

IS SUCCESS AT THE WORLD JUNIOR ATHLETICS CHAMPIONSHIPS A PREREQUISITE FOR SUCCESS AT WORLD SENIOR CHAMPIONSHIPS OR OLYMPIC GAMES? – PROSPECTIVE AND RETROSPECTIVE ANALYSES.

Abstract

Whether success at a World Junior Athletics Championships is a prerequisite for success as an Elite Senior is debated. In this study we analysed (a) Elite Senior athletes tracked retrospectively to when they were Elite Junior athletes, and (b) Junior Medalists tracked prospectively to when they competed at global competitions or otherwise. Retrospective analysis showed that of the 137 world senior gold medalists who had competed at a World Junior Championships previously, 80% had been either a World Junior Championships medalist or finalist. Of Olympic gold medalists from 1992 – 2008 who were Elite Juniors, 90% of them had been a Junior Medalist or a Junior Finalist and from the 2008 Beijing Olympic Games medalists, 82% of the Elite Juniors had been a Junior Medalist or Junior Finalist. The retrospective analysis supports the notion that having success as a Junior Medalist or Junior Finalist is a prerequisite for success as a senior athlete at a global championship. A contrasting picture emerges from the prospective study with only 34% of Junior Medalists going on to be a Global Medalist or a Global Finalist, whilst a further 12% became just a Global Competitor. Over a half (54%) of Junior Medalists (1986 – 2004) did not go on to be a Global Competitor.

Five countries, (USA, Kenya, China, Germany, and Russia) produced the most individual Junior Medalists, 1986 – 2004, but had both a conversion rate (the sum of the Global Medalists and Global Finalists as a percentage of the total number of Junior Medalist from that country) that was lower than the mean, and a higher than the mean attrition rate (the percentage of Junior Medalist from each country who did not compete at a subsequent global competition), of the 22 countries analysed, suggesting that their senior global success is not due to their Junior Competitors' making a successful transition to the senior ranks. Conversely, nine other countries had both a better than the mean conversion rate and a lower than the mean attrition rate, suggesting that their senior global success could, in the main, be attributed to a successful transition of their Junior Competitors.

We discuss the implications for maximising the conversion of junior talents to senior performers and reducing attrition and make suggestions for further research.

Definitions

In the context of this paper the following definitions and terms apply:

- Medalist:** Gold, silver or bronze (i.e., 1st, 2nd, 3rd place) medal in a competition.
- Finalist:** An athlete who qualified for a final at the competition; normally top 8 for a laned event, top 12 for all other events.
- Competitor:** A competitor who did not make a final or win a medal.
- Global:** World Championships (Senior), outdoor or indoor, held every two years or Olympic Games, held every four years.
- Elite:** A Global Medalist or Global Finalist or Global Competitor.

Senior: Open-age competition.
Junior: An athlete at the World Junior Championships.
Transition time: The number of years between an athlete first becoming a Junior Medalist or Junior Finalist and becoming, for the first time, a Global Medalist or Global Finalist.

Introduction

There is debate as to whether success at a World Junior Athletics Championships is a prerequisite for success as a senior athlete at the global level (Hollings, 2006). The discussion of the transition from Elite Junior to Elite Senior athlete by coaches of junior athletes is usually based on anecdotal evidence; however there have been several analyses of international data reported in the literature (see Table 1). Previous studies have attempted to describe the extent and magnitude of the transition from Elite Junior to Elite Senior athlete from both a prospective and a retrospective viewpoint. A limitation of prospective studies has been that athlete career data for athletes from earlier editions of the World Junior Championships are incomplete, and as more than 12,500 athletes have competed in the past 11 editions of the World Junior Championships from 1986 – 2006, tracking all athletes has proved difficult given athletes changing circumstances (e.g. name changes due to marriage, change of country, loss of contact with the national federation, and perhaps the greatest factor, dropping out of the sport). Prospective studies have focussed on small, selected groups of junior athletes (e.g. throwers, or just one gender) and do not give a truly authoritative account of the transition. Retrospective studies have focussed mainly on Global Medalists and Global Finalists, by ascertaining their performances when they were juniors; however data for junior performances have often not been available.

