STATISTICAL ASSESSMENT OF PERFORMANCE OF MALAYSIAN TRACK AND FIELD ATHLETES

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Abstract

The purpose of this study was to assess the foundation depth of track and field events and objectively identify if there had been a significant advancement of performance in athletics at a foundation level. Data was taken from all 45 athletics events (23 male, 22 female) over the last seven biannual National Games from 2002 to 2014. The performances for the top five finalists across each event were analyzed. A correlation co-efficient was calculated to assess the strength of linear performance relationship over time. *T*-tests were performed to assess mean differences across high prospect events versus major international benchmarks. Using $r = 0.70$ as a high correlation, only five events (men's 400 m, 400 m hurdles, high jump, and both men's and women's hammer throw) out of 41 individual events demonstrated strong positive linear relationships over the assessment period. Only men's high jump and women's hammer throw had a non-significant difference ($p = > 0.05$) when compared with the means performance measure at the two Southeast Asian Games, indicating the events' degree of capacity to compete at an international level. In comparison to higher level competitions, men's high jump and women's hammer throw also demonstrated fragility. The performance gap between the National Games and comparable international event was very large, ranging from 5.3 to 71.0%. Overall, there appears to be a trivial or stagnant trend for many athletics events, which has been unable to create a foundation needed for developing consistent elite performance. Taking into account this data, consideration of the development of new intervention action plans within the overall strategy should be determined and implemented.

Keywords: Athlete development, athletics statistics, sports investment, performance analysis

Introduction

Significant financial and human resources are invested into sport programs throughout the world (Pedersen, Parks, Quarterman, & Thibault, 2011; *Bernama Online*, 2014) with many different outcome-based objectives. For instance, establishment of World Class program was to ensure that the most talented athletes in the nation have every chance of realizing their full potential (*UK Sport*, n.d.), the launch of Winning Edge was the nation's high performance strategy for moving from world class to world best (*Australian Institute of Sport*, n.d.), and creation of the Pelapis program was to produce a group of foundation or second-tier athletes that are competitive in major international games (*Majlis Sukan Negara*, n.d.). It is important in management, as well as in high performance sports development, to continue to review and reflect on the current and past program structures. The current review enables objective and quantifiable assessment for the achievement of targeted objectives within the strategic plan.

It is difficult to review large organizations with an all-encompassing overview without analyzing the key working hubs within the system. Understanding outcomes from these hubs may help to identify and determine

the necessity for adaptation and evolution of work streams, directives, and initiatives. This process will result in future programs being unambiguously outcome based, in the pursuit of stronger performance depth and long term progression of results at the senior and elite levels.

For this reason, it is important to objectively evaluate one of a number of working hubs within the national structure of sport and athletics. One platform for assessment is the Cost Benefit Ratio, which involves the monitoring and evaluation of the impacts and outcomes of the present development programs (Coalter, 2006). Through one large network, the program operators coordinate with all athletic stakeholders for the purpose of identifying and development of future athletes and coaches through the National Games (NG) program.

The NG is one of the key sports development programs for the Ministry of Youth and Sports and are held biannually. The NG can be considered as the primary feeder event from which athletes will progress into the elite national sport programs. It is administered and funded by the National Sports Council (NSC) in co-operation with participating National Sports Associations (NSA), the Ministry of Education (MOE) via their specific sports schools, and each State Government (SGOV). The SGOVs' contributions to the NG include supporting athletes and coaches in their bid to be the best sporting state in athletics. The MOE runs the sports school programs and a national school sports competition is contested each year. The NSC contributes significantly via both youth and development programs for athletes who are under 23 years old. NSAs assist in the facilitation of all programs and contribute further to international and national sanctioning of competitions within the games, as well as their own national development programmes. For more details, see www.nsc.gov.my.

The current analysis was designed to objectively quantify whether current investment into the national athletics and feeder programs is delivering on the key athletic performance indicators. The overall target was to increase the foundation performance depth of athletics events to satisfy the outcome-based expectations of the stakeholders. This analysis was performed with an understanding that the medal standings in local athletics at international events have been declining since early 2000's, as compared to neighbouring countries. It is intended that the assessment will also provide evidence-based data to evaluate events that are improving, regressing, or stagnating in terms of performance development, and to identify potential factors underlying success.

