The Kalenjins: A look at why they are so good at long-distance running.

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Human Adaptability

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Introduction

When it comes to long distance running, certain populations, on average, have natural advantages: East Africans, North Africans from mountainous regions (Khalid Khannouchi), certain populations of East Asian ancestries including Amerindians (Takayuki Inubushi and Harumi Hiroyama of Japan, Mexico's Adriana Fernandez), and southern Europeans (Abel Anton of Spain, for example) who have a shared evolutionary history and a significant amount of gene exchange with continental Africa. The Kalenjin tribe of the Rift Valley in Kenya is so good at long-distance running that they win forty percent of the top international distance running events. They only make up .0005 percent of the whole population on earth. Their performance is extraordinary and has resulted in a variety of studies. Research in the field of sports medicine, sports training, genetics, evolutionary biology and anthropology is aimed at investigating the Kalenjin phenomena.

The purpose of this paper is to examine the Kenyan tribe of elite long-distance runners called the Kalenjins and to try to understand how they evolved to be such superior runners. Is it because of their lean bodies and with a large lung capacity? Is it because they live in a high altitude or is it because of their diet and training? Also, does being black them in any way? This paper will look at these questions and try to answer them appropriately.

Results

The Kalenjins are a group of tribes totaling about 3 million living in Kenya's Rift Valley. They live on a plateau about 7,000 feet above sea-level. The Kalenjins are believed to have migrated from the region of Sudan about 2000 years ago to their present location. The Kalenjin broke up into several smaller groups becoming mostly cattle rustlers and warriors. (Entine 2000:49) One of the native groups called the *Chemwal* means "raid cattle." Some of the other smaller native groups besides the Chemwal are the Nandi, Terik, Tugen, Keiyo, Marakwet, Pokot, Sabaot, and the Kipsigis. There are over 35 different groups. What these groups share is the ability for endurance racing. They dominate this sport and other groups have not been able to replicate the performance of the Kalenjin runners despite replicating the training and the dietary routines. Their abilities have been studied in many venues as science and sport try to uncover the secret of their remarkable ability. The Kalenjins are the superstars of long distance running producing world class athletes at 9.79 times the world per capita norm. Tanzania, Kenya's neighbor to the south, only produces world class athletes at .22 times the world per capita norm. Of the past 14 Boston marathons, 13 of them have been won by a Kenyan. Kenyan men hold the world records in the 3,000 (km); 15000; 20,000; 25,000; the half marathon, and the marathon. Not to be left out, the Kenyan women hold 5 out

of the top ten marathon times and have the world records in the 20,000 (km); 25,000; and 30,000 km track races. (Entine 2000:30)

Running Studied

A variety of studies have looked at muscle, skeleton and body type to analyze the factors contributing to \both endurance and speed. An essential clue is the Kalenjin's capability to withstand fatigue longer. Lactate which is produced by exhausted, oxygen deprived muscles, builds up more slowly in their blood. That allows them to gain 10% more distance from equivalent oxygen intake as Europeans. (Holden 2004:637) Kalenjins have an elevated concentration of an enzyme in their skeletal muscle that stimulates high lactate turnover and low lactate production. Kalenjins are able to convert oxygen into energy more efficiently than other groups. The capacity of the skeletal muscles to use oxygen has both genetic and training components. Kravitz and Robergs explain:

> The capacity of skeletal muscle to utilize oxygen has strong genetic and training components. The maximal ability of skeletal muscle to utilize oxygen will depend on the proportion of slow twitch muscle fibers in the working muscle, as well as the endurance training nature of the muscle. slow twitch muscle has a higher capacity to consume oxygen than fast twitch muscle, and the proportions of these fibers are developed during fetal life and consolidated during infancy. Strength or endurance training can not change these proportions. However, strength and endurance training can alter the capacities of these fibers. For example, endurance training will increase the ability of certain fast twitch muscle fibers to use oxygen, thereby increasing the endurance potential of the muscle. conversely, strength or sprint training will detrain the oxygen uptake capacity of slow twitch muscle, and train fast twitch muscle to better utilize muscle glycogen and the ability to continue generating ATP at high rates with minimal oxygen consumption (Kravitz and Robergs, 1995:70).

