Journal of Physical Education & Health, 2021, (18), 43-51

https://doi.org/10.5281/zenodo.6656626

AN ANALYSIS OF SPORTS CAREER DEVELOPMENT IN THE 400-METRE DASH

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Abstract

One of the indicators of an optimally conducted training process is the athlete's achievement of sports success in all age categories. The analysis of sports career development is helpful in determining the periods of maximizing and maintaining sports results, but also in choosing the development path leading to the achievement of top-level results at the senior age. The aim of the study was to assess the development of sports championship in the 400-metre dash, comprising sports careers of 400 m medalists of the World Cadet and Junior Championships and European Junior Championships in the most important sports events in the senior age category, namely the European Championships, World Athletics Indoor Championships, World Championships, and the Olympic Games. The analysis involved a group of 69 male and 69 female medalists of the European Junior Championships, 27 male and 27 female medalists of the World Youth Junior Championships as well as a group of 48 male and 48 female medalists of the World Junior Championships in the 400 m. The research revealed that from 4% to 7% of the World Cadet Championships medalists and 1-3% of the male and 4-6% of the female medalists of the European Junior Championships achieved their highest sports success by winning medals at the World Championships and the Olympic Games. 6% to 10% of the studied World Junior Championships male medalists were successful in the World Championships. Among the World Championships female medalists, 12% won medals at the World Athletics Indoor Championships, 6% won medals at the World Championships, and 2% won the Olympic Games medals.

Key words: *400 m, ontogenesis, sports career development*

Introduction

The analysis of sports career development is helpful in determining the periods of maximizing and maintaining sports results and achievements, but also in choosing the development path leading to top-level sport achievements at the senior age. Early puberty and puberty-related accelerated physical development, along with simultaneous sports training and its specialization commenced at an early age, lead to the development of athletes featuring a high sports level despite their young age. Experts point to an increasing tendency to lower the age at which the highest sports results are achieved in many sports and to shift the ranges of first success [1, 2]. According to Adamczyk and Sozański [3] young sports practitioners can be divided in terms of pace of their biological development into two groups, i.e. with an early and with a late onset of puberty. This creates the necessity for diversified training "philosophies". The authors divided the training approach in terms of two different training methods: progressive and intensive. The intensive training path is often chosen by coaches for athletes with the "early puberty" onset, and progressive training for "late puberty" athletes. Another type of career development concerns athletes characterized by a constant, progressive pace of sports development, the apogee of which is achieved at puberty. Usually, those athletes did not achieve any outstanding sports success in the younger age categories [4-7]. It is less beneficial when athletes whose biological development is

characterized by a slower puberty rate enter the path of intensive training. This may result in premature exploitation of the young athlete's body and thus in the inability to achieve success in sports that would be optimal for their talent at the senior age category. Those athletes very often finish their sports careers early. Two factors, i.e. the levels of talent and rational training, have a decisive influence on the full development of young persons' sports skills [8, 9]. Rational training should include, first of all, optimal training loads (average and submaximal), gradually increasing and in line with the principle of training individualization. This ensures optimal elicitation of young athletes' sports abilities in the course of their careers, and also protects athletes against overloads and sports injuries.

The high sports level of young champions is first of all the result of specialized training in the youngest age categories. Those who make further progress usually trained differently, based on a comprehensive and targeted preparation [5]. Youth sport should not be directed towards maximizing achievements in the youngest age categories. As a consequence, prematurely exploited young athletes are unable to make further progress, often sustain injures, and finally quit training. There are characteristic age ranges in which the percentage rates of stagnation of sports results and withdrawal from sports are at the highest level, also in the case of track-and-field athletes. At the age from 19 to 21 years, this concerns almost 65% of women and 52% of men [2]. An early commencement of physical activities will have a positive impact on the later sports career only when those activities aim at general development, fun, and are dominated by positive emotions [10, 11].

One of the indicators of an optimally conducted training process is the achievement of sports success in all age categories. According to Vaeyens et al. [12] less than a half (44%) of competitors of the 2004 Olympic Games in Athens had taken part in international junior competitions in their respective sport disciplines. Most of them (56%) debuted only in their senior years. Out of examined 387 athletes taking part at the 28th Olympic Games, 8% took up sport before the age of 8, 10% - between 9 to 10 years, 17% - between 11 and 12 years, 22% - between 13 and 14 years, and as many as 43% over the age of 15 years.

