

# The dominance of Kenyans in distance running

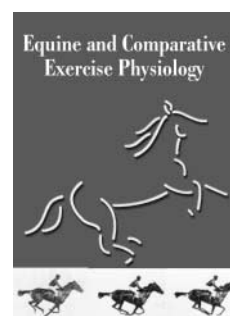
Yannis P Pitsiladis<sup>1,\*</sup>, Vincent O Onywera<sup>2</sup>,  
Evelina Geogiades<sup>1</sup>, William O'Connell<sup>3</sup> and  
Michael K Boit<sup>2</sup>

<sup>1</sup>International Centre for East African Running Science (ICEARS), Institute of Biomedical & Life Sciences, University of Glasgow, Glasgow G12 8QQ, UK

<sup>2</sup>Department of Exercise and Sports Science, Kenyatta University, PO Box 43844, Nairobi, Kenya

<sup>3</sup>Head Athletics Coach, St. Patrick Iten High School, PO Box 143 Iten, Eldoret, Kenya

\*Corresponding author: Y.Pitsiladis@bio.gla.ac.uk



## Review Article

### Abstract

Kenyan runners, and especially those originating from the Kalenjin tribe, have dominated international middle- and long-distance running for over 40 years, prompting significant interest in the factors contributing to their success. Proposed explanations have included environmental factors, psychological advantage and favourable physiological characteristics, which may be genetically conferred or environmentally determined. Running is inherent within local Kenyan tradition and culture, and the Kenyan way of life, which involves many outdoor activities and pastimes in addition to mostly unfavourable living conditions, is conducive to enhanced distance running performance. Despite economic deprivation, Kenya has produced world and international running champions repeatedly over the past few decades; these champions have become role models for the younger generations, who take up running in the hope of a better future for themselves. Favourable environmental conditions such as altitude, diet and anthropometry, in addition to the motivational and socio-economic factors mentioned above, have all been proposed as possible reasons for the unsurpassed achievements of Kenyan distance runners. However, the fact that the majority of internationally successful runners originate from a small tribe that accounts for approximately 3% of the total Kenyan population also points to a possible genetic component. Whether this is subject to influence from other co-factors, such as altitude or training effects acquired during childhood, remains as yet unresolved.

**Keywords:** Kenya; athletics; environment; demographics

### Introduction

Kenyan runners have been the dominant force in middle- and long-distance running events for more than 40 years, thus establishing themselves as the world's premier distance runners. Kenyans emerged on the international stage for long-distance running in 1954 at the British Empire and Commonwealth Games in Vancouver (British Columbia), and took part in their first Olympics in Melbourne (Australia) in 1956. Kenyan athletes, like Nyandika Maiyoro, who competed in the 3 miles and Kanuti Sum, competing in the marathon, were Kenya's first world-class runners who paved the way for the subsequent dominance of Kenyan distance runners in world athletics. The Kenyan distance running success story is arguably second to none; since 1968 Kenya has

won every Olympic steeplechase race it has entered, in addition to an impressive 38 Olympic medals in distances between 800 m and the marathon, far more than any other country. The 1968 Mexico City Olympics provided an indication of what was to follow, with Kenyan athletes winning gold in the 10 000 m (Naftali Temu), the 3000 m steeplechase (Amos Biwott) and the 1500 m (Kipchoge Keino).

The unparalleled achievements of Kenyan runners on the international running circuit are in stark contrast to Kenya's economic/social infrastructure, where it ranks poorly in nearly every social and economic category (e.g. life expectancy, *per capita* income and child mortality). The dominance of African middle- and long-distance running, which is not just confined to Kenya but includes athletes from the

greater East African region (Ethiopia being the prime example), North and South Africa (e.g. Morocco and the Republic of South Africa), has been attributed to a number of factors. These include favourable environmental conditions, genetic endowment resulting in physiological and/or anatomical advantage, and specific social and cultural development and motivation<sup>1-7, 22</sup>.