A mainly descriptive study by Zelichenok (2005) identified four groups with analogous career patterns. The first group comprised athletes (an indicative selection of names only was provided) whose careers could be defined as ideal: they all won either European or World Junior Championships and then went on to become Global Medalists or Global Finalists. The second group comprised athletes who did not win a major junior championship but did play a prominent role at that level (finalist or minor medalist) and later became bright stars in the world of athletics. The third group were athletes who did not achieve notable success as an Elite Junior but eventually became an Elite Senior. The fourth group of athletes were dominant as juniors and then either disappeared or became athletes of an average level.

Zelichenok (2005) commented that “with regret that this list is very long” and indicated that his analysis of the results of the World Junior Championships showed that 60-70% of the Junior Medalists and Junior Finalists did not go on to achieve any serious success at the senior level.

In order to lift the debate as to whether success as an Elite Junior is a prerequisite to success as an Elite Senior athlete from an exchange of statements of uncorroborated opinion, which are, in the main, based on anecdotal individual case studies, it is essential that supporting empirical data be analysed and produced. We chose to analyse the issue of the transition from two perspectives as previous studies involving either a retrospective approach or a prospective approach had produced somewhat differing perspectives of the issue.

Many developed athletics nations have Elite Junior development programmes where the aim is to identify and develop talent. The success or otherwise of these programmes is whether they produce Elite Junior athletes who succeed on the Junior world stage. All of these countries also have a high performance programme or equivalent that is focussed at achieving success of senior athletes on the global stage. The successful transition of athletes from the junior development programme to the high performance programme is vital if senior success is desired. One measure of the success of the transition for a country would be to determine how many of their Elite Juniors go on to become Elite Seniors.

Table 1: Studies that have evaluated transition from junior to senior athletics performances.

Study	Approach	Results
Julin (1995)	Prospective n=98 medalists (1 st – 3 rd) 1989 European Junior Championships (EJC) → 1994 European Senior Championships (ESC)	(a) 7/98 (7%) EJC athletes won a medal at ESC. (b) 7/98 (7%) EJC athletes were finalists at ESC. (c) 16/98 (16%) EJC athletes competed but did not perform as well as a finalist at ESC. (d) 68/98 (68%) EJC athletes did not compete at ESC.
	Retrospective n=36 gold medal winners 1994 European Senior Championships (ESC) → prior European Junior Championships (EJC) and prior World Junior Championships (WJC)	(a) 24/36 (66%) had competed at a previous EJC or previous WJC. (b) 14/36 (38%) had been a medalist at a previous EJC or previous WJC.
Otte (2002)	Prospective n=853 male finalists	(a) 546/853 (64%) WJC finalists showed further performance

	1986-1996 World Junior Championships (WJC) → World Championships (WC) or Olympic Games (OG)	improvements. (b) 222/853 (26%) WJC finalists reached finals at subsequent WC or OG.
Zelichenok (2005)	Retrospective n=~1500 "top" athletes (1986 -2005) → 1986-2000 World Junior Championships (WJC)	(a) 75 (42 Men, 33 Women) OG gold medalists 1986-2004 had taken part at a previous WJC.
	Prospective 1986 – 2000 World Junior Championships → senior athlete	(a) ~ 60-70% of medalists at WJC did not go on to achieve any serious success at the senior level.
Scholz (2006)	Retrospective n= (selected global gold medalists only) Throwing events 1991-2003 global competitions → 1986-2002 World Junior Championships (WJC)	(a) 18 (8 Men, 10 Women) world and Olympic champions in throwing events 1991-2003 had previously participated at a WJC. (b) 5 of the top-8 place-getters (62%) in the men's shot put at the 2003 World Championships had been a medalist at a World Junior Championships.
	Prospective n=7 (selected medal winners only) Throwing events 1986 – 2002 World Junior Championships (WJC) winners → 1991-2003 global competitions	(a) 7 (4 Men, 3 Women) World Junior Championships winners went on to become world or Olympic champions.
Grund & Ritzdorf (2006)	Prospective n=266 finalists 1999 World Youth Championships (WYC) → 2006	(a) 240/266 (90%) of 1999 World Youth finalists continued to improve in subsequent years. (b) 234/266 (88%) of 1999 World Youth finalists made world top 100 ranked performances of the year in their event. (c) 55/266 (21%) 1999 World Youth finalists qualified for World Championships or Olympic Games 2000-2004.
Hollings (2010)	Retrospective n=121 2008 Beijing Olympic Games (Beijing OG) medalists → prior World Junior Championships (WJC)	(a) 57/121 (47%) Beijing OG medalists had previously competed at a WJC. (b) 35/57 (61%) Beijing OG medalists had won a medal at a WJC. (c) 12/57 (21%) Beijing OG medalists were a finalist at a WJC.