Proving a genetic reason for the endurance running ability of the Kalenjin's has been the most difficult and controversial aspect of determining the reasons for their successes. Geneticists cannot find out yet which genes are vital for enhancing running performance. Therefore it is not known if the Kalenjins have better genes that aid them in long distance running but it is clear that there are many interactions genetics plays on exercise.

Altitude also plays a role in the Kalenjin's success. At the elevated altitude at which they live, oxygen levels in the atmosphere begin to drop. To make up for the lack of oxygen, the body has to increase the amount of red cells transporting oxygen in the blood. (Sutton 1993:4) According to Dr John R Sutton of the Health Sciences of the University of Sydney (Sutton 1993:4), high altitude can have dramatic effects on sport performance. He noted that because endurance performance depends highly on aerobic metabolism and very little oxygen is stockpiled in the body, the assumed advantage of high altitude training must include effects on the carrying and consumption of oxygen. Oxygen transport and utilization requires a sequence of closely incorporated links involving the lungs and breathing, the transfer of oxygen from the pulmonary alveoli to the blood, the carriage of oxygen by the blood in association with hemoglobin, the pumping of oxygenated blood around the body by the heart, the distribution of the oxygenated blood to the working muscle

and the extraction of the oxygen and its use in metabolism by working muscles. Sutton also states that the maximum capability to distribute, remove and make use of oxygen is referred to as one's maximal oxygen uptake or VO2max. The basic components of VO2max are demonstrated in **Figure 1. Figure 2** shows how maximal oxygen uptake declines more and more with increasing altitude.

> The activities of key enzymes involved in aerobic metabolism in muscle will also increase on ascent to altitude as will the capillary density and mitochondrial density in skeletal muscles. However, much of the increase in capillary density and mitochondrial density are not true increases in absolute capillaries or number of mitochondria but instead are due to a loss of muscle mass. (Sutton 1993:7)

The main adjustment to exceedingly high altitude appears to be increased ventilation, increased hemoglobin concentration, and improved maximal oxygen removal.

Science has also looked at the nutritional factors that may influence performance for Kalenjin runners. The Kalenjin diet is very basic: small amounts of roasted meat, cooked greens and other vegetables, fruit, eggs, milk and their favorite—ugali. They eat ugali daily which is basically like stiff grits. It is made from white corn flower, water, and salt and is very bland. They use it as a base and add things to it. (Eberle 2000:45) Ugali's central role in the Kalenjin diet provides richness in carbohydrates and very little fat. The greens, fruit, and milk give them essential nutrients. The Kalenjins eat two times a day and are very

adamant about not eating fatty foods and sweets. (Eberle 2000:45) Diet can be replicated but its effects on highly conditioned runners have been nominal.

One of the central issues that develop from the study of the Kalenjin runners of Kenya is that of race. Anthropologists debate whether the human races are genetically different. Stephen J. Gould states repeatedly that "Human equality is a contingent fact of history (Gould, 1985:198)." "Human races are not separate species or ancient divisions within an evolving plexus. They are recent, poorly differentiated subpopulations of our modern species, *Homo sapiens,* separated at most by tens or hundreds of thousands of years, and marked by remarkably small genetic differences." (Gould, 1985:191) Gould argues that there is no 'race gene', a gene that exists in all members of one group and none of another group. That is, there are no important genetic differences between the races. Gould states, "Human groups do vary strikingly in a few highly visible characters (skin color, hair form) – and these external differences may fool us into thinking that overall divergence must be great. But we know that our usual metaphor of superficiality – skin deep – is literally accurate." (Gould, 1985:196) Gould argues that the human race is young and that the division into races is even more recent. There has not been enough time for substantial and accumulated differences that are deep and genetically significant in their distinctions to have distanced the races into separate species. Gould sums it up: "Racial variation is quantitatively insignificant (for genes) and,

quite literally, a superficial (for bodies) aspect of the biology of our species (Gould, 1985:198)."

Richard Lewontin helped his Harvard colleague, Gould, from his perspective as a geneticist. "When we [geneticists] found that there were practically no genetic differences between groups except skin color and body form and a few things like that, it became a great deal less likely and less interesting to talk about genetic differences between groups. And the consequence is that from the biological standpoint those major so-called races – black, brown, yellow, white and red – were not biologically interesting (Lewontin, 1995:97)." Eighty-five percent of genetic differences between individuals are, according to Lewontin, within races rather than between races. Genetic research does not support race as a factor in human differences that exist in subpopulations. Adaptations stemming from the evolution of humans evolving in radically different climates and ecologies occurs in ethnic groups but is not represented in the total population.