Material and Method

The present research paper is primarily data based with performance variables collated from publicly available sources (i.e. official games results). A total of 45 athletics events for both men (23 events) and women (22 events) from each of the seven NGs from 2002 to 2014 were extracted for statistical evaluation.

The purpose of the data collection over three Olympic cycles was to perform regression analysis to quantify performance development. For the purpose of elucidation, the term performance development was defined as the rise in the broader foundation performance of athletes in each event. Therefore, results for each event with average top five performances in the final were analyzed to obtain a foundation performance baseline.

A sample of high prospect events from NG with expectations to transfer to medal prospects for Southeast Asian Games (SEAG), Asian Games (AsiG), and Commonwealth Games (CG), was compared in terms of average performances of the top five event final performances at the most recent of the above mentioned games. The term high prospect in this analysis was used to describe the events that displayed consistent positive linear correlation. Further analysis on performance foundation was performed by comparing NG data with the age 19 and under Australian Junior Championships (AJC).

Participants of NG were track and field athletes aged 21 and under (aged 23 and under for 2008 and 2010 editions). Informed consent was not required, as the study analyzed and reported data available from official games results; however, all data was reported anonymously.

Statistical Analysis

Data analyses began by extracting and assembling the top five results from each athletics event into a Microsoft Excel spreadsheet (Microsoft Corp., Redmond, WA, USA). These results were recorded in standard metric system using time (hours, minutes, seconds, and hundredths), distance (meters and centimeters), and the points system using the International Association of Athletics Federations (IAAF) scoring for combined events. The spreadsheets were used afterwards to calculate correlation coefficient and percentage difference.

All measurements recorded in time were converted into velocity (m/s) for analysis and uniformity of linear interpretation, but the actual times were maintained in the presentation of data. Investigators then calculated the correlation co-efficient (*r*) to determine degree of the linear relationship between the variables. The rate of improvement (slope analysis) and performance versus AJC was also assessed. One-sample *t*-test was employed to analyze mean difference between the most recent NG and national top performance with the subsequent major international games. The spreadsheets were used to compare and analyze the top five performances for selected events from NG, AJC, and CG. The alpha level was set at 0.05 in order for the difference to be considered significant.

The statistical procedures (*t*-tests) were performed using the SPSS software package (SPSS, Version 16.0, SPSS Inc., Chicago, IL, USA). Correlation co-efficient was interpreted in accordance with the scale of magnitudes by Hopkins (2002), were considered as trivial ($r < 0.1$), small ($0.1 < r < 0.3$), moderate ($0.3 < r < 0.5$), large ($0.5 < r < 0.7$), very large ($0.7 < r < 0.9$), and nearly perfect ($r > 0.9$).

Results

Based on linear model relationship (Table 1 and 2), two out of 41 individual events (men's high jump and women's hammer throw) produced $r = > 0.9$, indicating a nearly perfect association between two variable measures (year and performance). This suggests a consistent improvement in these events over the period of assessment. Three other events (men's 400 m, 400 m hurdles, and hammer throw) also showed a very large association ($r = > 0.7$). The highest correlation for the *individual* women's track event was the 200 m ($r = 0.61$).

Results in Table 3 indicate that there was a significant gap to make up from the NG to the first step of achieving success in SEAG and an even more significant gap to the AsiG and CG prospects. One-sample *t*-test analysis indicated significant differences between NG mean performance and each of the other major games in all events, except for the men's high jump with non-significant differences, in comparison to SEAG editions of 2013 ($p = 0.250$) and 2015 ($p = 0.370$), women's hammer throw in 2013 ($p = 0.597$) and 2015 ($p = 0.348$) editions, and men's 400 m hurdles in comparison to 2013 SEAG ($p = 0.105$).

A comparison between NG and AJC (2010 and 2014 editions) showed that three men's events (400 m hurdles, high jump, triple jump) of NG were consistently superior to AJC, while the men's 100 m and women's triple jump were competitive (Table 4). However, all other women's events from AJC were superior to NG with an enormous gap displayed particularly in women's pole vault (31.3 and 25.2%) and discus throw (38.7 and 30.7%) (Figure 1). Furthermore, analysis of gap differential with CG shows that NG has displayed a larger gap with respect to CG (range of 5.3 to 71.0%), compared to AJC (3.3 to 35.1%) (Table 4).

