Cultural Organization (UNESCO), which recently renewed a 2006 Memorandum of Understanding for cooperation with European Athletics. In his conference introduction, European Athletics President Hansjörg Wirz presented an overview of the European Athletics strategy to use the values of athletics to engage young people and other target groups in the Sport under the slogan ‘Your Sport for Life’. Olympic gold medallist Lord Sebastian Coe, then gave the keynote speech. Coe, who is also a Vice President of the IAAF and the chairman of the London 2012 Olympic Games Organising Committee, described changes in youth culture in recent years, using the experience of his own children as examples. He said it was critical that the sport of athletics communicates with young people using new media. “Without youth, the rest of athletics is meaningless,” he said. “We, in Europe, need to develop a coherent, co-ordinated and global strategic approach to youth development.” Eight guest speakers gave the main presentations focusing on the three conference themes: “Engagement & Retention”, “Talent Identification & Development” and “Towards a European Strategy for Youth Athletics”. Brief summaries are presented in this report and all the presentations can be viewed at www.european-athletics.org.

With obesity levels rising, fitness levels declining and pressures on primary schools to look good in the latest media academic league tables, very few children and adolescents now possess the natural physical capacities to perform sporting tasks. Students entering high school now struggle to complete a jogged lap of an oval, throw and catch a ball or stand/hop on one leg. The purpose of this article is therefore to make peo-
people think about what they are doing to prepare and condition young athletes and look at keeping it simple, cheap and revisiting activities that were used in the past that can easily be incorporated in today’s environments. A particular emphasis of this article is on varieties of the squat exercise.

Nunn-Cearns, G.
Beginning coaching
Modern Athlete and Coach, Adelaide, 50 (2012), 1, pp. 7-9
According to the author, the following points should be taken into account by coaches working with young athletes: 1. Recruiting or searching for talented and interested athletes; 2. looking towards other sports because quite often athletics talents can be found for example in football or other explosive sports; 3. their own behaviour which should be a model for the athletes under their care; 4. the smooth integration of new athletes in the already existing training group, so that they feel comfortable; 5. measuring the performance capacity of new athletes so that they can be assigned to the correct performance group or can be loaded correctly; 6. frequent communication with the athletes’ parents and the recognition of their rights to be interested in their athlete and development; 7. to motivate the young athlete to stay in the sport; 8. to support the young athlete even when he/she turns to another sport or wants to end his/her career; 9. the permanent readiness to be critical of oneself and to expand his/her knowledge; 10. the readiness to be available even when things are getting tough.

Schiffer, J.
Children and youths athletics
Children’s and youths’ athletics is a very broad and diversified topic. The most important of its facets are covered in this bibliography, which is divided into the following chapters: The IAAF’s position on children’s and youths’ athletics; Publications dealing with talent selection, identification, and development in general and in specific countries; Publications dealing with the dropout problem; Publications dealing with the topic of early specialisation vs basic training in children’s and youths’ athletics in general and about strength training in particular; Publications about training aspects in children’s and youths’ athletics; Publications dealing with the physical and motor development of children and youths; Publications dealing with performance development aspects of children’s and youths’ athletics; Publications dealing with psychological aspects of children’s and youths’ athletics; Publications dealing with medical aspects of children’s and youths’ athletics.
there are a lot of textbooks on athletics available. However, most of these books deal with the individual athletics events or with group of events, as for example, distance running, the jumps, the throws, or the sprints and the hurdles. This is quite understandable, because track-and-field athletics is an extremely heterogeneous sport and the overlap between, for example, the discus throw and the middle-distance races is almost non-existent. Authors who are so competent to cover all athletics disciplines are very rare. That is why most of the few textbooks dealing with athletics as a whole are compilations of contributions from experts for the various events. This applies, for example, to the famous German textbook edited by Gerhardt Schmolinsky, Leichtathletik (10th ed., 1980) (in English: Track and Field, 2nd ed., 1983), or Grundlagen der Leichtathletik (5th ed., 1998) edited by Karl-Heinz Bauersfeld. In original English, a typical example of these kinds of books is the USA Track & Field Coaching Manual, coordinated by Joseph L. Rogers (2000). The only English book about the whole of track-and-field athletics by one author is, to my knowledge, Ken Doherty’s Track & Field Omnibook (5th ed., 2007).