While Kenyans and other East and North Africans currently hold all men's running world records ranging from the 800 m to the marathon, there is an overwhelming over-representation of elite runners from Kenya. According to the 2004 International Association of Athletics Federations' world ranking of top 1000 male and 1000 female athletes, Kenya has an output of approximately 45% of all African athletes (i.e.  $n = 134$  athletes) compared with only 11% from Ethiopia ( $n = 33$ ) and 10% from South Africa ( $n = 31$ ), with the majority of these athletes being males (Table 1). When the population of each African country is taken into account, Kenya's dominance of world distance running becomes even more apparent. Kenya has a world index of 12.0 athletes *per capita*, compared with 4.4 for Namibia, 3.6 for Botswana and only 2.1 and 1.4 for South Africa and Ethiopia, respectively (Table 1). Even more compelling is the finding that most of the successful Kenyan runners come from a group of eight small tribes, collectively known as the Kalenjin (Nandi, Kipsigis, Tugen, Keiyo, Marakwet, Pokot, Terik and Sabaot)<sup>3,8</sup>. Kenya has a population of around 30 million, distributed

amongst eight provinces, and is populated by three main language groups. The largest of these groups are the Bantu speakers, who account for approximately 65% of the Kenyan population. Nilotic speakers account for approximately 25% of the population and include the Kalenjin, while Cushitic speakers account for part of the remaining 10% of the total population<sup>9</sup>. The Kalenjin account for approximately 3 million, or about 10% of the Kenyan population, yet have earned about 75% of Kenya's distance running honours<sup>3</sup>. One particular Kalenjin sub-tribe, the Nandi, with a population of about 100 000 adult males, has historically excelled in distance running compared with the other sub-tribes. Nandi typically make up the nucleus of all Kenyan middle- and long-distance athletics teams. As such, there is a disproportionately large number of Nandi athletes ranked amongst the all-time best middle- and long-distance runners, including Henry Rono, Kipchoge Keino, Amos Biwott, John Kipkurgat, Ben Kogo, Mike Boit, Patrick Sang, Moses Kiptanui and Moses Tanui. In the most comprehensive study of Kenyan runners to date<sup>9</sup>, 25% of the runners who competed nationally and 45% who competed internationally belonged to the Nandi sub-tribe, yet the Nandi population accounts for only about 3% of the total Kenyan population. It is tempting, therefore, to attribute this overwhelming over-representation of elite Nandi/Kalenjin runners to some degree of genetic predisposition for superior running performance (for a review see Scott *et al.*<sup>10</sup>).

**Table 1** Output of world-class athletes from Africa (based on the International Association of Athletics Federations' top 1000 rankings, 2004)

Country	% African population	No. of athletes	% African athletes	No. of female athletes	% African female athletes	No. of male athletes	% African male athletes	Athletes per capita	Male athletes per capita	Female athletes per capita
Algeria	3.8	13	4.3	4	3.7	9	4.6	1.1	1.2	1.0
Botswana	0.2	2	0.7	0	0.0	2	1.0	3.6	5.9	0.0
Burundi	0.7	1	0.3	0	0.0	1	0.5	0.5	0.7	0.0
Cameroon	1.8	7	2.3	5	4.7	2	1.0	1.3	0.6	2.6
Egypt	8.7	1	0.3	0	0.0	1	0.5	0.0	0.1	0.0
Eritrea	0.5	1	0.3	0	0.0	1	0.5	0.7	1.0	0.0
<b>Ethiopia</b>	<b>7.8</b>	<b>33</b>	<b>11.0</b>	<b>20</b>	<b>18.7</b>	<b>13</b>	<b>6.7</b>	<b>1.4</b>	<b>0.9</b>	<b>2.4</b>
Ghana	2.4	8	2.7	3	2.8	5	2.6	1.1	1.1	1.2
<b>Kenya</b>	<b>3.7</b>	<b>134</b>	<b>44.5</b>	<b>31</b>	<b>29.0</b>	<b>103</b>	<b>53.1</b>	<b>12.0</b>	<b>14.3</b>	<b>7.9</b>
Madagascar	2.0	2	0.7	1	0.9	1	0.5	0.3	0.3	0.5
Morocco	3.7	20	6.6	5	4.7	15	7.7	1.8	2.1	1.3
Mozambique	2.0	2	0.7	2	1.9	0	0.0	0.3	0.0	0.9
Namibia	0.2	3	1.0	1	0.9	2	1.0	4.4	4.6	4.2
Nigeria	15.6	17	5.6	14	13.1	3	1.5	0.4	0.1	0.9
Senegal	1.2	8	2.7	6	5.6	2	1.0	2.2	0.9	4.4
South Africa	5.0	31	10.3	9	8.4	22	11.3	2.1	2.4	1.6
Sudan	4.5	4	1.3	1	0.9	3	1.5	0.3	0.3	0.2
Tanzania	4.2	7	2.3	2	1.9	5	2.6	0.6	0.6	0.4
Togo	0.6	2	0.7	1	0.9	1	0.5	1.0	0.8	1.4
Tunisia	1.2	3	1.0	1	0.9	2	1.0	0.9	0.9	0.8
Uganda	3.0	2	0.7	1	0.9	1	0.5	0.2	0.2	0.3