Table 1: Mean performances for all women's 22 events from 2002 to 2014 National Games, correlation co-efficient (*r*), and slope (y), with slope for AJC.

Events	Women National Games editions									
	2002	2004	2006	2008	2010	2012	2014	*r*	y	y AJC
Track events (time; hours:minutes:seconds.hundredths)										
100 m	12.26	12.59	12.54	12.18	12.34	12.50	12.32	0.10	0.0022x	0.0181x
200 m	25.51	25.95	26.09	25.45	25.45	25.50	25.20	0.61	0.0135x	0.0007x
400 m	58.30	58.21	59.48	58.96	58.51	58.08	57.55	0.43	0.0073x	-0.0023x
800 m	2:22.85	2:26.11	2:19.43	2:21.38	2:24.46	2:24.19	2:22.37	0.00	5E-05x	0.0065x
1500 m	5:09.91	5:01.54	5:02.00	4:56.55	5:04.33	5:07.75	5:04.99	0.00	-8E-05x	0.0056x
5000 m	20:04.11	20:57.06	20:27.86	20:26.87	20:04.55	21:13.65	20:09.21	-0.07	-0.0014x	0.1118x
3000 m SC	NC	12:27.67	12:33.99	12:57.12	12:40.54	12:39.38	12:56.09	-0.64	-0.035x	-0.0035x
100 m H	15.54	15.35	15.16	14.86	14.52	15.36	14.81	0.59	0.022x	0.0358x
400 m H	64.91	65.08	65.51	64.61	66.30	66.29	65.01	-0.40	-0.0058x	0.0161x
5000 m W	27:36.37	27:01.29	27:50.27	27:45.51	26:39.23	28:58.65	26:46.15	0.00	-4E-06x	NC
10000m W	59:19.94	57:34.94	58:38.16	60:02.02	56:07.34	57:41.25	56:34.23	-0.17	-0.0034x	0.0193x
4x100 m	49.29	49.69	49.08	48.13	48.37	48.86	47.67	*0.79*	0.0218x	NC
4x400 m	4:06.94	4:05.49	4:05.86	4:01.07	4:01.69	4:01.09	3:58.86	**0.94**	0.018x	NC
Field events (distance, height, score; meter.centimeter, points)										
High Jump	1.63	1.64	1.58	1.63	1.71	1.65	1.63	0.30	0.0027x	0.0005x
Pole Vault	3.22	3.20	2.80	3.06	2.68	3.09	3.06	-0.31	-0.0146x	0.0091x
Long Jump	5.81	5.73	5.45	5.47	5.70	5.41	5.36	-0.75	-0.0311x	0.0177x
Triple Jump	12.10	12.16	11.90	11.87	12.18	11.99	11.93	-0.35	-0.0102x	0.0043x
Shot Put	10.47	11.73	11.69	12.06	12.49	11.41	11.83	0.52	0.0757x	0.093x
Discus	35.61	33.46	35.97	37.75	34.69	36.77	36.45	0.43	0.1404x	0.2986x
Hammer	35.31	38.02	36.34	42.52	42.62	41.81	48.21	**0.91**	0.9386x	0.5145x
Javelin	33.72	37.86	39.51	39.84	36.39	38.88	38.84	0.51	0.255x	-0.1088x
Heptathlon	3770	3690	3491	3367	3597	3798	3643	-0.03	-1.0536x	38.913x

AJC = Australian Junior Championship; m = meters; NC = Not Contested / Non Comparable; SC = Steeplechase; H = Hurdles; W = Walk

Bold = nearly perfect correlation; Italics = very large correlation

Table 2: Mean performances for all men's 23 events from 2002 to 2014 National Games, correlation co-efficient (*r*), and slope (y), with slope for AJC.

