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Exercise Like a Hunter-Gatherer: A Prescription for Organic Physical Fitness

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Abstract A large proportion of the health woes beleaguering modern cultures are because of daily physical activity patterns that are profoundly different from those for which we are genetically adapted. The ancestral natural environment in which our current genome was forged via natural selection called for a large amount of daily energy expenditure on a variety of physical movements. Our genes that were selected for in this arduous and demanding natural milieu enabled our ancestors to survive and thrive, leading to a very vigorous lifestyle. This abrupt (by evolutionary time frames) change from a very physically demanding lifestyle in natural outdoor settings to an inactive indoor lifestyle is at the origin of many of the widespread chronic diseases that are endemic in our modern society. The logical answer is to replicate the native human activity pattern to the extent that this is achievable and practical. Recommendations for exercise mode, duration, intensity, and frequency are outlined with a focus on simulating the routine physical activities of our ancient hunter-gatherer ancestors whose genome we still largely share today. In a typical inactive person, this type of daily physical activity will optimize gene expression and help to confer the robust health that was enjoyed by hunter-gatherers in the wild. (Prog Cardiovasc Dis 2011;53:471-479)

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Physical exercise and fitness are decreasing in our society, in children, and in adults.[1] A large body of evidence shows that regular physical activity (PA), whether it be endurance training (sustained aerobic exercise), resistive (strength) training, or cross-training (a mixture of the 2, with a focus on conditioning major muscle groups and improving overall fitness), has many health benefits including improvements in cardiovascular (CV) risk factors, CV prognosis, and life expectancy.[2] Daily PA substantially alters the expression of a substantial proportion of the genes that comprise the human genome.[3,4] These exercise-induced changes in genetic expression result in immediate but transient improvement in many parameters including CV, musculoskeletal, pulmonary, and general fitness; glucose and lipid metabolism; blood pressure; autonomic balance; mood; sleep quality; and immunity.[5] These profound and far-reaching changes in genetic expression may explain why CV fitness and daily energy expenditure on PA are among the best predictors of long-term health and survival.[3-8] Indeed, large observational studies have found that, among all clinical and exercise test variables assessed, fitness level, as measured by performance on a treadmill exercise test, is the strongest correlate of freedom from all-cause mortality (Fig 1).[7,9] Daily PA level has also been found to be highly correlated with long-term survival

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Abbreviations and Acronyms

CV = cardiovascular

PA = physical activity

(Fig 2).[8] Moreover, improved levels of daily physical exercise in previously inactive middle-aged individuals reduced all-cause mortality rates during follow-up as well as does smoking cessation.[8]

From the emergence of the human genus, *Homo*, about 2.4 million years ago,[10] our ancestors, for approximately 84,000 generations, survived as hunter-gatherers.[11] To survive in the wild required large expenditure energy on a daily basis for requisite activities such as foraging and/or hunting for food and water, social interaction, confrontation with or flight from predators, making and maintaining shelters and clothing, and other. This way of life represents the prototypical PA regimen for which our genome remains adapted. Accordingly, humans are highly capable of performing the wide variety of PA required of a forager in the wild. Dramatic advances in technology such as those that ushered in the agricultural revolution (350 generations ago), the industrial revolution (7 generations ago), and the digital age (2 generations ago) have resulted in large systematic reductions in the amount of physical work demanded of humans in their day-to-day routines.[12,13] Particularly for the past 2 or 3 generations, technological advancements have, in many cases, completely eliminated the need for PA in our daily regimens. Notwithstanding, our inherent exercise capabilities and needs that were selected for more than tens of thousands of years remain essentially unchanged as compared with our Stone Age ancestors. The profound and progressively wider discrepancy between current day PA and the indigenous *Homo sapiens*' exercise patterns predictably results in atrophy, disability, and disease. Accordingly, the archetypal hunter-gatherer's daily physical exercise regimen would seem to be the logical template to use when devising an ideal exercise program for humans today.[14]