### Sociocultural factors

Tradition and culture form the very basis of the profound interest in long-distance running among the Kenyan population. Many cultural practices, common to the Kalenjin, who form the bulk of Kenyan runners, and the Nilotic people, are conducive to exceptional middle- and long-distance running performance. Cattle-raiding expeditions, which often involve covering distances of up to 100 miles, in addition to male circumcision, which is widely practised among the indigenous Kenyan populations, may provide a foundation for the development of long-distance runners. Historically, such traditions and customs would have been subject to immense influence from early 20th century European missionaries, the (English) Amateur Athletic Association (AAA as it was then known) and the British Empire. For example, the extent to which the British Colonial Administration intended to harness the energy once used by the Kenyan 'warriors' for cattle raiding into competitive running is subject to much speculation (for a detailed historical account see Bale and Sang<sup>11</sup>).

The notion that the seemingly endless supply of Kenyan running talent stems from local traditions, culture and the particular lifestyles of certain ethnic groups is compounded by growing evidence which indicates that running talent in Kenya is no longer confined to the Nilotic and Cushitic groups. A number of runners from the Bantu tribes, whose customs and traditions differ markedly from those of the Nilotes, have also emerged with particular success in recent years. As stated previously, the Bantu groups are the most populous in Kenya and Bantu tribes have produced a great number of world-class athletes, like the Kisii (e.g. Yobes Ondieki, Naftali Temu, Charles Asati), the Kikuyu (e.g. John Ngugi, Douglas Wakiihuri, Charles Kamanthi) and the Kamba (e.g. Cosmas Ndeti, Joseph Musyoki). These Bantu tribes traditionally practised male circumcision and live at high altitude. The Kisii, a neighbouring tribe of the Kalenjin, also practised cattle raiding, primarily against the Kalenjin and the Masai. While some traditional practices such as female circumcision and cattle raiding are becoming less prevalent, male circumcision is still practised in Kenya and many other African countries (e.g. Ethiopia and Tanzania). A typical African child endures difficult living conditions with many hardships such as hunger and sickness. Therefore, the ability to withstand such arduous conditions is very much part of the African way of life. A life of deprivation and the ability to endure suffering renders the African child in good stead for accepting and completing the exhaustive training that is a prerequisite for modern-day competitive distance running.

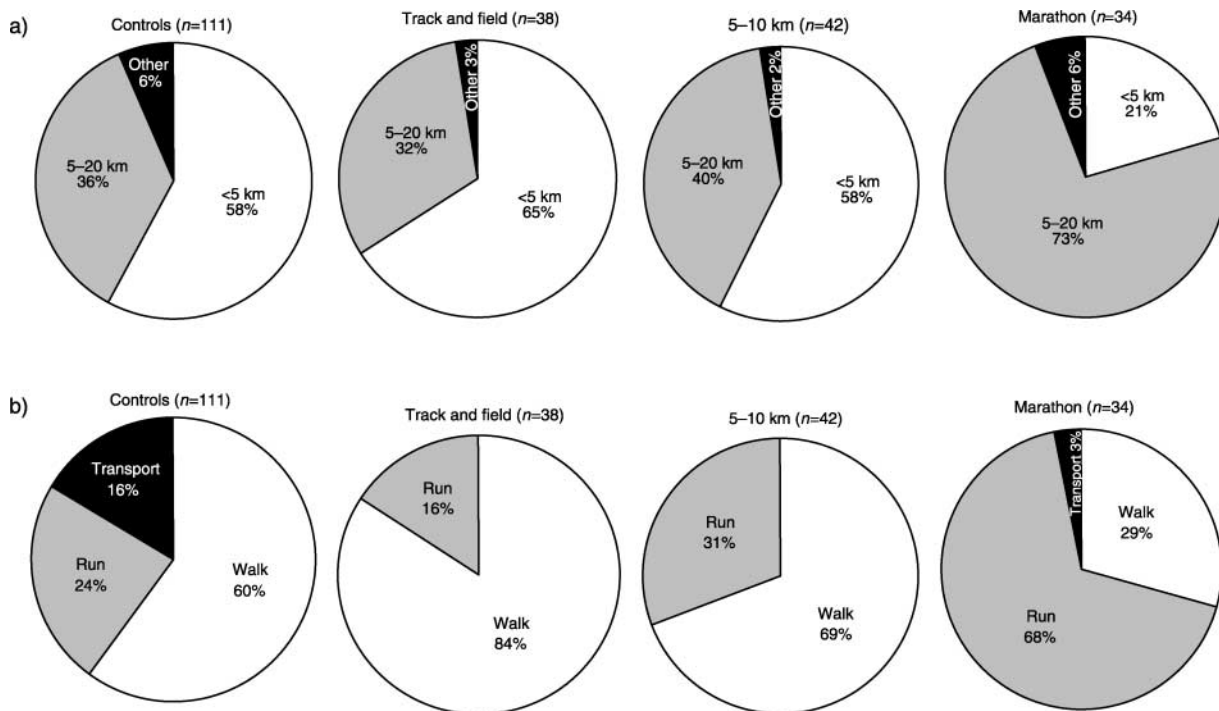
Despite the hard living conditions, young children living in rural Africa tend to live a life that focuses