The 400 m is a particularly strenuous sports event that was first included in the track and field program at the Olympic Games in Athens in 1896. During the first modern Olympics only men were allowed to compete over the distance of one athletic lap. The demanding training and competition requirements for participants in this longest sprint race can be illustrated by the fact that this distance was included in the women's program only in 1964 during the 18th Summer Olympic Games in Tokyo, i.e. almost 100 years after its debut in men's competitions [13]. The final result in one-lap race around the track and field stadium is determined mainly by runners' exceptional anaerobic endurance predispositions, allowing them to continue the sprint race in conditions of significant muscle "acidification" [14, 15].

In athletics the analysis of career development of the World Championships, European Championships or the Olympic Games medalists in various age categories may be helpful in defining the optimal age for athletes' sports championship [3].

Until now the age range of 22 to 26 years has been considered to be the age of record attainments in sprint events [16]. According to Iskra et al. [17], the best time for men to start competing over the 400 m distance is the age range of 18 to 20 years. Karvonen [18], who studied athletes taking part in running competitions between 1947 and 1953 (n = 136) also arrived at similar conclusions. He proved that the optimal age for sports championship for 400- m runners was 24.5 ± 3.1 years. Competing over the distance of one lap around the athletic stadium can be continued at the world level by runners until the age of 29 years. According to research, after that age a regression of sports results can be observed.

Aim of the study

The aim of the study was to assess the sports career development of World Championships medalists in the youth (U18) and junior (U20) age categories and of

European Championships medalists in the junior age category in their later sports career based on their sports successes achieved in the U23 category and in senior age categories in the women's and men's 400 m dash.

Material

The further sports career development of medalists of World Cadet Championships (U18) held from 1999 to 2015, and of medalists of World Junior Championships (U20) held from 1986 to 2016 in the most important sports events in the senior age category, i.e. the World Championships and the Olympic Games, was subjected to a detailed analysis. The sports career development of medalists of the European Junior Championships (U20) between 1970 and 2015 as well as their subsequent results at the European Youth Championship (U23), European Championships, World Championships and Olympic Games in the women's and men's 400 m were also analyzed.

Table 1. Characteristics of 400-m medalists of the European Junior Championships

Sex	Number of athletes under study (n)	Periods under study (years)
Women	69	1970- 2015
Men	69	1970- 2015

Table 2. Characteristics of 400 m medalists of the World Cadet and Junior Championships

Sex	Age category	Athletes under study (n)	The years of World Championships for the appropriate age category
Women	Cadets (U18)	27	1999 - 2015
	Juniors (U20)	48	1986 - 2016
Men	Cadets (U18)	27	1999 - 2015
	Juniors (U20)	48	1986 - 2016

To analyze the careers of the best male and female 400-m sprinters from Europe and other continents a database was created using the data from the International Athletics Federation (https://www.iaaf.org) and the EAA website (www.european-athletics.org). The missing data were supplemented using an online archive and data collected in athletic statistical publications, e.g. ATFS (Association of Track and Field Statisticians) yearbooks by Matthews [19] (1985-2016), and Butler [20].

Methods

While examining the course and development of sports careers of European and the world top 400 m competitors in the cadet and junior age categories, the authors took into account their sports achievements in the most important events of the senior age category based on an analysis of individual cases. The assessment of sports championship development in the 400-metre dash focused on the sports career development of the medalists of World Cadet Championships (U18) between 1999 to 2015 and of World Junior Championships (U20) between 1986 to 2016 in the most important sports events in the senior age category, i.e. the World Championships and the Olympic Games. The sports career development of medalists of the European Junior Championships (U20) from the years 1970-2015 as well as their subsequent successes at the European Youth Championships (U23) and the Senior European Championships were also analyzed.

Results

Athletes' age is of indisputable importance in determining the model of sports championship. The modelling methods result in most cases from the analysis of changes in the sports results level of the best, most successful athletes in a given sport or sports event. In this study the further sports careers of the World Championship medalists in the youth junior age category (Table 4) and the medalists of the European Championships (Table 3) and World Championships (Table 5) in the junior age category were analyzed. In each of the groups, the sports careers of women and men in the 400 m race were considered.