Events	Men National Games editions									
	2002	2004	2006	2008	2010	2012	2014	*r*	y	y AJC
Track events (time; hours:minutes:seconds.hundredths)										
100 m	10.74	10.73	10.66	10.74	10.79	10.92	10.82	-0.49	-0.0123x	0.018x
200 m	21.78	22.00	21.80	21.97	21.95	21.99	21.88	-0.37	-0.0032x	-0.0033x
400 m	49.10	49.17	49.88	48.46	48.46	48.51	47.98	*0.75*	0.0183x	0.0067x
800 m	1:56.95	1:57.84	1:56.81	1:55.21	1:55.36	1:57.12	1:57.99	-0.01	-0.0002x	0.0073x
1500 m	4:07.80	4:04.88	4:06.04	3:59.16	4:03.08	4:05.85	4:08.34	-0.01	-0.0002x	-0.0002x
5000 m	16:11.49	16:12.32	15:50.90	15:54.79	15:35.76	16:14.35	16:38.89	-0.25	-0.0064x	0.0181x
10000 m	34:28.98	34:16.92	33:09.73	33:44.35	34:05.31	35:146.16	35:04.32	-0.48	-0.0116x	NC
3000 m SC	10:07.96	9:57.51	9:46.16	9:46.44	9:44.70	10:10.60	10:03.44	-0.08	-0.0016x	-0.0116x
110 m H	15.02	15.01	15.11	14.79	14.65	15.11	15.01	0.13	0.0026x	NC
400 m H	54.37	54.28	54.72	53.49	53.42	53.78	53.21	*0.79*	0.0142x	0.0093x
10000 m W	48:06.70	47:28.62	52:34.03	49:44.15	50:35.69	50:02.20	50:27.30	-0.49	-0.0128x	0.0251x
20000 m W	1:42.49	1:44.09	1:51.48	1:47.23	1:43.08	1:43.00	1:50.34	-0.25	-0.0064x	NC
4x100 m	42.10	42.30	41.63	41.64	41.57	42.35	41.61	0.32	0.0058x	NC
4x400 m	3:20.22	3:18.54	3:20.68	3:18.83	3:17.67	3:21.49	3:19.346	-0.03	-0.0004x	NC
Field events (distance, height, score; metre.centremetre, points)										
High Jump	1.92	1.98	1.97	2.05	2.02	2.13	2.10	**0.92**	0.0159x	0.0055x
Pole Vault	4.33	4.26	4.61	4.38	4.42	4.30	4.29	-0.15	-0.0041x	0.032x
Long Jump	7.10	6.76	6.90	7.10	7.06	7.13	7.04	0.41	0.0129x	-1.1529x
Triple Jump	14.89	14.44	14.54	14.79	15.05	14.60	15.04	0.41	0.0229x	-0.0096x
Shot Put	12.79	12.92	13.62	14.09	14.02	13.53	12.90	0.28	0.0348x	NC
Discus	38.34	37.83	38.32	39.79	36.89	38.19	42.43	0.49	0.2064x	NC
Hammer	38.68	37.95	31.67	39.27	42.75	45.83	47.06	*0.76*	0.9282x	NC
Javelin	56.52	54.22	52.36	55.08	57.38	53.98	52.80	-0.28	-0.1182x	0.122x
Decathlon	5301	5515	5001	5464	5107	5398	5524	0.20	9.6607x	NC

AJC = Australian Junior Championship; m = metres; NC = Not Contested / Non Comparable; SC = Steeplechase; H = Hurdles; W = Walk
Bold = nearly perfect correlation; Italics = very large correlation

Table 3: Mean (*SD*) of high prospect and additional events for national and international games, and national best performance.