The theories of evolutionary change that demand great periods of time and lead to strong genetic differences are disputed by anthropologists who hold that race is important to the understanding of human adaptations and to differences between races. They view Gould's arguments as being politically correct but invalid. J. Phillipe Rushton asserts that it enormous variations in environment throughout the history of human evolution would naturally produce differences between races (Rushton, 1996:579). Different selection patterns for

survival resulted in distinctions in intelligence and physical attributes between races. The essential argument is the fact that the percentage of differences is far less important than which genes are different. Evolutionary and hence, genetic models are needed to explain multifarious sets of disparate data (Rushton, 1996:579). Minute differences in DNA can have profound differences while significant apparent variations between species may be genetically insignificant.

In *Racism,* Sarich and Miele provide extensive, specific scientific support for their rationale that human differences are, in fact, a case for race as a biological concept. Data and differences exist in discrete groups and reasonable evolutionary explanations are attached to the division. The study of marked group differences provides evolutionary perspective to the analysis of human variation. (Sarich, 2004:10) When Sarich writes of the dominance of black athletes in certain sports, he clearly points to genetics as the source of their achievements: "Africans are better than the rest of us at some of those things that most make us human and they are better because their separate African histories have given them, in effect, better genes for recently developed tests of some basic human adaptations. The rest of us or, more fairly, our ancestors have had to compromise some of those African specializations in adapting to more temperate climates and more varied environments." (Sarich, 2004:183). Sarich and Miele argue that the genetics of race have been buried because of cultural and political controversy. When the issue is regarded through

observable, replicable science, genetics indicate that the races and ethnic populations within the races are different.

The significance of the differences between Gould racial differences based on genetics and evolutionary adaptations is important. If there is a 'running gene' or a 'jumping gene' then there are scientifically distinguishable elements of race that can be identified and validated. This means that the issues of brain size and intelligence will be back in the realm of scientific investigation. The very idea that there are genetic differences between races has been problematic for anthropologists because it ignites the debates of brain size that lead to larger political and cultural issues of racism. Jensen has argued that because there are differences in intelligence between the races, no amount of compensation, schooling or nurture will bring equality. Jensen states that "the fact of substantial heritability of IQ within populations does increase the a priori probability that the population difference is attributable to genetic factors (Jensen et al., 1976:79)." Lewontin counter argues that it is not possible to infer the structure of a complex machine from a few descriptive parameters (Feldman, 1975:1163). He states in his case against Jensen's methodology, "Certainly the simple estimate of heritability, either, in the broad or narrow sense, but most especially in the broad sense, is nearly equivalent to no information at all for any serious problem of human genetics." Even the issues of how to acquire and analyze data are controversial in the studies involving race and genetics. The entire argument for genetic differences between the races is linked to culture, to

habit and to environment. There are many conditions and variables in the study of human evolution that suggest that adaptations by small populations within a larger racially distinct group are inevitable. This does not mean that the races are distinct one from another in significant genetic ways. It means that a subgroup has developed a particular adaptation growing from environmentally diverse conditions. The Kalenjin people of Kenya are not representative of all black people. They are a distinct group living in the Rift Valley of Africa who have specific chemical and physical features that allow them to run effectively over long distances. This is adaptation. It is not evidence of genetic characteristics of a race that are part of what makes that race unique from another.

Individual differences occur in all populations. That is not debated. Whether traits shared by a distinct group of individuals constitute an argument for scientific evidence of distinct races based on genetics is arguable. Adaptation seems to be a plausible and scientifically grounded argument for populations to be different but does this mean that the races are ultimately distinguishable genetically? This area of research is in its fledgling stages and the evidence gathered from studying the Kalenjins will certainly contribute to the direction of the argument. Scientists are already linking endurance running and human evolution. Bramble and Lieberman assert that endurance running is a derived capability of *Homo sapiens,* and may have been instrumental in the evolution of the human body form. Sustained long distance running produces a diverse array