Table 3. The results of medalists of the European Junior Championships (EJC) in the 400 m during the European Youth Championships (EYC), European Athletics Indoor Championships (EAJC), European Championships (EC), World Athletics Indoor Championships (WAIC), World Championships (WC), and Olympic Games (OG)

Sex	Sports event	Athletes (medalists of European Junior Championships) taking part in the given sports event n/% of all medalists	Finalists n/%	Medalists n/%
Women	EYC	-	-	7/21%*
	EAJC	-	-	5/7%
	EC	-	-	9/13%
	WAIC	13/19%	5/7%	4/6%
	WC	18/26%	6/9%	4/6%
	OG	9/13%	6/9%	3/4%
Men	EYC	-	-	7/21%*
	EAJC	-	-	21/30%
	EC	-	-	16/23%
	WAIC	12/17%	4/6%	1/1%
	WC	12/17%	6/9%	2/3%
	OG	7/10%	5/ 7%	2/3%

* The European Youth Championships (EYC) have been held since 1997 thus only 33 male and 33 female athletes - medalists of the European Junior Championship - had a chance to participate in them.

The results of the research on sports career development of the Women's' and Men's European Junior Championships medalists in the 400 m indicate that a large part of the examined athletes won medals in the European championships in the older age categories. 21% of the female and male athletes taking part in the European Junior Championships since 1995 have won medals in the European Youth Championships held since 1997. 30% of the analyzed male athletes won subsequently medals at the European Championships, and 23% of them won medals at the European Championships in their later sports careers. Among the examined female runners that percentage was much lower. 7% of the medalists of the European Junior Championships in the 400 m won medals at the European Athletics Indoor Championships and 13% won medals at the European Championships.

A different trend was observed among the respondents when analyzing their participation and successes during the most important worldwide sports events. 13% of women and 10% of men after winning medals at the European Junior Championships qualified for the most important sports event in the senior age category, namely the Olympic Games. 9% of the female and 7% of the male athletes qualified for the Olympic finals. 4% (women) and 3% (men) won the Olympic medals. 6% of the female 400 m runners won medals at the World Senior Championships indoors and outdoors after their successes at the European Junior Championships. In the later course of their sports careers, 3% of the examined men won medals at the World Championships and 1% won medals at the World Athletics Indoor Championships. In terms of the number of participants, among the finalists and medalists of the most important international sports events (WAIC, WC, OG) in the group of the European Junior Championships medalists, the men achieved the highest sports results more often in the European-level competition, while the women more often than men participated in the world-level competitions and won medals at the World Championships and the Olympic Games.

Table 4. The results of 400-m medalists of the European Cadet Championships (EJC) at the European Youth Championships (EYC), European Athletics Indoor Championships (EAJC), European Championships (EC), World Athletics Indoor Championships (WAIC), World Championships (WC) and Olympic Games (OG).

Sex	Sports event	Athletes (medalists of World Youth Junior Championships) taking part in the given sports event n/% of all medalists	Finalists n/%	Medalists n/%
Women	WJC	17/63%	12/44%	9/33%
	WAIC	2/7%	2/7%	2/7%
	WC	8/30%	4/15%	2/7%
	OG	5/18%	2/7%	1/4%
Men	WJC	15/55%	7/26%	4/15%
	WAIC	2/7%	2/7%	-
	WC	8/30%	2/7%	1/4%
	OG	6/22%	3/11%	1/4%

The analysis of the later course of sports career of medalists of the World Youth Junior Championships (cadets) showed that as many as 55% of the male and 63% of female medalists of the World Youth Championships participated in the World Junior Championships (U20). 33% of the examined female and 15% of the examined male medalists of the World Youth Junior Championships won medals during the most important sports events in the junior age category. 30% of the examined female and male athletes participated in the World Senior Championships, whereas 18% of the male and 22% of female medalists of the World Youth Junior Championships participated in the Olympic Games. Medals at the World Senior Championships were won by two women, i.e. 7% of the studied female athletes, while an Olympic medal was won only by one female athlete. Among the men, two World Championships medals and two Olympic medals were won by Kirani James from Grenada, which is absolutely unique compared to the other examined athletes. Kirani James also won two medals at the World Youth Junior Championships, thus also being qualified as a medalist of the World Junior Championships.