Fitness for life in the wild

Approximately 10,000 years before the current era, a small tribe of Middle Eastern people discarded their hunter-gatherer lifestyle, choosing instead to domesticate animals and cultivate plants. These revolutionaries planted the first seeds of agriculture and, in so doing, followed a different lifestyle than that followed by all prior humans. What began as a rebel way of life in the Middle East was ultimately adopted around the globe and eventually drove the hunter-gatherer lifestyle into extinction. Save for a few secluded tribes in Amazon rain forests and on the Andaman Islands in the Bay of Bengal, unmodernized hunter-gatherer societies no longer exist.[5] Ironically, as the last of the hunter-gatherers cultures became extinct, modern science is coming to understand the importance of this lifestyle to the health of all humans

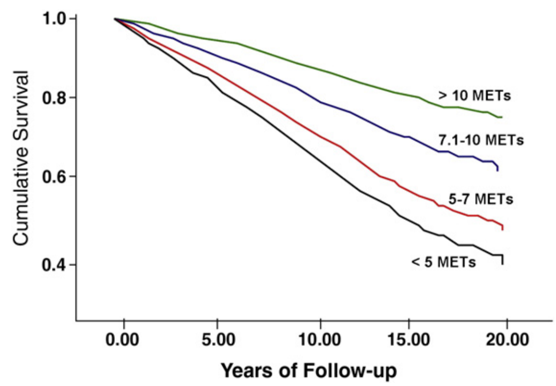

Fig 1. Long-term mortality as a function of fitness is closely associated with fitness as assessed by peak exercise level achieved on a maximal treadmill exercise test. Reproduced with permission from Kokkinos et al.[7]

alive today.[15,16] In comparison with the millennial pace of genetic evolution, human technological and social evolution has occurred at light speed. This incongruence has left us genetically adapted for the demands of life as a forager in the wild despite the fact that we are living in a high-tech, sedentary, overfed, emotionally-stressed 21st century world. The instinctive solution to this conundrum is to replicate the PA patterns of our Stone Age hunter-gatherer ancestors.

Anthropologist Kim Hill, PhD, had the unique experience of what it was like to "run with the hunt." He spent 30 years living with and studying the Ache hunter-gatherers of Paraguay and the Hiwi foragers of Southwestern Venezuela. His descriptions of these hunts that occurred decades ago represent a rare glimpse into the PA patterns that were inherent in the hunter-gatherer way of life.

> "I have only spent a long time hunting with two groups, the Ache and the Hiwi. They were very different. The Ache hunted every day of the year if it didn't rain. Recent GPS data I collected with them suggests that about 10 km (kilometers) per day is probably closer to their average

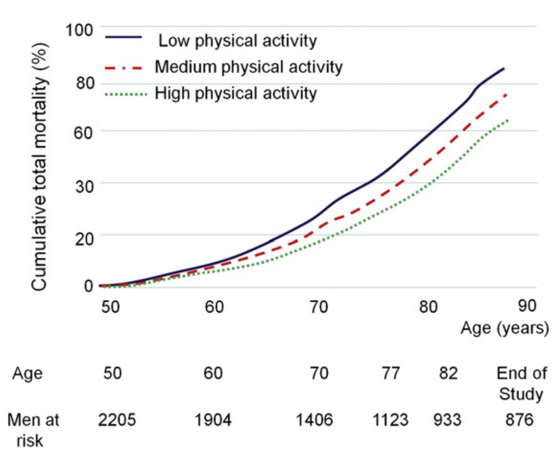

Fig 2. Reduction in long-term mortality in proportion to the amount daily PA performed. Reproduced with permission from Byberg et al.[8]

distance covered during search. They might cover another 1-2 km per day in very rapid pursuit. Sometimes pursuits can be extremely strenuous and last more than an hour. Ache hunters often take an easy day after any particularly difficult day, and rainfall forces them to take a day or two a week with only an hour or two of exercise. Basically they do moderate days most of the time, and sometimes really hard days usually followed by a very easy day. The difficulty of the terrain is really what killed me (ducking under low branches and vines about once every 20 seconds all day long, and climbing over fallen trees, moving through tangled thorns etc.)

“The Hiwi on the other hand only hunted about 2-3 days a week and often told me they wouldn't go out on a particular day because they were ”tired”. They would stay home and work on tools etc. Their travel was not as strenuous as among the Ache (they often canoed to the hunt site), and their pursuits were usually shorter. But the When I hunted with Machiguenga, Yora, Yanomamo Indians in the 1980s, my days were much, much easier than with the Ache. And virtually all these groups take an easy day after a particularly difficult one.