(A) Elite Senior athletes tracked retrospectively to when they were Elite Junior athletes

Our study retrospectively traced the performances of Elite Senior athletes back to the time they were Elite Juniors. We selected Olympic Champions, World Champions and Beijing Olympic medalists as the cohort.

Methods

Data extraction

Biographical data and competition performance results throughout their athletics career were obtained for 275 athletes who were either World champions (gold medalists) between 1987 – 2007 (n=137) (identified from web-based databases and athletics statistical pages - (Tilastopaja, 2010)), an Olympic champion (gold medalist) between 1988 – 2004 (n=81) (identified from (IAAF, 2010)) or a Beijing 2008 Olympic medalist (1st – 3rd) (n=57) (identified from games organisers' website - (IAAF, 2008)). Athletes performances were tracked retrospectively for competition results from World Junior Championships during 1986-2006 (identified from official handbooks) (Butler, 2006, 2008).

The percentages of performance outcomes (medalists, finalists or non-finalist competitors) at previous World Junior Championships (1986-2006) for world champions (1987-2007), Olympic champions (1988-2004) and Beijing 2008 Olympic medalists were calculated using Excel.

Results

The percentages of performance outcomes (medalists, finalists or non-finalist competitors) at previous World Junior Championships (1986-2006) for world champions (1987-2007), Olympic champions (1988-2004) and Beijing 2008 Olympic medalists (see Table 2) showed that the higher the level of achievement (medalist – finalist – competitor) at a WJC translated to the highest level of achievement at the global level.

Of 137 world champions (gold medal in an individual event at a World Athletics Championship) who had previously competed at a World Junior Championships, 80% were Junior Medalists or Junior Finalists.

Eighty-one Olympic Games athletics gold medalists from 1992 – 2004 had previously competed at a World Junior Championships; 90% were Junior Medalists or Junior Finalists.

Of the 121 unique 2008 Beijing Olympic track and field medalists, 57 (47%) had competed at a prior WJC. Of these 57 athletes, 47 (82%) were Junior Medalists or Junior Finalists.

World Senior Champions, Olympic Champions and 2008 Beijing Olympic medalists who did not compete at a prior World Junior Championships

Approximately one-half of all World champions, Olympic champions and Beijing Olympic medalists did not compete at a prior WJC. Of the 269 unique world senior champions between 1995 and 2007, 131 (49%) did not compete at a prior WJC. Of the 121 unique Olympic champions at the 2000, 2004 and 2008 Olympic Games, 66 (54%) did not participate at a prior World Junior Championships, Of the Beijing Olympic medalists, 52% did not compete at a prior WJC.

Table 2. Percentage of performance outcomes (medalists, finalists or non-finalist competitors) at previous World Junior Championships (1986-2006) for world champions (1987-2007), Olympic champions (1988-2004) and Beijing 2008 Olympic medalists.

		Outcomes at previous World Junior Championships 1986-2006
World champions (gold medalists) 1987-2007	n=137	55% JM; 75 25% JF; 34 20% JC; 28
Olympic champions (gold medalists) 1988- 2004	n=81	64% JM; 52 26% JF; 21 10% JC; 8
Beijing 2008 Olympic medalists (1 st -3 rd)	n=57	61% JM; 35 21% JF; 12 18% JC; 10

JM = Junior medalists
 JF = Junior finalists
 JC = Junior non-finalist competitors

(B) Junior Medalists tracked prospectively to when they competed at global competitions or otherwise

In this study we prospectively followed all Junior Medalists (1986 – 2004) through to global performances or otherwise. We also determined which countries had a high “conversion” rate (the sum of the Global Medalists and Global Finalists as

a percentage of the total number of Junior Medalist from that country), together with their “attrition” rate (the percentage of Junior Medalists from each country who did not compete at a subsequent global competition).