	Events	NG 2014	MAS National 2014	SEAG 2013	SEAG 2015	AsiG 2014	CG 2014
Women	200 m	25.20 (0.41)	24.84 (0.39)	24.06 (0.32)	23.84 (0.18)	23.38 (0.24)	22.53 (0.17)
	400 m	57.55 (1.82)	56.58 (1.70)	54.19 (1.11)	53.91 (1.60)	52.34 (0.59)	51.55 (0.95)
	100 m H	14.81 (0.19)	14.44 (0.34)	13.90 (0.38)	13.69 (0.13)	13.18 (0.30)	12.98 (0.26)
	Shot Put	11.83 (0.76)	12.38 (0.57)	13.71 (1.70)	13.84 (0.67)	17.76 (0.79)	17.89 (1.35)
	Hammer	48.21 (7.10)	50.75* (4.21)	50.38*† (5.12)	52.12*† (5.04)	66.12 (8.88)	68.34 (2.82)
	Javelin	38.84 (3.77)	43.48 (3.36)	48.81 (3.16)	49.37 (2.90)	60.57 (3.06)	63.08 (1.89)
Men	400 m	47.98 (0.35)	47.90* (0.31)	47.70 (0.39)	46.74 (0.68)	45.63 (0.68)	44.90 (0.52)
	400 m H	53.21 (0.87)	52.96* (0.55)	52.21* (0.86)	50.94 (1.07)	50.34 (0.61)	49.03 (0.50)
	High Jump	2.10 (0.02)	2.16* (0.04)	2.12* (0.03)	2.11* (0.02)	2.29 (0.05)	2.26 (0.04)
	Triple Jump	15.04 (0.29)	15.52 (0.51)	16.16 (0.44)	16.05 (0.46)	16.84 (0.34)	16.74 (0.30)
	Discus	42.43 (6.62)	43.80* (5.93)	52.02 (0.87)	52.40 (3.11)	61.63 (2.38)	62.34 (1.25)
	Hammer	47.06 (6.88)	52.04 (7.47)	58.13 (4.16)	61.46 (2.73)	73.64 (1.98)	71.94 (1.66)

*denotes non-significant difference ($p > 0.05$), in comparison with NG 2014
†denotes non-significant difference ($p > 0.05$), in comparison with MAS National 2014

MAS = Malaysia; NG = National Games; SEAG = Southeast Asian Games; AsiG = Asian Games; CG = Commonwealth Games

High prospect events ($r = > 0.5$): women's 200 m, 100 m hurdles, shot put, hammer, javelin; men's 400 m, 400 m hurdles, high jump, hammer
Additional events (latest international success): women's 400 m; men's triple jump, discus throw

Discussion

The purpose of this statistical analysis of athletics performance data was to evaluate the foundation depth of track and field events and to identify if there had been a significant difference in the advancement of performance in athletics at a foundation level. The statistical analyses showed that performances in five events (men's 400 m, 400 m hurdles, high jump, and both men and women's hammer throw) demonstrated a substantial positive relationship with time.

Comparisons with the three major international games, namely SEAG, AsiG, and CG were also done to ascertain if the foundation created by the current development program (evaluated through NG) had been favorable. Only men's high jump and women's hammer throw performances from NG produced an insignificant difference ($p > 0.05$) in comparison to 2013 and 2015 SEAG, while men's 400 m hurdles displayed insignificant difference ($p > 0.05$) in 2013 SEAG. This comparison demonstrated the strong and resilient foundation of the men's high jump and women's hammer throw, also indicating successful investment into these events. Although there was positive progression in the women's relay events, it was not considered for further analysis, possibly due to the possible confounding effects of baton change.

Table 4: Mean of selected events and percentage difference of NG and AJC to CG.

	Events	NG		AJC		CG		NG vs. CG	AJC vs. CG	NG vs. CG	AJC vs. CG
		2010	2014	2010	2014	2010	2014	2010	2010	2014	2014
Women	200 m	25.45	25.20	24.18	24.44	23.38	22.53	8.1%	3.3%	10.6%	7.8%
	400 m	58.51	57.55	55.04	55.05	51.49	51.55	12.0%	6.4%	10.4%	6.4%
	100 m H	14.52	14.81	14.41	14.15	13.09	12.98	9.8%	9.2%	12.4%	8.2%
	Pole Vault	2.68	3.06	3.52	3.83	4.09	4.31	52.6%	16.2%	40.8%	12.5%
	Triple Jump	12.18	11.93	11.75	12.33	13.87	13.97	13.9%	18.1%	17.1%	13.3%
	Shot Put	12.49	11.83	13.61	13.38	17.70	17.89	41.7%	30.1%	51.2%	33.7%
	Discus	34.69	36.45	48.11	47.64	59.18	62.34	70.6%	23.0%	71.0%	30.9%
	Hammer	42.62	48.21	48.03	52.41	64.89	68.34	52.3%	35.1%	41.8%	30.4%
	Average							32.6%	17.7%	31.9%	17.9%
Men	100 m	10.79	10.82	10.82	10.58	10.22	10.11	5.3%	5.6%	6.6%	4.4%
	400 m	48.46	47.98	47.86	47.07	45.54	44.90	6.0%	4.9%	6.4%	4.6%
	400 m H	53.42	53.21	53.78	54.00	49.11	49.05	8.1%	8.7%	7.8%	9.2%
	800 m	1:55.36	1:57.59	1:51.10	1:50.58	1:47.82	1:45.78	6.5%	3.0%	10.3%	4.3%
	1500 m	4:03.08	4:08.34	3:49.12	3:58.12	3:42.49	3:39.67	8.5%	2.9%	11.5%	7.7%
	5000 m	15:35.76	16:38.89	14:47.96	14:46.10	13:34.29	13:15.80	13.0%	8.3%	20.3%	10.2%
	High Jump	2.02	2.10	1.98	2.07	2.27	2.26	12.4%	14.5%	7.6%	9.1%
	Triple Jump	15.05	15.04	14.39	14.65	17.04	16.74	13.2%	18.4%	11.3%	14.3%
	Average							9.1%	8.3%	10.2%	8.0%