The Ache do converse and even sing during some of their search, but long distance peccary pursuits are too difficult for any talking. Basically men talk to each other until the speed gets up around 3 km/hour which is a very tough pace in thick jungle. Normal search is more like about 1.5 km/hour, a pretty leisurely pace. Monkey hunts can also be very strenuous because they consist of bursts of sprints every 20-30 seconds (as they monkeys are flushed and flee to new cover), over a period of an hour or two without a rest. This feels a lot like doing a very long session of wind sprints.”

“Both my graduate student Rob Walker and Richard Bribiescas of Harvard were very impressed by Ache performance on the step test. Many of the guys in their mid 30s to mid 50s showed great aerobic conditioning compared to Americans of that age. While hunter gatherers are generally in good physical condition if they haven't yet been exposed to modern diseases and diets that come soon after permanent outside contact, I would not want to exaggerate their abilities. They are what you would expect if you took a genetic cross section of humans and put them in lifetime physical training at moderate to hard levels. Most hunting is search time not pursuit, thus a good deal of aerobic long distance travel is often involved (over rough terrain and carrying loads if the hunt is successful).

“So the bottom line is that foragers are often in good shape and they look it. They sprint, jog, climb, carry, jump, etc all day long but are not specialists.”[5]

Fitness among forager women

Hunter-gatherer women almost never participated in the hunting of large game animals[17]; nonetheless, they typically stayed physically fit by performing their requisite daily activities. Historical accounts of hunter-gatherer tribes living in the wild indicate that women typically went out foraging for food every other or every third day. Women gathered vegetables, fruits, berries, nuts, tubers and other plant foods; yet, they also foraged for animal food sources such as turtles and other small reptiles and amphibians, shellfish, insects, bird eggs, and small mammals.[17-19] Women generally foraged in groups, walking sometimes for hours to find, retrieve, and carry home items such as food, water, and wood. Women would also help to carry butchered game back to camp. These foraging efforts often demanded digging, climbing, bending, and stretching and frequently involved carrying heavy loads back to camp.[5] In addition, these hunter-gatherer women often had to carry their children for long distances. The average forager-mother carried her child until he or she was about 4 years, covering upwards of 3,000 miles with the child in her arms or on her back during this interval of time.[20] Other routine female responsibilities included tool and shelter construction and repair, butchering, food preparation, and socialization. Communal dances were often an central recreational activity for these cultures and could be held as often as several nights a week, often lasting for hours.[21] Table 1 displays examples of common hunter-gatherer activities and their modern equivalents as well as the associated number of energies burned.[5]

Our genetic adaptation to physical labor

Evolutionary forces crafted the human genome during the course of thousands of generations; this genetic adaptation allowed our remote ancestors to not only survive the physical demands and challenges faced on a daily basis by a hunter-gatherer but also to thrive in response to these adversities.[22] Similar to the case where bone and muscle, when relieved from the strain of resisting gravity, grow atrophied and weak, a human being, when unchained from the highly variable and physically taxing daily chores that were required of the hunter-gatherer lifestyle and instead relegated to an indoor overfed sedentary existence, becomes ridden with disease and debility. The rationale behind the effectiveness of daily cross-training is written in our genome, which was forged via natural selection to allow us to thrive within the hunter-gatherer niche.

For humans surviving in the wild as foragers and hunter-gatherers, a physically active lifestyle was not optional—their demanding world required daily manual labor of a highly variable nature for their entire life.[5] An adult hunter-gatherer would not consider going out for a recreational run or repetitively lifting a heavy stone simply to build his or her fitness level. Indeed, through natural selection, we have an instinct compelling us to “move when we have to, and rest when we can.” A significant portion of each day was spent performing physical chores required of everyday life (Table 2). Except for children under age 5 years and those who were infirm or disabled

Table 1
Energy cost of various hunter-gatherer or forager activities and recommended equivalent modern activities[5]