Methods

Data extraction

Biographical data and competition performance results of Junior Medalists (1986 – 2004) were identified from the official handbook (Butler, 2006). Their achievements at the global championships or otherwise were identified from a web-based database (Tilastopja OY 2010) and athletics statistical page (IAAF 2010). We used the same data sources to collect the information on each athlete’s country of representation. We tracked only the athletes who had won individual medals at the World Junior Championships 1986 – 2004. Although data are available for the two subsequent editions of the World Junior Championships (2006 and 2008), the time span between these championships and the present time may be too short to allow Junior Medalists to demonstrate their abilities at the global level. Julin (1995) in a study of the transition between the European Junior Championships and the European (senior) Championships used a separation of five years between the two competitions, assuming that the former junior athletes would have established themselves in the senior ranks by this time “if they were ever going to.”

Data statistical analysis

For the Junior Medalists progressing to Elite Senior we categorised subsequent achievement in ranking order as: 1. Global Medalist; 2. Global Finalist; 3. Global Competitor; 4. Did not compete at a world championships or Olympic Games. Junior Medalists winning more than one medal at the same, or more than one, World Junior Championships were recorded as one individual medalist. Only athletes who won a medal in an individual event (i.e., excluding relays) were recorded.

We tabled the countries (n=22) that had produced, in total, more than 10 individual Junior Medalists over the 10 editions of the World Junior Championships (1986 – 2004) and calculated the “conversion rate” and “attrition rate’.

Results

Of the 1,054 individual Junior Medalists (1986 – 2004), 225 (21%) went on to become Global Medalists, a further 13% went on to be Global Finalists, whilst a further 12% were Global Competitors. Slightly more than half (54%) of the Junior Medalists, did not compete as an Elite Senior (Table 3).

The mean conversion rate of the 22 countries that had more than 10 athletes who were Junior Medalists, was 35%, whilst the mean attrition rate was 53% (Table 4). Countries that had a higher than the mean conversion rate were Morocco, Spain, Cuba, Ethiopia Jamaica, Belarus, Australia, South Africa, Bulgaria, Nigeria, Kenya, and Great Britain. Countries that had a higher than the mean attrition rate were Japan, France, USA, Italy, Romania, Germany, China, Belarus, Kenya, Russia, Finland, and Bulgaria. Countries that had both a better than the mean conversion rate and a lower than the mean attrition rate were Australia, Cuba, Ethiopia, Great Britain, Jamaica, Morocco, Nigeria, South Africa, and Spain.

The five countries, (USA, Kenya, China, Germany, and Russia) that produced the most individual Junior Medalists, 1986 – 2004, had both a conversion rate that was lower than the mean, and a higher than the mean attrition rate, of the 22 countries analysed.

Table 3. Frequency of Junior Medalists 1986- 2004, who went on to become Senior Global Medalists, Global Finalists, Global Competitors or did not compete further.

	No. of Medalists at World Junior Championships	Global			Did not compete at a Global event
		Medalist	Finalist	Competitor	
Men					
1986 Athens, GRE	61	13	6	2	40
1988 Sudbury, CAN	63	19	8	2	34
1990 Plovdiv, BUL	59	16	2	8	33
1992 Seoul, KOR	47	12	3	6	26
1994 Lisbon, POR	61	12	8	10	31
1996 Sydney, AUS	57	14	13	8	22
1998 Annecy, FRA	58	12	13	9	24
2000 Santiago, CHI	58	11	12	11	24
2002 Kingston, JAM	57	8	6	15	28
2004 Grosseto, ITA	57	11	5	11	30
Total Men	578	128 22%	76 13%	82 14%	292 51%
Women					
1986 Athens, GRE	47	13	1	3	30
1988 Sudbury, CAN	38	7	6	2	23
1990 Plovdiv, BUL	46	8	5	4	29
1992 Seoul, KOR	43	11	2	3	27
1994 Lisbon, POR	46	11	5	6	24
1996 Sydney, AUS	45	6	13	3	23
1998 Annecy, FRA	55	10	5	4	36
2000 Santiago, CHI	51	13	5	5	28
2002 Kingston, JAM	47	13	8	10	16
2004 Grosseto, ITA	58	5	8	7	38
Total Women	476	97 21%	58 12%	47 10%	274 57%
Total (M & W)	1054	225 21%	134 13%	129 12%	566 54%

Table 4. Frequency, by country of Junior Medalists 1986 - 2004, who went on to become a Global Medalist, Global Finalist, Global Competitor or did not compete at a global competition.