predominantly on outdoor activities, those being typical games, such as skipping, running and jumping, in addition to games associated with herding cattle. Teamwork and co-ordination are also promoted through these activities, providing an excellent foundation for athletic development. The lack of economic means, combined with covering long distances on foot and the (as yet) minimal Western influence, means that children in rural Africa are very active physically and therefore physically fit, especially when compared with children in developed countries. Years of running to and from school as children and adolescents has often been proposed as contributing significantly to the development of Kenyan and other East African runners<sup>1,8,10</sup>. Indeed, Saltin *et al.*<sup>1</sup> describe their elite runners as having run or walked an average of 8–12 km a day, five days a week, from an early age (i.e. 7–8 years), increasing to 90 km a week as adolescents. These authors also found that Kenyan adolescents who walked and ran long distances daily to school, but did not train, had 30% higher maximal oxygen uptakes than those who did not and whose maximal oxygen uptakes were similar to those of Danish adolescents. However, these authors describe how Kenyan teenagers 'out of training for some months' had significantly lower maximal oxygen uptakes than those who had been training regularly, which suggests that organized training plays a significant role in the development of high maximal oxygen uptake in Kenyan adolescents. In contrast, Bale and Sang<sup>11</sup> report that 14 out of 20 elite Kenyan runners interviewed had never run long distances to school.

Further support for the notion of increased physical activity in childhood/adolescence being instrumental in the development of running talent in East Africa comes from two recent studies of elite Ethiopian<sup>6</sup> and Kenyan<sup>8</sup> runners. In a study of 114 elite Ethiopian runners, a higher proportion travelled long distances to school by running relative to an Ethiopian control population (Fig. 1). Similarly, in the study of approximately 400 elite Kenyan runners, a high proportion of runners travelled further than 5 km to school each day compared with a Kenyan control population, and a significantly higher proportion of athletes travelled these distances by running (Fig. 2). These findings confirm the previous somewhat anecdotal evidence that running long distances to school each day may have a strong influence on the success of East African runners.

### Favourable environmental conditions: focus on altitude

Although conclusions are equivocal (see Saltin<sup>2</sup> for a review), some studies have concluded that chronic altitude exposure and endurance training, as experienced



**FIG. 1** (a) Distance travelled to school. Percentage of subjects travelling each distance to school each day is shown. The distance that the marathon athletes travelled to school each day differs significantly from all the other groups. There were no significant differences between the other groups. (b) Method of travel to school. Percentage of subjects using each method of travel to school each day is shown. The marathon athletes differed significantly from all groups, as did controls. Track and field athletes did not differ significantly from the 5-10 km athletes. Data from Scott *et al.*<sup>6</sup>.

by many East African runners, combine synergistically to induce haematological adaptations which may partially account for their success<sup>12</sup>. The common stimulus of living at altitude and endurance training is the lack of oxygen that acts, either directly or indirectly, via some messenger linked closely to tissue oxygen availability<sup>2</sup>. The idea is that this stimulus, when living at altitude, is additive to the ordinary training stimulus and cannot be elicited by training at sea level alone. This notion is contrary to the more recent approach of 'living high-training low'<sup>13</sup>. The basic concept is that, although living at high altitude will induce many physiological responses that may be beneficial for endurance exercise performance (including increased oxygen-carrying capacity), training at high altitude may be ineffective due to the reduced partial pressure of oxygen. The vast majority of elite Ethiopian<sup>6</sup> and Kenyan<sup>8</sup> runners have been shown to originate and train in particularly high-altitude regions of Ethiopia and Kenya, respectively, although this may not necessarily be causal to their success.