Hunter-gatherer activity	Modern equivalent activity	Energy (kJ/h) 176-lb man	Energy (kJ/h) 132-lb woman
Carrying logs	Carrying groceries, luggage	893	670
Running (cross-country)	Running (cross-country)	782	587
Carrying meat (20 kg) back to camp	Wearing a backpack while walking	706	529
Carrying a young child	Carrying a young child	672	504
Hunting, stalking animals	Interval training	619	464
Digging (tubers in field)	Gardening	605	454
Dancing (ceremonial)	Dancing (aerobic)	494	371
Carrying, stacking rock	Lifting weights	422	317
Butchering a large animal	Splitting wood with an axe	408	306
Walking—normal pace (field and hills)	Walking—normal pace (outside on trails, grass, etc)	394	295
Gathering plant foods	Weeding a garden	346	259
Shelter construction	Carpentry, general	250	187
Tool construction	Vigorous housework	216	162

because of illness or advanced age, everyone did a wide variety of physical activities on a daily basis. Retirement was not an alternative for hunter-gatherers. The activities required of their day-to-day existence were the only exercises that Stone Age people would have ever needed to do to maintain excellent general fitness.[21] Instincts to conserve energy, strength, and stamina for these obligatory physical efforts conferred survival advantages to the hunter-gatherer. These instincts, still coded for in the genome of modern humans, are now counterproductive in the inactive high-energy milieu in which we live in the 21st century. Our inborn tendency to choose the path of least resistance while existing in our highly convenient mechanized urban environment means that most Americans rarely, if ever, physically exert themselves anymore, which leads to obesity, poor physical fitness, depression, debility, and disease.

Table 2
Energy expenditure on physical activity: hunter-gatherers vs modern Humans[23]

Species	Sex	Total daily energy expenditure*	Energies for PA*	Daily distances covered (km)
Fossil hominids				
Homo habilis		2,387	983	
Homo erectus		2,731	1,214	
Homo sapiens (early)		2,880	1,284	
Hunters-gatherers				
Kung	M	2,178	903	10
	F	1,770	600	8
Ache	M	3,327	1,778	16
Sedentary modern humans				
	M	2,000	306	2.4
	F	1,679	231	2.4

Abbreviations: M indicates male; F, female.
* Values are displayed in kCal.

Ideal exercise patterns

To date, most of the information from scientifically sound studies indicates that an exercise program incorporating elements of physical activities performed by hunter-gatherers or foragers would be expected to confer a high level of multifaceted fitness and other health benefits. Many of the positive health effects of exercise are realized by going from a sedentary lifestyle to even a relatively low-to-moderate levels of regular PA.[24] In 1 study, continuous higher intensity exercise, such as running at a slow pace for 32 km/wk, was not significantly superior to walking 19 km/wk for improving features of the metabolic syndrome.[25] In contrast, a routine of 45 to 90 minutes of cumulative daily PA appears to be necessary for most overweight or obese adults to attain and sustain their body weight in the ideal range.[26] Many programs have emphasized the “10,000 steps each day” strategy that focuses on total daily energy expenditure rather than a discreet period dedicated each day solely for exercise. This exercise program typically entails walking for short periods intermittently throughout the day, generally at varying speeds.[27] The combination of aerobic and strength training has been shown to be better to either alone for improving hyperglycemia for individuals with type 2 diabetes mellitus.[28] Interval training deploying intermittent short bouts of intense exercise with intervening rest and recovery periods is a strategy that has been proven to produce better weight loss, superior glucose control, and greater fitness gains than equivalent or longer amounts of continuous lower intensity activity.[29,30]

Although indoor PA can be expected to confer substantial health benefits,[31] some evidence suggests exercise performed outside may provide added benefits for health and well-being.[32] Outdoor exercise usually provides an opportunity for sunlight exposure that stimulates the epidermis to synthesize vitamin D.

Deficiency of vitamin D is an increasingly prevalent and potent risk factor for many health problems including CV disease.[33] Although vitamin D can be ingested orally, the vitamin D that is produced in the skin upon exposure to ultraviolet B rays maintains serum 25 (OH) vitamin D levels longer.[34] In addition, PA performed outside tends to reduce emotional stress and improve mood better than indoor exercise.[35,36] Individuals who regularly exercise outdoors, especially in natural settings such as those containing grass, trees, and bodies of water, may have better long-term adherence with their exercise regimen than people who habitually perform indoor fitness activities.[36] Moreover, evidence indicates that a 1-hour walk in a natural outdoor environment enhanced memory performance and attention span significantly better than a similar 1-hour outdoor walk through crowded urban streets.[35] Various weather conditions (warm and sunny, cold and overcast, etc) did not affect the superiority of exercise in a natural milieu compared with an outdoor urban man-made environment.