Table 5. The results of the World Youth Junior Championships medalists in the 400 m at the World Athletics Indoor Championships (WAIC), World Championships (WC) and Olympic Games (OG)

Sex	Sports event	Athletes (medalists of World Junior Championships) taking part in the given sports event n/% of all medalists	Finalists n/%	Medalists n/%
Women	WAIC	14/29%	10/21%	6/12%
	WC	23/48%	9/19%	3/6%
	OG	14/29%	8/17%	1/2%
Men	WAIC	11/23%	4/8%	4/8%
	WC	18/37%	10/21%	5/10%
	OG	18/37%	11/23%	3/6%

The analysis of the sports career development of male and female World Junior Championships medalists revealed that 29% of the studied female athletes and 23% of male World Junior Championships medalists participated in the World Athletics Indoor Championships (WAIC) in the senior age category, with 12% of female and 8% of male athletes winning the medals. On the other hand, 48% of female and 37% of male World Junior Championships medalists participated in the World Seniors Championships (WC). At those events, medals were won by 6% of the male and 10% of female athletes, respectively. 29% of female and 37% of male World Junior Championships medalists participated in the most important sports event in the senior age category, i.e. the Olympic Games. Only Shaunae Miller and LeShawn Merritt, Kirani James and Luguelin Santosz won the Olympic medals, which constitutes 2% of the studied female and 6% of male 400-m World Junior Championships medalists, respectively. Apart from the already mentioned winner of two World Championships medals and two Olympic medals, i.e. Kirani James, among the

examined 400-m World Junior Championships medalists, LeShawn Merritt won five World Championships medals and two Olympic medals.

Discussion

An accurate selection of training parameters according to athletes' needs and biological capabilities is a guarantee of harmonious development of athletes' fitness, health, and motor skills, i.e. the basis for subsequent sports success [21]. A well-chosen training approach according to the needs and capabilities of a young athlete leads to the attainment of record sports results in the senior age category. Moreover, the ability to maintain a worked-out, high sports level for a long time is also of key significance. In this approach, specialized training is implemented in stages, after the completion of general preparation [5, 22]. A premature commencement of training specialization (from the earliest years of the athlete's sports career) and maximization of training parameters can seriously inhibit the progress of sports results. It can lead to an excessive exploitation of the athlete's body, and result in frequent injuries, training absence, and, consequently, in the early end of professional sport [23, 24]. According to Hopkins [25], athletes who begin specialized training at a young age may have a greater chance of achieving top results at an earlier age than their peers who begin their specialization a little later. The study results show an annual improvement of 0.1-0.3% in most athletic events, when athletes underwent specialist training as early as at the age of 20 years. Therefore, in order to become a world-class athlete (top 100) in the senior age category, young athletes must be at a very high level already in their late teenage years. These conclusions, however, contradict the reports by Iskra [26], Iskra et al. [27], Walaszczyk and Szade [28] and Hanley [29].

The analysis of results regarding the age of sprinters by Iskra [26] did not show a statistically significant impact of the results in the cadet (U18) and junior (U20) age categories in relation to their subsequent record achievements. This confirms the assumption that taking up training and sports specialization too early does not promise the achievement of sports championship [26]. Iskra et al. [27] traced the further sports career development of the European Championships finalists in the junior age category in the years 1966 - 2000 in the later senior age category in the years 1969 - 2006, and found the successful continuation of sports careers of the most talented juniors in hurdles over the distance of 110/100 and 400 m only in 9-10% of men and 4-6% of women in the senior age category.

The above research can be supplemented by an analysis of career development of European Junior Championships medalists in the senior age category conducted by Walaszczyk and Szade [28]. They noted that more than a half (54%) of European Junior Championships medalists achieved results at a high world level in the senior age category. Furthermore, every fourth male junior and only 15% of female juniors after winning medals at the European Junior Championships qualified for the European Championships finals in the senior age category. Sprint events in which juniors are the least successful in the senior category were the 200 m and 400 m hurdles.