AJC = Australian Junior Championship; CG = Commonwealth Games; H = hurdles; m = meters; NG = National Games; vs. = versus

The potential reason for the steady and consistent performance of the men`s high jump and women`s hammer throw may be foreign coaching influence, with changes in conditioning and specific training. Although both events are already at an elite level in terms of Southeast Asian standards, they have shown a consistent rate of progression; however, the men's high jump demonstrated a small increase, while the hammer throw showed a large rate of improvement (Table 1 and 2) and highly competitive at junior level. It could mean that the hammer throw has created a stronger foundation in its recent development and the improvement was due to the fact that the women's hammer throw is a relatively new event. Also a significant amount of initiative and focus on development has come from the country's throwing stronghold in Sarawak.

Data from NG and AJC were further analyzed to examine the foundational depth of the two age-group competitions during two Commonwealth years (2010 and 2014). Noting the AJC is a junior (19 years and under) competition whereas competitors in NG can be up to 21 years of age (23 for 2010 edition), only three events (men's 400 m hurdles, high jump, and triple jump) from NG were consistently superior to AJC, with men's 100 m and women's triple jump seen as competitive but erratic. It appears that the performance differential in comparison to CG showed that a larger gap existed for NG (5.3 to 71.0%) when compared to AJC (3.3 to 35.1%) (Table 4). The performance benchmark of NG is further highlighted as a larger gap is shown in many women's events, particularly pole vault and discus throw, while a smaller gap was observed in many men's events (up to 12.6%) in comparison with AJC (Figure 1). Slope analysis was performed to identify the rate of change or how steep the line in respect to *y* axis. The values from Table 1 and 2 indicated that AJC has 19 events (57.6%) with a superior rate of positive (slope) changes or progression than NG (30.3%).

Additionally, we compared NG data with the AJC using the same format as this study (2002 to 2014) to evaluate a baseline performance level. From the two sets of event comparison data, the NG was competitive in three (9.1%) of the 33 comparable individual events, all men events, 100 m (10.77 vs 10.84 s), high jump (2.03 vs 2.03 m), and triple jump (14.76 vs 14.53 m). Numerous NG events showed a lower performance level as compared to the AJC. From this data, we can take a guideline that the performance level of the NG in athletics is relatively low compared to their Australian counterparts.

As Table 1 and 2 outline, overall consensus of this study was that from 45 track and field events, there appears to be a trivial or stagnant trend for many athletics events. Further, a gap is displayed by the performance's mean difference, with little chance of closing given the current rate of change (Table 3 and 4), advocating a very clear mandate to address potential limiting factors. The current program has been unable to create a foundation (group of athletes) needed for developing consistent elite performance at high profile international games.

It has been assumed that larger improvement in performances would be witnessed with sporting events in the 21st century, due to major technological, nutritional, and medical advances (Berthelot et al., 2008). With the rapidly changing sports environment of sport science interventions, coaching strategies, and the advancement of technology, athletes have greater opportunities to push the boundaries of human performance (Chong, 2008). Hence, it would not be unreasonable to expect considerable improvement in performances over the past 12-year period. The main outcome of this study was finding that athletics performance since the early 2000's has not shown a positive trend. This is further elaborated by the continuous decline of gold medal tally at the last eight SEAG, from eight gold medals in 2001 and 2003, seven in 2005 and 2007, six in 2009, five in 2011, four in 2013, and three in 2015.