Rest and cross-training

Beginning at age 5 or 6 years until they were debilitated from old age or illness, hunter-gatherers would have done a range of PA each day[37]; and they would, when possible, alternate difficult days with easier days.[21] Their regimens called for physical efforts that developed CV and pulmonary endurance, flexibility, and strength, thereby conferring multifaceted fitness upon them.[37] These highly variable routines of PA would have also improved their resiliency and reduced the likelihood injury, allowing them to forage and hunt with fewer major interruptions because of incapacitation.

Researchers today have reported that the same pattern of alternating a strenuous workout 1 day with a less demanding one the next day produces superior fitness with lower risk of injury.[38] Exercise physiologists have documented that an individual's aerobic capacity will improve based upon exercise frequency, intensity, and duration.[39] Among these 3 variables, exercise intensity has the most powerful effect in optimizing the aerobic capacity, especially in an individual who is already exercising regularly.[30,39] On the other hand, as the intensity of exercise increases, the chances of injury and illness escalate.[40] Therefore, strenuous interval workouts generally should not be performed more than twice weekly to minimize the risk of injury.

Hunter-gatherers, by necessity, were cross-training as a mandatory aspect of life in the wild. This pattern of exercise has been found to augment performance among many sports. For instance, when weight lifting was added to the varsity swimming program at Indiana University 50 years ago, it was considered as a novel strategy that improved strength, enhanced performance, and made the athletes more injury-resistant.[41] Now, most coaches for endurance sports include cross-training exercises such as strength and flexibility training into their teams' fitness routines.[42-44]

The dangers of excessive exercise and inadequate rest

Although regular PA is, without question, highly protective, emerging data[45] indicate that extreme exercise may be detrimental to general and CV health. Protracted and excessive CV exercise, such as marathons, ultramarathons, full-distance triathlons, and very long distance high-intensity bicycle rides, is incongruent with our genetic legacy. Even among the extremely active Ache hunters, average daily distances covered were approximately 6 miles. The types of exercise for which we are evolutionarily adapted include a variety of activities performed intermittently, at moderate intensities, for moderate durations. High-intensity extreme endurance exercise lasting more than a few hours even in highly trained individuals is associated with damage to the myocardium, joints, and muscles.[46-49]

A large number of studies have indicated that repetitive, prolonged, and intense aerobic activity may increase CV risk, possibly resulting from excessive physiological demands and protracted elevations of free radical–induced oxidative stress. Elevated biomarkers such a troponins suggesting myocardial damage have been documented immediately after marathon running.[50] A study of more than 100 middle-aged marathon runners reported higher levels of coronary calcium compared with risk-factor matched nonrunners, and their risk of CV events during follow-up was similar to that noted for a coronary disease population.[51] One case report demonstrated a 3-vessel disease in a 49-year-old marathon runner without risk factors and documented protracted oxidative stress with prolonged running.[52] Other studies evaluating elite runners found that those individuals who participated in a large number of competitive long-distance races had increased fibrosis in the myocardium, and the degree of the scarring in the heart muscle correlated directly with the number of marathons or ultramarathons (50-mile races) completed and number of years spent training.[53] In addition, long-term extreme exercise has been proven to induce myocardial fibrosis and dangerous ventricular arrhythmias in animal models of excessive long-distance running.[54] Hypothetically, extreme exercise–induced excessive myocardial demands and protracted oxidative stress might cause micronecrosis in the myocardium, as documented by elevated troponin levels. With time and recurrent excessive efforts, this scarring may coalesce into myocardial fibrosis, the pathological significance of which is currently unknown.