Indigenous populations living at high altitudes chronically experience the unique stress of hypobaric hypoxia. Barometric pressure falls with increasing altitude and although atmospheric air still contains 20.93% oxygen, there are fewer molecules of

oxygen in every breath. For example, at an altitude of 2400-3000 m (i.e. typical of Kenyan and Ethiopian highlands), each breath contains approximately 70% of the oxygen molecules present in one breath at sea level. The pioneering studies of Francois Viault in the 1890s identified a number of common traits amongst indigenous high-altitude populations following adaptation to hypobaric hypoxia, such as raised haemoglobin concentration, large lung volume and a blunted hypoxic response (see West<sup>14</sup> for the history of high-altitude research). More recently, however, the homogeneity of the adaptive response to high altitude has been questioned following the finding of important differences in oxygen delivery traits between different indigenous high-altitude populations. For example, Andean highlanders have haemoglobin concentrations that are considerably higher than in people from Tibet, who have haemoglobin profiles similar to sea-level dwellers<sup>15</sup>. In contrast, Ethiopian highlanders are reported to have haemoglobin concentrations within the normal sea-level range, but differ from both Andean and Tibetan people by having much higher oxygen saturation<sup>15</sup>. As a result, the blood oxygen content of all three indigenous high-altitude populations differs strikingly from that in sea-level dwellers. These contrasts raise the intriguing prospect of genetic adaptation to high-altitude

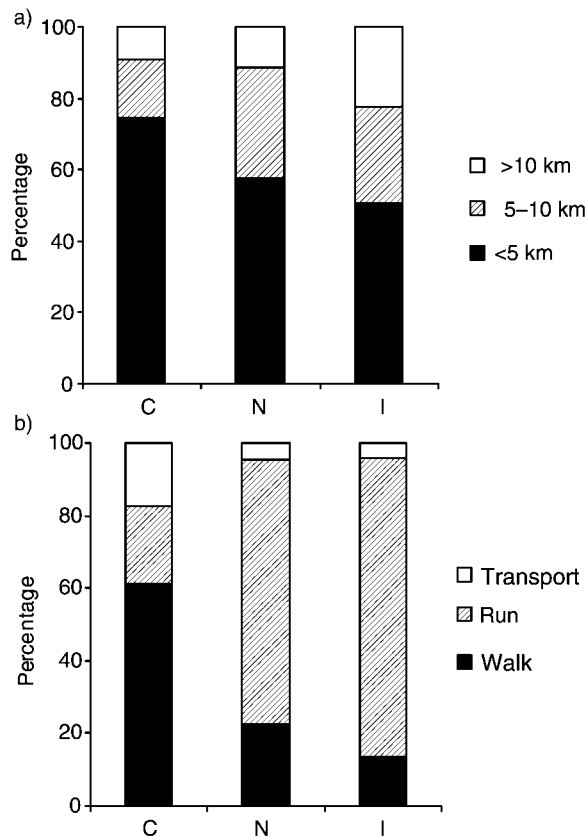


Fig. 2 (a) Distance travelled to school. Percentage of subjects travelling each distance to school is shown. All subject groups differed significantly from each other. (b) Method of travel to school. Percentage of subjects using each method of travel to school is shown. Controls (C) differed significantly from both athlete groups. National (N) and international (I) athletes were not significantly different in their distribution. Data from Onywera *et al.*<sup>8</sup>.

living that may be influenced by other environmental factors, such as physical fitness and nutritional status. Gene-environment interaction studies using available state-of-the-art techniques are now required to investigate the complex quantitative traits under high-altitude adaptation that are under the influence of many genetic loci (for a review see Scott *et al.*<sup>10</sup>).