Table 6. Participants of the European Youth Championships in sprint events taking part in the World Seniors Championships and the Olympic Games, and the time between the compared sports events

	Women				Men			
	EYC Participants (n)	WC and OG participants (years)	%	Waiting time (years)	EYC Participants (n)	WC and OG participants (n)	%	Waiting time (years)
100 m	171	43	25	0.9	184	40	22	1.3
200 m	144	48	33	0.9	169	48	28	0.6
400 m	145	37	26	2.2	173	39	23	1.7

Hanley [29] analyzed the further sports development of sprinters competing in eight editions of the U23 European Athletics Championships from 1999 to 2013, during eight World Championships and four Olympic Games from 1999 to 2013. In total, Hanley

studied 986 careers of sprinters (460 women and 526 men) participating in the European Youth Championships. The study revealed that from 22% to 33% (Table 6) of European Youth Championships participants in the period from 1999 to 2013 competed later in championship events (World Championships or Olympic Games) in the senior age category. The time athletes in the junior age category needed to participate in one of the two most important worldwide senior events ranged from 0.6 to 2.2 years. This range refers to the average time between participation in the U23 European Championship and in a worldwide event.

Table 7. Participants of the European Youth Championships in sprint events taking part in the final races at the World Seniors Championship and the time between the compared sports events

	Women			**Men**		
	WC finalists	Waiting time (years)	WC medals 1/2/3	WC finalists	Waiting time (years)	WC medals 1/2/3
100 m	6	3.8	1/0/0	3	2.3	0/0/0
200 m	6	4.5	0/0/1	6	2.9	0/0/0
400 m	6	4.2	3/1/1	6	2.8	1/3/2

Among the athletes studied by Hanley, only 15 male and 18 female sprinters, after participating in the EYC, became the World Championships finalists in the senior age category, winning 6 medals (men) and 6 medals (women). 6 out of 11 medals won by 400 m runners were won during the World Seniors Championships in 800 m.

Iskra et al. [27], Walaszczyk and Szade [28], and Hanley [29] suggest that only outstanding individuals are able to continue their sports careers from the junior to the senior age and achieve high sports results. Such abilities are based on the implementation of an appropriate training program and selection of training parameters appropriate to the intensive or progressive pace of a young athlete's sports development.

The above analyses of sports careers development coincide with the results of the sports championship development of medalists of the European Junior Championships, World Cadet and Junior Championships in the 400-m dash.

Only 4 to 7% of the World Cadet Championships medalists, 1-3% of male medalists of the European Junior Championships (EJC), and 4-6% of the European Junior Championships female medalists achieved the highest sports success in the world championships (WAIC, WC, OG), winning medals at those sports events in the senior age category.

Considering the World Junior Championships medalists in the 400 m race and their subsequent sports achievements, it can be noticed that from 6 to 10% of the examined men were successful in the World Championships. Among the female medalists of the World Junior Championships, 12% won medals at the World Championships, 6% at the World Athletics Indoor Championships, and 2% at the Olympic Games.

Conclusions

One of the indicators of an optimally conducted training process is the athlete's achievement of sports success in all age categories. The analysis of sports career development is helpful in determining the periods of maximizing and maintaining high sports results, but also in choosing the development path to the apogee of sports performance at the senior's age. The aim of the study was to evaluate the development of sports championship in the 400 m, which included the course of the sports career of medalists of the World Cadet and Junior Championships and the European Junior Championships in the most important sports events in the senior age category, namely the European Championships, World Athletics Indoor Championships, World Championships and Olympic Games. The analysis involved a group of 69 male and 69 female medalists of the European Junior Championships, 27 male and 27 female medalists of the World Youth Junior Championships, and a group of 48 male and 48 female medalists of the World Junior Championships in the 400-m dash. The research

revealed that 4% to 7% of the medalists of the World Cadet Championships, 1-3% of the male and 4-6% of the female medalists of the European Junior Championships, achieved the highest sports success by winning medals at the World Championships and the Olympic Games. 6% to 10% of the examined World Junior Championships male medalists were successful in the World Championships. Among the female medalists at the World Championships, 12% won medals at the World Athletics Indoor Championships, 6% at the World Championships, and 2% at the Olympic Games.

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Received: October 2021
Accepted: November 2021
Published: December 2021

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