Although the all-around strength of the working hubs (NSC, NSA, MOE, SGOV, coaches, parents, fans, media, and athletes) making large contributions to the NG, it appears that the current programs have been unable to create a solid foundation for athlete development. This shortcoming may be due to possible weaknesses in the systematic planning and implementation in organization and planning priority outcomes. This lack of synergy leads to a lack of cohesion from year to year, as there is no alignment between performance pathways. It is the combination of different setbacks that impede the progress of sports development. It has been reported that sports associations have often faced the problem of conflict internally (Yusof, Omar-Fauzee, Abdullah, & Mohd-Shah, 2009), which may also disrupt athlete development.

It is believed that the "critical" youth development has to be carefully structured in order to create a solid foundation. The extent of the transition from second-tier or foundation to successful elite senior athletes capable of winning a gold medal at SEAG and medals in AsiG and CG is dependent on effectiveness of talent management and development feeder programs (Abbott, Collins, Martindale, & Sowerby, 2002; Tucker & Collins, 2012). International exposure is also imperative as the best youth and junior athletes require access to major age-group events to enhance development. Indeed, limiting the competition opportunities is an identified barrier to athlete advancement (Hollings & Hume, 2010). The IAAF World Junior Championships (WJC) is thought to have been a key component in grooming senior level performers and statistics from 1992 to 2008, showing that 81 Olympic gold medalists (50 men and 31 women) competed at an IAAF WJC (Hollings & Hume, 2010). In order to increase proficiency of transition to be a successful senior athlete, the foundation needs to be strong. This may be effected by producing more successful junior and age-group athletes, retaining them through the senior level, while providing them with sufficient resources during the process (Hollings & Hume, 2011).

In cooperation with all stakeholders, the country's athletics standard can be improved with broader and effective development program structure with a strong aspiration towards unified athletics development. However, development requires determination of specific needs and resource alignment to ensure a fruitful-investment. The first goal ought to be to stop the decline of performance across events by facilitating and creating a strong foundation of second-tier athletes to be molded and given higher priority opportunities and advanced sports science exposure in training. Advanced coaching and technical strategies allow the process to progress, while effective, systematic, and comprehensive strength and conditioning support is essential. This requires all stakeholders to create a constructive environment that assists in producing positive results and a unified purpose and direction with strategic implementation. From a practical view, one option may be the implementation of youth, junior, and senior domestic competition series linked to performance base standard and incentives, with an alignment of coach education opportunities at each series event.

In a dynamic and diverse sporting environment, productive change requires total commitment, openness to a strategic plan, and action. Effective leaders use operative style and transparent interpersonal leadership skills in

the process of implementation of change (Hinckley, 2009). One main factor that can hamper change implementation is inability to accept changes or the refusal to consider new ideas and innovation, or in other words, change aversion. Competency, workload, and threats are some of the reasons associated with such aversion (Robinson, Povill, Henry, Vandeputte, & Clark, 2007). The results herein demonstrate that change is necessary. It is our contention that all stakeholders should be prepared to embrace a more systematic and result-orientated approach in the process of progressing athletics. It is the intent of this descriptive study to assist key stakeholders by providing an interpretation of the data such that planning objectives and appropriate actions can be implemented to deliver competitive and realistic outcome-based objectives for the future.