of features many of which leave traces in the skeleton (Bramble, 2004 432:345). Fossil evidence of these features suggests that endurance running is a derived capability of our genus originating about two million years ago (Walking upright was skeletally established approximately 3.12 million years ago) (Bramble, 2004 432:345). One theory suggests that early humans were savannah scavengers who needed to run to survive. Endurance running allowed this species to chase off predators and carry away the prey. "Such activity would require endurance for long periods of time necessary to search for food (Trujillo and Effland, 1996)." Human evolution can, then, be viewed as interplay between the environment and the human lineage's evolving predisposition, adaptability and versatility (Selig, 1999:23). Bipedalism altered the way human ancestors interacted with the environment. Biped walking and upright posture was a crucial adaptation that transformed the evolutionary process. Running followed with less significance but with a strong links to the more open habitats that developed three to four million years ago. The debate on race and the debate on the reasons for bipedalism will continue. Inquiry is the nature of science even when controversy dominates the discussion.

Discussion

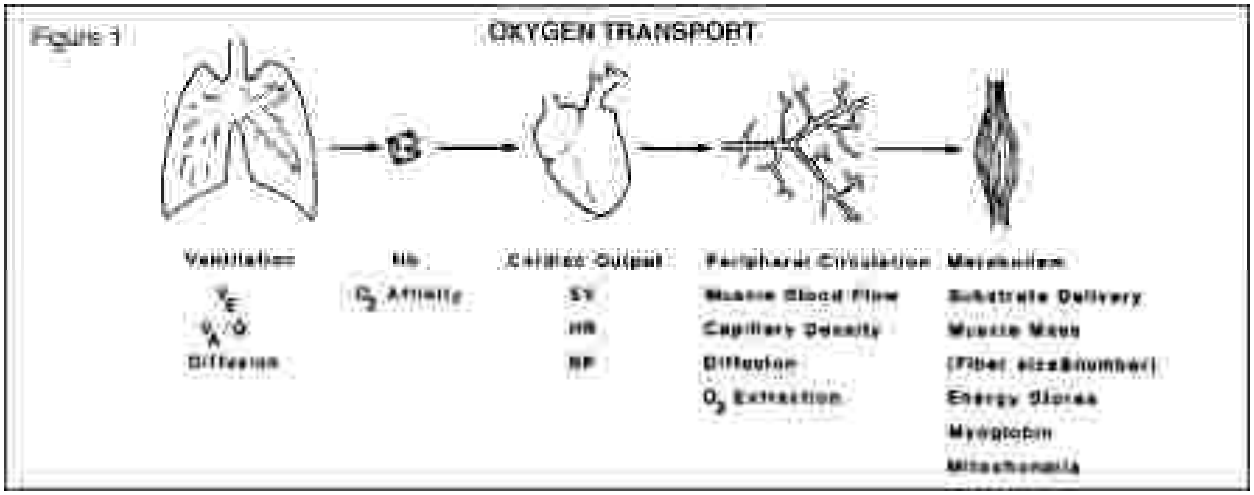
Scientific evidence of genetic differences in the Kalenjin group is accumulating. Yet it would not be good science to suggest that the genetic adaptations of a small population can be used to formulate a hypothesis about race. The Kalenjins are superior endurance runners. They are black Africans. This cannot equate that all black Africans have the genetic resources to compete internationally in endurance races. A Kalenjin advantage is indicated and only a Kalenjin advantage. If there is a biological advantage for the Kalenjins that advantage belongs to the Kalenjins, neither to East Africans nor to all blacks. Adaptations in specific populations are limited to that population and to their specific evolutionary history. There is little science that supports the notion that race is a genetic factor of the human population. What is suggested is that the relationship between sport, culture and genetics is complex. Arizona State University evolutionary biologist Joseph Graves states, "The fact that monolithic racial categories do not show up consistently in the genotype does not mean that there are no group differences between pockets of populations (Graves, 2001:125)." Ethnic groups within races exhibit environmental differences and these differences are expected to play a central role in shaping differences in adult phenotypes. They say little about entire races. Differences in athletic performance must result, in some part, from genetic differences. Some of the differences are clustered in particular populations and regions. This does not mean that the Kalenjins or any other distinct population is a race.