Country	Individual Medals at World Junior Championships (1986-2004)	Global Medalists	Global Finalists	Global Competitor	Conversion rate to Global Medalist or Global Finalist	Did not compete at a Global Competition	Attrition rate of Junior Medalists
USA	85	15	5	9	22%	57	67%
Kenya	76	17	10	6	35%	43	56%
China	62	8	7	8	24%	39	60%
Germany (from 1992)	46	5	7	6	26%	28	61%
Russia (from 1994)	45	9	6	5	33%	25	55%
Cuba	42	13	9	3	52%	17	40%
Ethiopia	37	16	2	1	48%	18	48%
Australia	35	6	8	8	40%	13	37%
Romania	34	5	6	2	32%	21	61%
Great Britain	28	7	3	4	35%	14	50%
South Africa (from 1992)	20	6	2	3	40%	9	45%
Finland	20	1	5	3	30%	11	55%
Jamaica	19	5	3	2	42%	9	47%
Spain	17	4	5	2	53%	6	35%
Poland	17	2	3	3	29%	9	52%
Nigeria	16	4	2	5	37%	5	31%
Japan	15	1	1	0	13%	13	86%
France	13	2	1	1	23%	9	69%
Bulgaria	13	1	4	1	38%	7	53%
Belarus (from 1994)	12	4	1	0	42%	7	58%
Morocco	12	6	1	0	58%	5	41%
Italy	11	2	0	2	18%	7	63%

BOLD: Conversion rate of Junior Medalists from these countries to Global Medalists and Global Finalists is higher than the mean (35%) of the 22 countries
Attrition rate of Junior Medalists from these countries is higher than the mean (53%) of the 22 countries.

Years to make the transition

Transition time from first becoming a Junior Medalist or Junior Finalist to becoming a Global Medalist or Global Finalist ranged from 1-11 years with a mean of 4.1 SD \pm 2.8 years for the men. The women had a longer transition time with a range of one to 13 years (mean 7.8 \pm 3.7 y). The analysis also shows that a large majority of the Junior Medalists and Junior Finalists stayed near to or at the top of their event for a further 10 to 15 years.

Discussion

This study focussed on competition performance aspects of the transition from an Elite Junior athlete to an Elite Senior athlete. We acknowledge that there are many other factors, e.g. social, psychological, economic, educational, career and sport political issues, that we did not consider that influence or determine whether the transition will be successful or otherwise.

Many national athletics federations and coaches who deal with the high performance aspects of sport are unquestioned in that the goal for their athletes should be to achieve their peak performances in adulthood rather than in late adolescence. National athletics federations have, in the main, invested considerable amounts of time and other resources, including financial, into junior athletes with the expectation that there would be a return on these investments when these athletes became senior athletes. Notwithstanding, many national athletics federations see the World Junior Championships as an obligatory stepping-stone in the preparation of senior level performers, being of the belief that Elite Junior athletes naturally translate to Elite Senior athletes. There is the conviction that these high achievers at the World Junior Championships will automatically follow the same pathway as previous other junior high achievers and become a force on the global stage as a senior. Our analysis showed that this assumption is flawed. A subsequent study of ours showed that over 50% of New Zealand and Australian Junior Medalists and Junior Finalists did not go on to represent their country at the senior level. Zelichenok's estimate of 70% of all Junior Medalists and Junior Finalists, who did not go on to be Elite Seniors was similar to our 54% of Junior Medalists alone who did not compete at a subsequent global championships. There must be concern therefore, amongst athletics federations, at the high attrition rate of these proven Elite Junior athletes.

The difference between competing in a junior category and competing as a senior is markedly different. An Elite Junior means that they are among the very best of those of the same age. In the case of a “junior age group” in athletics, this extends over a two-year period. Competing as a senior or open age athlete means that an athlete is competing against the very best in a 10 to 16 year age window. Put another way, this means when competing as a senior athlete they compete against the best athletes from 5 to 8 cumulative junior age groups. Consequently, an athlete can be more evident as an Elite Junior, than as an Elite Senior.