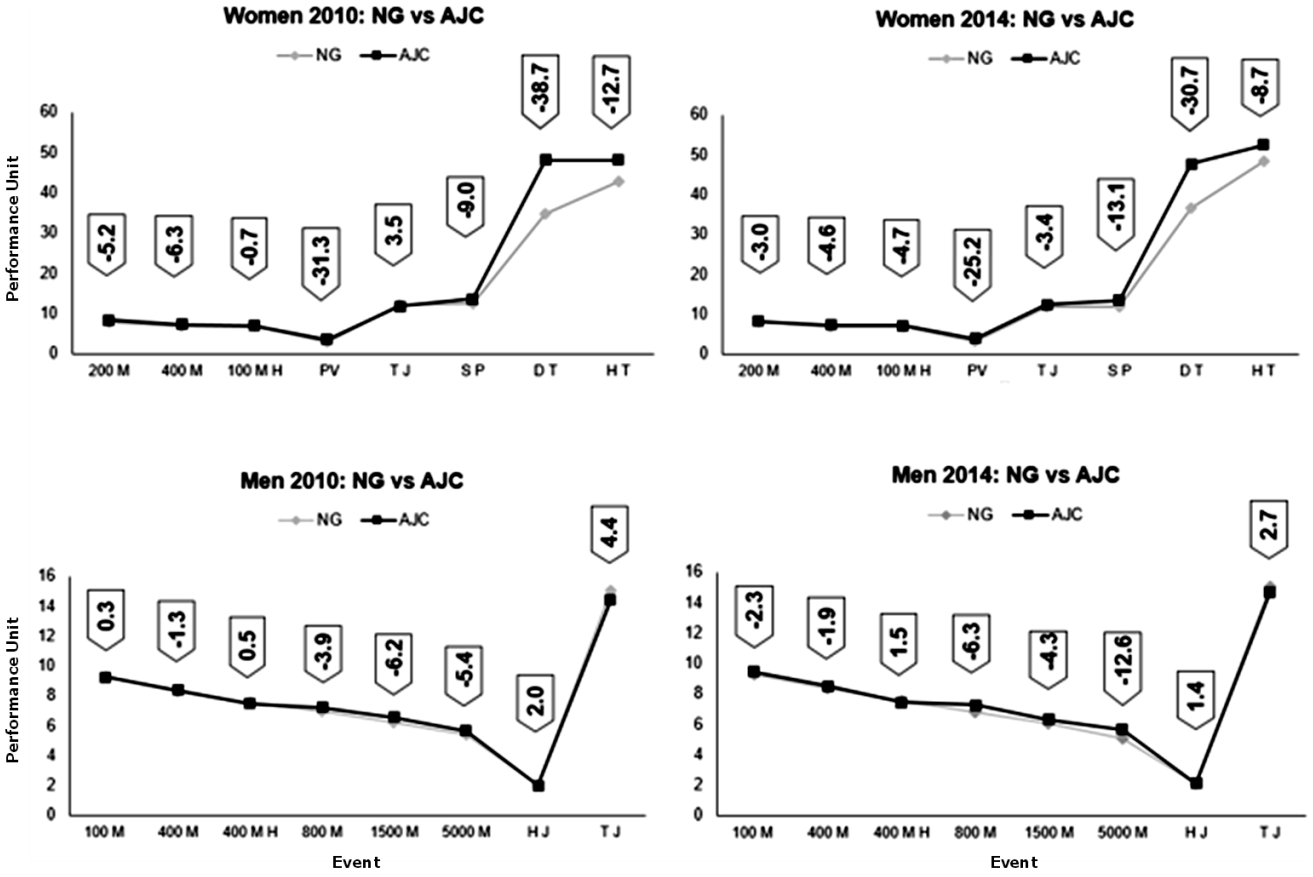

Figure 1: Percentage difference (%) between NG and AJC for 2010 and 2014.

AJC = Australian Junior Championship; DT = Discus Throw; H = Hurdles; HJ = High Jump; HT = Hammer Throw; M = Meters; NG = National Games; PV = Pole Vault; SP = Shot Put; TJ = Triple Jump;

Performance Unit = performances in velocity (m/s) for track events (for uniformity of interpretation), and actual distance (meters) for field events; Percentage value difference between NG and AJC is shown in boxes.

Conclusion

Although there have been significant resources-invested into high performance programs for athletics through the NG, they appear to have resulted in limited progress. Taking into consideration the athletes that have entered the elite performance domain through a development program, the data in this study shows a trivial impact on overall athlete depth for both men's and women's events from 2002 to 2014.

With technological advances in sports and athletics in terms of sports science and coaching, and considerable investment in terms of dollars and resources, positive outcomes can be anticipated. The limited progress

combined with a relatively low athletics performance baseline, indicates that the program strategies over the assessed period have not been effective with respect to performance outcomes. Thus, consideration of the development of new intervention action plans within the overall strategy should be determined, evaluated, and implemented.

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