Against this background, the all-encompassing book Leichtathletik: Trainings- und Bewegungswissenschaft – Theorie und Praxis aller Disziplinen (in English: “Track and Field Athletics: Training and Movement Science – Theory and Practice of all Disciplines”) deserves the highest attention because it includes the latest knowledge concerning all track-and-field disciplines presented in over 900 pages.

Who are the authors of this book? Professor Dr. Heiko K. Strüder is the Director of the Institute of Movement and Neurosciences at the German Sport University Cologne and is responsible for the training and movement
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science of individual sports. Ulrich Jonath is the retired head of teaching in the Athletics Department of the German Sport University in Cologne. He was also a lecturer at the Cologne Coaches’ Academy, National Coach of the German Athletics Federation (DLV), and coach instructor for the IAAF. He is the author of numerous athletics textbooks and instructional films. Kai Scholz is a sports teacher, certified A-level coach for the DLV, and teacher for athletics at the German Sport University in Cologne. Together, these authors make up a team that almost ideally represents both the scientific and practical aspects of athletics. It should also be mentioned that the following people were involved in the proofreading of the texts for the book: Prof. Dr. Wildor Hollmann, Dr. Axel Knicker, Dr. Wolfgang Ritzdorf, and Dr. Norbert Stein.

Their textbook is loosely based on the three textbooks about running (vol. 1), jumping (vol. 2), as well as throwing and the combined events (vol. 3) by Jonath, Krempel, Haag, and Müller published by Rowohlt in 1995. Since this three-volume textbook was recommended by the IAAF (although an English version was not available commercially) it became very popular even abroad.

However, the present book has almost no similarity with its distant predecessor. Progress and modern knowledge in the various fields of sports science has required an intensive revision and update of the contents. The result is a comprehensive textbook with a completely new design.

Modern athletics training is characterized by two factors: On the one hand, experiences and opinions and thus training methods and contents are passed from one successful generation of coaches on to the next generation. On the other hand, the current findings of sports science have a great influence on training. Both factors are closely interlinked and each factor has its own advantages and disadvantages. This book attempts to represent athletics in all its complexity and as a symbiotic interaction of training science and practice. As far as practical training is concerned, the individual coach’s intuition and know-how is as important as a sound scientific foundation. This new textbook bears testimony to this basic truth.

The book includes a general section that applies to all athletics events and deals with the following areas:
- Interdisciplinary aspects of athletics training;
- Motor forms of exertion (coordination, flexibility, speed-strength, speed, and endurance);
- Adaptation and performance ability (training and load organization, super-compensation and overload, overtraining syndrome, hierarchy and brain plasticity, the brain as a performance-limiting factor);
- Training control (target-value analysis, actual-value analysis and test/control methods, training planning, objectives, periodization phases, periodization models, model training plans for children’s athletics and basic training);
- Training methods (coordination training, flexibility training, strength training, speed training, endurance training);
- General training contents (preparation and loading, coordination: play and exercise forms, flexibility: exercise forms, strength: play and exercise forms, warm-down).

In the discipline-specific section, all Olympic disciplines of athletics are dealt with. In each case the respective discipline is introduced by an anecdotal and historical chapter. Then, the following aspects are covered:
- Competition rules;
- Findings from sports science, phase structure and technique;
- Summary of the most important technique characteristics and technique analysis sheet;
- Picture sequence;
- Tactics of the event;
- Didactics of the event;
- Training contents;
- Special test and control procedures;
- Faults, their causes and corrections;
- Training planning.

The latest findings from training practice are presented taking into account the available na-
In summary, this new and comprehensive German textbook of athletics is the most update book on this topic currently on the market. Therefore, it is a must for all people involved with and interested in athletics. Its only disadvantage is that at present it is only available in German. An English translation would be highly desirable.

Reviewed by Jürgen Schiffer

This new textbook is designed for coaches, physical education teachers, athletes and sports scientists. It is a useful handbook both for people who want to get an overview of athletics in general, and for advanced and specialized readers who want to deal with one discipline in detail.
Youth Sport – Crowdsourcing and Talentsourcing

Introduction

Long a fundamental activity for sports organisations from clubs to national federations, the identification, confirmation and development of talented athletes has recently become increasingly sophisticated and a strategic ‘hot topic’ in sport.