The analysis, when looked at retrospectively of how Elite Senior athletes performed as juniors, would support the notion that having success as a Junior Medalist or Junior Finalist is a prerequisite for success as a senior athlete at a global championship. However, when the analysis is undertaken prospectively, i.e., what happens to Elite Junior athletes when they become senior athletes, a contrasting description of the transition emerges.

Elite Seniors as Elite Juniors

We showed that over 70% of gold medalists at global competitions who previously competed at a World Junior Championships achieved high level performances as a junior athlete by virtue of being a Junior Medalist or Junior Finalist. However, the career achievements at the senior level are not solely dependent on being a Junior Medalist as the analysis showed that a further 30% of athletes who were Junior Finalist went on to become a Global Medalist. At the senior global level, a high proportion of world champions, Olympic champions and Olympic medalists had been highly successful junior athletes, winning medals or making finals at prior World Junior Championships. There were a number of circumstances that have perhaps prevented this statistic from being even better. Some athletes came from nations where the standard was high and there was considerable depth, particularly in specific events. A junior athlete could have been among (say) the best ten in the world in an event, but was precluded from attending a World Junior Championships as s/he was unable to qualify in an event for either of the only two places available on the national team. Other factors also include the prevailing selection policy and criteria of the national athletics federation. There are known instances where the best junior athletes in an event have not been selected for

whatever reason. The dissolution of the Soviet Union into its constituent member states in 1991 enabled more junior athletes to attend the subsequent editions of the World Junior Championships, but prior to this the Soviet Union team, like every other nation was restricted to selecting a maximum of two athletes per event. By way of contrast, the unification of Germany in 1990 restricted the number of German athletes attending the World Junior Championships to two per event, whereas prior to re-unification, four German junior athletes per event – two from the German Democratic Republic and two from the German Federal Republic were able to compete. Finally, personal circumstances such as finance, schooling and employment commitments and injury have prevented some athletes from attending the World Junior Championships.

Junior Medalists to Elite Seniors

Almost half (46%) of Junior Medalists between 1986 and 2004 went on to a global competition, with over a third of them becoming a Global Medalist or Global Finalist. It was three times more likely that a Junior Medalists, if they stayed in the sport, would become a Global Medalist or Global Finalist rather than just a Global Competitor. Conversely, the attrition rate of Junior Medalists is a cause for concern. Over a half of Junior Medalists did not compete at the global level. This is not to say that they did not compete as a senior athlete. They may have competed at the Area or Regional, or Group Games level, but, for whatever reasons, they did not produce the same level of achievement as their Junior Medalist peers.

Elite Seniors who were not Elite Juniors

It is difficult to quantify the number of Elite Seniors who were not Elite Juniors, let alone the reasons why they became Elite Seniors without having been an Elite Junior. However, from our analysis of the Beijing Olympic medallists, 53% of athletes had not competed at a previous World Junior Championships. Conversely, in a subsequent study of New Zealand and Australian Elite Junior and Elite Senior athletes we could identify only two New Zealand athletes and 11 Australian athletes who were Elite Seniors who had not competed at a World Junior Championships but

were eligible to do so by age. They were either late comers into the sport or did not demonstrate ability as a junior.

Transition times and event bias

The most recent editions (2004 onwards) of the World Junior Championships have not yet produced as many world or Olympic champions as those produced from earlier editions of the World Junior Championships. The reason for this may be in the variable time gap that it takes between being a Junior Medalist and becoming a Global Medalist. The time span could be as short as less than one year, or it could be much longer, as exemplified by athletes who took 12 to 13 years to progress from being a Junior Medalist to becoming a Global medalist.

There is anecdotal debate that in some of the technical events such as throwing events and jumping events, that the transition time is longer. Our analysis does not support this premise, as there was no particular bias towards the technical disciplines than other events.

Country analysis

It is extremely difficult to quantify the total number of athletes who have achieved success at the global level yet did not compete at a World Junior Championships and were eligible by age to do so. Notwithstanding, our data showed that there was a very large number of athletes from the USA who were Junior Medalists or Junior Finalists, but were not seen on the global stage. Similarly, a high number of USA Global Medalists and Global Finalists did not compete at a World Junior Championships and were eligible by age to do so. This situation is not unique to the USA, but in their case it is probably the result of the structure of the sport, i.e., a wealth of opportunities at high school and college level and lesser opportunities post college, and exacerbated by a large population. The high attrition rate post juniors in the USA can easily be handled due to the high population base; athletes are easily replaced with others of similar ability. Another populous country, China, also had a low conversion rate and a high attrition rate from the World Junior Championships. Unlike the USA they did not produce as many Global Medalists.