### The Kenyan diet

The Kenyan running success story has also been attributed to the Kenyan diet<sup>3</sup> and a number of studies have now been carried out to investigate this. One of the first studies, performed by Mukeshi and Thairu<sup>16</sup>, evaluated the food intake of male Kenyan runners two days per month over a three-month period using a combination of dietary recall and direct observation. These authors found that the average daily energy intake was reported to be 2340 kcal, substantially less than the estimated average requirement (EAR; 2550 kcal day<sup>-1</sup>) for energy for the average male<sup>17</sup>. Based on current thinking, such low energy intake would render it 'impossible' to carry out and maintain

optimal endurance training. The athletes in this study consumed on average 441 g of carbohydrate daily (8.1 g kg<sup>-1</sup> body mass, approximately 75% of energy intake in the form of carbohydrate). Two other studies on Kenyan runners assessed the food and macronutrient intakes of male adolescents<sup>18</sup> and elite adult Kenyan runners<sup>19</sup>, and both reported considerably higher average energy intakes (i.e. range 2750–3558 kcal day<sup>-1</sup> and 2987 ± 293 kcal day<sup>-1</sup>, respectively). While the adolescent Kenyan runners were in energy balance, the elite Kenyan adult runners were in slight negative energy balance, which resulted in a 0.6 kg loss in body mass over the 7-day study period. In both studies, however, the food and macronutrient intakes of the runners fulfilled current recommendations for endurance athletes for carbohydrate, fat and protein intake. The carbohydrate intake of both adolescent Kenyan runners and elite adult runners was very high (i.e. daily intake was 71 ± 0.5% (mean ± standard deviation), 8.7 ± 0.4 g kg<sup>-1</sup> body mass and 76.5%, 607 ± 57 g, 10.4 g kg<sup>-1</sup> body mass, respectively), in line with current recommendations for optimal endurance performance. On the basis of these data, there is no evidence to support the notion that the Kenyan diet *per se* can explain the outstanding performances of Kenyan runners (see Christensen<sup>20</sup> for a review of the Kenyan diet).

The remarkably low energy intake of male Kenyan runners first reported by Mukeshi and Thairu<sup>16</sup> may therefore be accurate (the validity of this report was initially questioned<sup>18</sup>) and an important advantageous feature of the Kenyan diet with regard to distance running performance. For example, elite Kenyan distance runners have been found to have a lower body mass index (BMI) and a more slender body shape than elite Caucasian distance runners<sup>21</sup>. In a recent review of Kenyan dominance of distance running<sup>7</sup>, it was argued that lower BMI, body mass and leg circumference were responsible for the superior running economy first reported by Saltin *et al.*<sup>21</sup> (see Larsen<sup>7</sup> for a review of Kenyan running dominance with particular reference to superior running economy). Interestingly, Margaret Okeyo, the female Kenyan runner who won the London Marathon in 2004, weighed only 39 kg. This particular feature of the Kenyan diet and its resultant effects on body morphology/composition warrant further research attention.

### Motivational factors

Most Kenyan athletes become exposed to competitive running at a very young age through the traditional Kenyan way of life, experiencing at first hand aspects both of training and competition. Kenyan children and adolescents, especially from the Kalenjin community in the Rift Valley, come into frequent contact with

world-class athletes from the numerous high-altitude training camps managed by Olympians. In the recent demographic study of Kenyan runners<sup>8</sup>, a high proportion of both the national and international runners were motivated to run for economic reasons, tradition and Olympic glory. For example, 39% of national and 31% of international runners became athletes for economic empowerment; 10% of national and 18% of international runners became athletes due to the Kenyan running tradition; and 12% of national and 18% of international runners became athletes in the search of Olympic glory. Typically, Kenyan runners see athletics as a means of escaping poverty and making money to help their families, parents and siblings. Young athletes who show promise in regional competitions are signed and paid salaries by international agents, or are offered employment and run representing the prisons, military and the police. In other words, success on the track can bring quite dramatic change to the modest lives of Kenyans (i.e. 'life-changing' races). It is estimated that 40% of the total Kenyan population is unemployed and at least 50% lives below the poverty line; it would stand to reason, therefore, that economic factors would have a significant motivational role in the success of East African athletes in distance running.

## Conclusions

It is unlikely that a single factor is solely responsible for the unparalleled success that Kenyan distance runners currently enjoy and have enjoyed for the past 40 years on the international running circuit. Although multiple explanations have been proposed, no single factor is able to stand on its own without evidence against its likely contribution to enhanced distance running performance. Rather it appears that a number of factors, including the socio-economic conditions present in Kenya, the Kenyan way of life (including typical activities, the common method of travel - walking or running - and unfavourable living conditions), Kenyan culture and traditions, favourable environmental conditions such as living and training in areas of high altitude, anthropometry and morphology, in addition to one or more genetic components, may all contribute to the dominant force of Kenyan distance runners. The extent to which each of the putative contributors influences this phenomenon remains to be determined.

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