Abnormally increased left ventricular mass and enlarged cardiac chamber sizes usually develop because of high-level, intense, long-term exercise especially among cyclists, cross-country skiers, and rowers.[55] These athletes often have abnormal electrocardiograms and complex ventricular ectopy and rarely can die of sudden cardiac arrest.[56] In addition, long-term, high-intensity, long-distance bicycle training/racing has been associated with osteopenia in elite cyclists, especially in the spine.[57]

Naturally reestablishing energy balance

For all *Homo sapiens* before relatively recent times, energy intake (food) and energy expenditure (PA) were closely related. When our ancient ancestors were hungry, they had to hunt, gather, forage, fish, and other.[5] Hunger, or even the threat of food scarcity, inspires a strong impetus to move with intensity and purpose. The convenient modern world has largely abolished the primal link between energy expenditure and energy ingestion. Today, our "search and pursuit" time has been eliminated, whereas the energy payoff is almost limitless. The ubiquitous availability of inexpensive energy-dense foods and beverages allows for acquisition of massive amounts of easily digestible energies with little to no energy expenditure, such as a few steps to the refrigerator, a visit to the supermarket, or a drive through a fast-food restaurant lane.

The health implications of this disruptive decoupling of the primal evolutionary link between energy expenditure and energy consumption are ubiquitous and profound. When energies eaten regularly outweigh energies expended, the excess energy is stored as fat tissue. Excess adipose tissue, particularly that is stored intra-abdominally, is closely linked to many of the most common and pernicious chronic diseases in our culture.[58,59] More than 2 of every 3 American adults are overweight or obese[60,61]; CV disease remains the leading cause of death, lifetime risk of hypertension is 90%, and both type 2 diabetes mellitus and Alzheimer disease are on steeply rising trajectories.[62] This pervasive disconnect between energies eaten and energies burned is an essential factor in these growing epidemics. For example, multiple studies suggest a strong association with lifetime PA and risk for developing dementia.[63-67]

Ever-increasing dependence on prescription drugs to offset this problem is much less rational than simply realigning our lifestyle and diet with those of our ancient hunter-gatherer ancestors. This means that we need to be have much higher PA and eat predominantly unprocessed naturally low-energy whole foods.[62]

Essential features of a hunter-gatherer fitness regimen

Natural selection shaped the human genome not to run marathons or exclusively lift extremely heavy weights but rather to survive and thrive as very active outdoor generalists in the wild.[5] Accordingly, the cross-training physical exercise regimens that appear to be ideal for developing and maintaining fitness and general health while reducing risks of injury are similar to the lifestyle required of the typical hunter-gatherer.

1. We are genetically adapted for a great deal of requisite routine light-to-moderate activity such as walking and carrying. The amount of daily walking or running would have been highly variable depending on the ecological niche that the bands or tribes were occupying along with their foraging and hunting habits, seasons, weather, cultures, traditions, and others; but most estimates place the typical daily distances covered in the range of 3 to 10 miles.
2. Strenuous days were usually followed by a relatively easy day, but each day demanded a range of physical activities just to secure the basic needs for existence in the wild. The daily energy expenditures for PA typically were typically 3349 to 5024 kJ or about 5-fold that of modern sedentary adults.[37]
3. Ambulating, both walking and running, was always done on relatively softer natural surfaces such as grass and dirt, often over uneven terrain. Humans in the wild were almost never walking or running on solid flat rock for miles on end. Modern exercisers do most of their walking and running on concrete and asphalt surfaces that have a uniform, rigid, and unyielding composition or density for which our musculoskeletal system is not adapted.
4. Walking and running were generally done barefoot or in simple leather shoes/slippers. Current day running shoes tend to be highly cushioned with elevated heels, pronation correction support, and other features that restrict reference range of motion of the foot during ambulation. These shoes, often the more expensive ones, can partially cast or splint the foot, causing atrophy of musculature; shortening and stiffening of tendons and ligaments in the feet, ankles, and lower legs; and predisposition to common overuse walking and running injuries including plantar fasciitis, ankle sprain, Achilles tendonitis, hamstring tears, and lower back pain.[68,69] Certainly, barefoot walking/running is not practical or recommended for most individuals; however, the use of simpler shoes that do not drastically restrict foot motion or alter natural foot strike dynamics may be superior to expensive highly cushioned running shoes for long-term orthopedic health.[70] The combination of more natural and less unyielding walking/

running surfaces and less biomechanically restrictive shoes is a strategy that will reduce impact loading of the joints and is more in line with the environmental conditions in which humans evolved.