They are, however, like the USA in that from their large population base, they were able to produce Elite Senior athletes.

A similar situation was evident amongst the middle- and long-distance runners of East Africa, particularly Kenya. Athletes from Kenya, who have been Junior Medalists and Junior Finalists, infrequently appear at the global level, whilst many of their Global Medalists and Global Finalist did not compete at a World Junior Championships. Kenya had a reasonable conversion rate, but a high attrition rate of Junior Medalists and Junior Finalists. The reason for this would relate to the intensity of competition amongst a large number of highly ranked and of similar standard athletes at the senior level for the three places available to them at the World Championships or Olympic Games. Most other countries in the world do not share this envious situation. Ethiopia, Kenya's rival in the middle- and long-distance events, by contrast, has an equal conversion rate to that of its attrition rate.

Ideally an athletics federation should have a high conversion rate and a low attrition rate. Our analysis identified nine countries (in alphabetical order), Australia, Cuba, Ethiopia, Great Britain, Jamaica, Morocco, Nigeria, South Africa and Spain, who had an above average conversion rate and a below average attrition rate. These nine countries have diverse socio-political, ethnic and cultural, economic, population and geographical size, as well as general sport structure and athletics cultural characteristics. Whether it is because they have programmes in place to achieve the aspiration of low attrition and high conversion, or whether this happens by chance of having gifted athletes, requires further investigation.

General

Our data showed that there was no particular bias towards the gender of the athlete who made the successful transition from Junior Medalist or Junior Finalist to becoming an Elite Senior. Approximately the same numbers of male global champions as female global champions were Junior Medalists or Junior Finalists. Similarly, there appeared to be no bias towards an event or an event group. Each event and event group was represented throughout the prospective and retrospective data sets, with no single event or event group dominating.

From our analysis a fifth category, the general attrition rate, could be added to Zelichenok's initial four categories assigned to World Junior Championships

competitors. The general attrition rate of Elite Junior athletes who did not compete as seniors at a global championship was extremely high. From our previous analysis, using the Australian and New Zealand data as an example showed that the general attrition rate was greater than 70%.

One concern that has been expressed about the transition from Elite Junior athlete to Elite Senior athlete has been that the intensity of the necessary preparation and the level of competition faced at an early age may have a detrimental effect on an athlete's prospect as a senior athlete. The results of our analysis do not appear to substantiate this concern as many successful senior athletes who were successful at the junior level continued to be Global Medalists and Global Finalists over a period of 10 – 15 years. However, that is not to say that there were athletes who were encouraged to participate at the World Junior Championships when they were neither physically or emotionally ready for this level of competition and subsequently the World Junior Championships were their last athletics competition. There are also cases where the early physical maturity and the imposition of intensive training have been capitalised on to bring short term gains both for the athlete and the national federation.

Another barrier to advancement could also be associated with limited competition opportunities. A junior athlete, post World Junior Championships, may find themselves competing with athletes from the same country for a place on the national team. With normally only a maximum of three athletes from the one country allowed to compete in a single event at a global competition, an immediate post Elite Junior athlete would be challenging more experienced and better performed senior athletes for a place on the team. Depending on the strength of a particular event in the country and with the limited number of event team places available a former Elite Junior athlete may not have the opportunity to compete at global championships.

The transition time frame from being a Junior Medalist or Junior Finalist to becoming a Global Medalist or Global Finalist has been shown to be highly variable; less than one year to thirteen years. There is a tendency towards women taking longer to make the successful transition. Notwithstanding, there are implications for both athletes and for national federations in that they need to account for the planning of any transition programme, that some athletes will make a quick transition, whilst others will take longer to achieve the success expected of them.