With many nations having relatively small talent pools and an ever-growing number of sports demanding attention and participants, there is an increasing need to make the best of exiting talent across sports through strategic talent ‘transfer’ initiatives or by adopting wider, broader and smarter ways of finding talent that may not reside in the various sports’ natural development or competition pathways.

Technology developments through social media crowdsourcing have the potential of providing novel ways that help identify individuals with the physical prerequisites and basic abilities for high-level performances in the future.

What is Crowdsourcing?

Crowdsourcing is a method of distributed problem solving. By distributing tasks to a large group of people you are able to mine collective intelligence. It is similar to the concepts introduced in the TV series known as ‘Who Wants to Be a Millionaire?’, where contestants have the opportunity to ask the audience on mass for the answer to a question (http://en.wikipedia.org/wiki/Who_Wants_to_Be_a_Millionaire%3F) they are unsure of. It is estimated that success rates when a question is posed to an audience exceed 90%.

Crowdsourcing is not a new concept – James Surowiecki wrote about the ideas in 2004 in a book called The Wisdom of Crowds. What has changed in the past five years has been the development of social media and technology platforms that make it possible to apply the concept on a national or international scale.

The technology has extended to business and industry where it is often used to raise funds to support new designs and products, e.g. www.kickstarter.com and numerous other applications (see http://www.crowdsourcing.org/). Big brands have used the concept to help canvass opinion and insight on their core products – recent examples include:

• Google used it to come up with a globally recognizable and famous Google Chrome icon.
• IBM’s 2006 “Innovation Jam” was attended by over 140,000 international participants and yielded around 46,000 ideas.

Crowdsourcing Sporting Talent

In sport, the St Louis Cardinals baseball club in the USA has successfully used its fans and network for some time to help with its recruitment campaigns (http://online.wsj.com/article_email/SB120485693123318577-IMyQjAxMDI4MDE0MzgxNTM2Wj.html).
The bringing together of talent concepts and crowdsourcing has recently come to the world of sport through a concept called ‘Create.it’ (www.create.it). It is described as talent identification content management software for the social enterprise and is increasingly being used for talent sourcing in sport. By putting out calls to the community in search of specific talent, the aim is that the community identifies and sources unearthed talent through extended networks.

The most recent examples are from the Canadian Ski Team, which sourced acrobats for some of its winter sports events; the USA ski team, which sourced tumblers for its aerial ski team; and Red Bull’s future surf camp, which unearthed talented individuals as part its extreme academy.

Within each of these campaigns, individuals can upload videos of various performers or their own performances and skills – the community can then vote and report on various videos based on skills they see. Collectively, the software tools behind the uploaded videos help to rate and rank the performers and prioritise those based on a collective view and expert opinion. It enables talent to be discovered based on the wisdom of the crowds.

**Would it Work for Athletics?**

With the ever-increasing focus of youth on technology it is essential for the sport of athletics to find more effective ways to reach out and use the international, national and local communities to find, source and attract talent. The concept of talentsourcing through a platform like Create.it could have value in this way. And it could help engage new fans by meeting the behaviours of Generation Y in a simple but interactive way.

Create.it gives federations the potential to work at local and national levels through schools and clubs across all sports with a focus on unearthing athletic talent. A federation could conduct a campaign in which kids themselves (or teachers, parents and friends) could be invited upload videos that demonstrate their ability or potential. These videos could be evaluated by experts who then advise on the best course of action for the sport to make contact and recruit those of particular interest.

Of course, such a campaign would have to be carefully planned. The required experts would have to be in place, and the arrangements to make contact, receive and develop the identified individuals would have to be made. But if these things can be organised, young athletic talent that would otherwise not be selected for the sport has a greater opportunity of coming into athletics before the attraction of other more easily accessible sports becomes a possibility.

The simplicity of integrating technology we use on an everyday basis could be appealing for national federations looking to expand their own scouting network beyond its traditional club and competition pathways.

There is an expectation that Create.it and other crowdsourcing concepts will grow and develop in the next decade and provide a low cost, rapidly accessible method for talent identification.

Be ready for it, keep it simple and grasp it before your competitors do!

Please note: the author has no involvement with any of the commercial companies or products mentioned in this report.

*Reported by Scott Drawer*

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Preview

Special Topic

Combined Events

including:

- NSA Roundtable including Harry Marra, Toni Minichiello and Jitka Vinduskova

NSA is translated into Chinese, French, Russian, Spanish and Arabic

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