5. Interval training sessions should be performed once or twice per week. This involves intermittent bursts of moderate-to-high level intensity exercise with intervening periods of rest and recovery. This type of exercise was required regularly for hunter-gatherers and is highly effective for improving fitness but should be followed by easier days to allow for musculoskeletal recovery and rebuilding.
6. A variety of exercises should be performed regularly, including activities targeting strength building (weight training) and aerobic conditioning (cardio) and flexibility (stretching). Cross-training among various different types of exercise promotes resilience and multifaceted fitness, lowers the susceptibility to overuse injury, reduces boredom and emotional burnout, and enhances long-term adherence to a daily exercise program.
7. Daily life entailed a large amount of carrying weight loads such as children, water, food, wood, rocks, and others. Our modern highly mechanized culture has largely engineered lifting, carrying, and climbing out of our lives, although the price for all this convenience is an epidemic of osteoporosis, osteopenia, and sarcopenia among its inhabitants. At least twice weekly sessions of weight training and/or other strength-building exercises are necessary for developing and maintaining musculoskeletal integrity and general health and fitness.
8. Hunter-gatherers were lean, and obesity was virtually nonexistent.[21] The requisite energy expenditures coupled with the day-to-day challenges of procuring adequate amounts of food meant that hunter-gatherers were almost never overweight or obese, which reduced trauma to their joints and minimized diet-induced inflammation.
9. Almost all PAs were performed outside in the natural environment. Outdoor exercise will help to maintain ultraviolet-stimulated vitamin D production in the epidermis, improve mood, and facilitate long-term compliance to a regular exercise program.
10. Much of the day-to-day exercise was performed in a social setting (small groups of people who were hunting or foraging and/or were cooperatively working on various chores that demanded PA). Studies indicate that some of the improvements in health and well-being and the psychological benefits of formal exercise training programs result from the interpersonal and emotional connections developed during the group exercise sessions.[31] The special benefits derived from exercising with a companion include better adherence to a long-term program and can be bestowed by structured programs and/or informal exercise sessions involving 2 or more individuals.
11. DNA evidence indicates that humans and dogs have been living in a symbiotic fashion for as long as 135,000 years.[71] The reciprocal advantages made possible by this coevolutionary process have been hypothesized to include cooperative hunting between domesticated wolves and our ancient hominin ancestors and the mutual protection the 2 species provided for each other. Hence, the canine and the human genomes appear to be specifically adapted to outdoor exercise involving cooperation between these 2 species.[72] In fact, research indicates that dog ownership can improve compliance to an exercise program, enhance fitness, and reduce excess weight among these individuals.[73]
12. Hunter-gatherers routinely participated in dancing, especially as part of celebrations and ceremonies. These periods of dancing sometimes continued for hours.[21] Dancing is an excellent form of exercise that enhances fitness and flexibility, promotes social bonding, and relieves stress.[74] Because most individuals find dancing enjoyable (particularly when done regularly and with a partner), it can facilitate to adherence to a regular fitness program.
13. Sexual activity is and always has been an essential element of human existence and would certainly qualify as an archetypal component of an organic fitness program. Observational studies consistently report that an active sex life is associated with several important benefits to health, well-being, and life expectancy for both sexes.[75,76] After adjusting for baseline characteristics such as age and CV risk factors, men and women who report the highest frequency of sexual relations have lower mortality rates and significantly reduced risks for CV disease even after fully adjusting for potential confounding variables.[75,76] Sexual activity at least once or twice weekly is linked to numerous health benefits, including enhanced immune system function and reduced risk of prostate cancer.[77]
Sexual activity, if nothing else, requires some physical exertion. A half hour session of vigorous sexual activity can expend up to 837 joules—similar to the energy required for walking 2 miles or running 15 minutes on a treadmill. In a healthy individual at the time of orgasm, the peak heart rate is generally runs about 120 to150 beats per

minute; and the systolic blood pressure can rise to as high as 200 mm Hg, resulting in a double product similar to that produced by demanding physical exertion. Sexual activity often involves exercise of the muscles of the pelvis, thighs, buttocks, arms, neck, and thorax. Sexual interactions and orgasm also boost production of testosterone, which promotes improved bone and muscle strength. Sexual intercourse stimulates the production of prolactin, which has been linked to improvements in mood, psychological bonding, and sense of smell.[75,76]

14. Plentiful time for sleep, relaxation, and rest was typically available to help facilitate complete recovery after physical exertion.

Statement of Conflict of Interest

All authors declare that there are no conflicts of interest.

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