The results of our analysis give national athletics federations some quantitative basis on which to develop or restructure their development programmes. Many developed national federations do have established and worthwhile junior development programmes, where the emphasis is on the development of junior age grade athletes. These same federations also normally have high performance or elite programmes, where the emphasis is directed towards supporting athletes who will compete at global championships. In between these two programmes there is sometimes a void. The purpose of a transitional development programme should be to determine the best way for the talented and proven young athlete to make the transition to the senior ranks. It would appear from our analysis that the selection of junior athletes into such a programme should be those who have the ability to achieve high-level results in winning a medal or making a final at a World Junior Championships and therefore have a greater probability of a positive return on the investment if they are appropriately nurtured through such a programme.

In the light of our analysis, the challenge for athletics federations, if they wish to achieve success at the senior global level is two-fold. First, is to aim to have a greater number of juniors who achieve success, by becoming a Junior Medalist or Junior Finalist. Secondly, to retain these athletes post World Junior Championships.

Future directions

Further research needs to focus on determining the reasons why some Elite Junior athletes go on to be Elite Senior athletes and why other junior athletes of comparable ability do not make this successful transition. The reasons are not necessary exclusively performance related and will include, but not be confined to, many social, psychological and environmental factors. Having established that there is a high probability that a high-achieving junior will go on to be an Elite Senior athlete, it needs to be determined how good a junior the athlete needs to be to amplify this probability. Just achieving the World Junior Championships qualifying standard to participate will not necessarily identify the junior athlete who has the performance ability to succeed as a senior athlete.

It is desirable to determine whether athletes who were Elite Juniors, who went on to be Elite Senior athletes, annually progress at a different rate to those athletes who come into the sport at a later stage and achieve senior success, or whether this

latter mentioned group come into the sport at a high level and then continue to progress at the same rate as the aforementioned group. Similarly, it is necessary to establish if the athlete, who does not become a Junior Finalist and only makes a lesser impact at the senior level, annually progresses at the same rate as the high-achieving junior who has success at the senior level. If this is so it will further exemplify the premise that the junior athlete needs to be very good in order to succeed as a senior athlete.

Research also needs to be undertaken into the optimum structure of transitional development programmes to ensure that the attrition rate, both generally, and specifically of those Elite Juniors is reduced. The basis for selection of athletes into both junior development and transitional programmes requires refinement to include some subjective and social and environmental parameters rather than just focusing on the more traditionally applied performance objective standards.

Conclusions

The analysis, when looked at retrospectively of how Elite Senior athletes performed as juniors, would support the notion that having success as a Junior Medalist or Junior Finalist is a prerequisite for success as a senior athlete at a global championship. However, when the analysis is undertaken prospectively, i.e., what happens to Elite Junior athletes when they become senior athletes, a contrasting description of the transition emerges. There is a high attrition rate (54%) of Junior Medalist and Junior Finalists to Seniors. There is a reasonable probability that athletes who have achieved a high level of success as a junior athlete will go on to be a high achieving senior athlete at the global level. The probability is greater if the junior athlete won a medal or made a final of their event at a World Junior Championships. Conversely, there are athletes who have succeeded at the global level who were not finalists or medalists when they competed at a World Junior Championships. They are rare when compared to the Junior Medalists and Finalists who made the transition to the global level.

Countries with large populations have the luxury of being able to produce Elite Seniors despite the high attrition rate of their Elite Juniors. Less populous countries, if they wish to produce Elite Senior athletes, need to produce more Junior Medalists and Finalists and retain them in the sport.

References

- Butler, M. (Ed.). (2006). *The 11th IAAF World Junior Championships in Athletics - Statistics Handbook*. Monaco: IAAF.
- Butler, M. (Ed.). (2008). *The 12th IAAF World Junior Championships - Fact & Figures*. Monaco: IAAF.
- Hollings, S. C. (2006). World junior success is a prerequisite for world senior success. *Modern Athlete and Coach*, 44(1), 14-17.
- IAAF. (2008). <http://www.iaaf.org/OLY08/index.html>
- IAAF. (2010). <http://www.iaaf.org/history/index.html>
- Julin, A. L. (1995). Where have all the flowers gone? In P. Matthews (Ed.), *Athletics 1995* (pp. 140-142). Surbiton, Surrey: SportsBooks Ltd.
- Tilastopaja. (2010). <http://www.tilastopaja.org/>
- Zelichenok, V. (2005). The long-term competition activity of the world's top athletes. *New Studies in Athletics*, 20(2), 19-24.