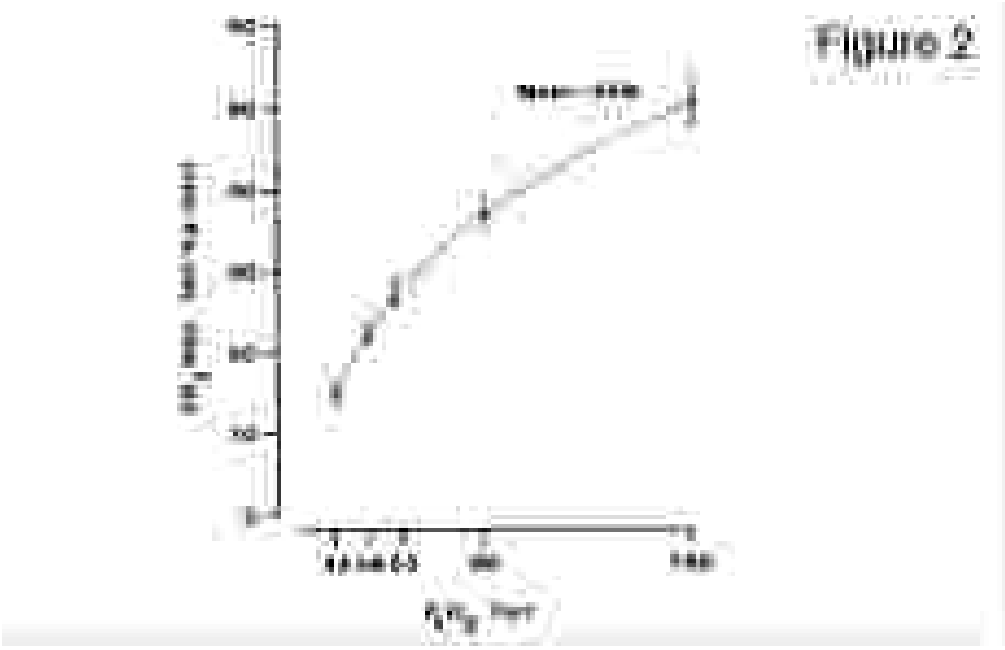
Rushton argues for genetic evidence of race. He asserts a trade-off between brain and brawn occurred during the early evolutionary history of humans. His evidence is in the relationship of the pelvic girdle size of Asian, white and black women. Rushton's line of reasoning is that Asian and white children are born with bigger heads than black infants. This then, he argues, indicates that the black women with smaller pelvic girdles are better suited to running. This also indicates to Rushton that Asians and whites are smarter. There has been an evolutionary trade off between brain and brawn (Rushton, 1996:579). The debate about differences in sporting ability and intelligence must come from evidence and data. Rushton assumes that that is what he is doing. He is confusing racial and population differences. Different population groups are physically distinct. This fact does not mean that such differences can be reduced to racial distinctions. Divisions of the world into white, black, and oriental races are as rooted in social convention as it is in genetics. The distribution of one physical or genetic characteristic is not necessarily the same as that of another (as skin color compared to blood group). Races might just as easily be aligned according to lactose tolerance, sickle cell or any other genetic trait (Malik, 2000:129). In Graves's book on race science, he states, "Populations with roots in equatorial Africa are more likely to have lower natural fat levels. That is likely a key factor in running. It's an adaptive mutation based on climate. It varies by characteristic. It doesn't necessarily correlate with skin color, but rather by geography. But that's a long way from reconstructing century old race

science." Alan McGowan of the Gene Media Forum concurs (McGowan, 2003:20). He maintains that there may be genetic factors and environmental and cultural ones but there is not a black-white issue. "Rather, a particular people living as cattle herders in the Rift Valley have developed this capacity to run better than most others. Most other Kenyan tribes people run as slowly as anybody else in the world." (McGowan 2003:20)

Genetic research will continue. Data will be gathered. The research is just beginning to put together the programs that will allow behavioral or cognitive traits to be matched to their specific genes. The genes that have selective value under different ecological conditions, such as genes for intelligence, introversion, religiosity and many more are of interest to those who study racial differences. But the real debate will come when the evolutionary biologists, the geneticists and the anthropologists sift the data and analyze the results. There will, most likely, be no common conclusions. The field has too many variables and too many ways of looking at the variables for there to be any final, conclusive theory.

Tables and Figures





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