

## PHYSICAL ACTIVITY AND HUMAN EVOLUTION

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Six million years ago the story of human evolution began. The earliest humans were found in Africa, which is where much of human evolution occurred. The fossils of these early hominids, which lived 2 to 6 million years ago, all come from that continent. Most scientists believe early humans migrated out of Africa into Asia between 2 million and 1.7 million years ago, entering Europe some time within the past 1 million years. The genus *Homo* first evolved at least 2.3 million to 2.5 million years ago. The oldest known fossils with skeletal features typical of modern humans are dated from 195,000 years ago. Modern *Homo sapiens* evolved in Africa and began spreading to other parts of the world 90,000 years ago or a little earlier, and it was not until about 40,000 years ago that anatomically modern humans, *Homo sapiens sapiens*, emerged (18).

From the dawn of humankind to around 10,000 BC, men had a constant motive to move: “Run for your life!” Physical development followed a natural path that was determined by the practical demands of life in a wild landscape as well as the vital need to avoid threats and seize opportunities for survival. To survive in a harsh environment full of natural and human obstacles and enemies, early man had to know not only how to run, but also walk, balance, jump, crawl, climb, lift, carry, throw and catch things, and fight. The strength and mobility of early man was not developed through structured programs, methods, or schedules, but rather was forged by the daily, instinctive, necessity-driven practice. We can also safely assume that playful or creative moves like early forms of dancing were performed when food was enough and predators weren’t around (14).

Starting between 10,000 and 8,000 BC, the Agricultural Revolution is often considered to be the dawn of civilization. Man’s transition from nomadic hunter-gatherer to farmer led to dramatic changes in his physical activity. The numerous demands of growing food and raising cattle meant a lot of chores and a lot of daily labor for farmers. But these tasks were largely repetitive, and required a very limited range of movement. At the same time, the need for performing a variety of complex movements – running, balancing, jumping, crawling, climbing – greatly diminished. Such movements were rarely performed in a farm environment, or were performed in much simpler ways (6).

Between 4,000 BC and the fall of the Roman Empire in 476 AD, civilizations rose and fell through war and conquest. Assyrians, Babylonians, Egyptians, Persians, and later on,

the Greeks and Romans all imposed physical training on boys and young men. The main purpose was preparing for battle.

Ancient military training had similarities to the movements performed in nature by our ancestors, but with more structure and a different end goal. Young men practiced fundamental skills such as walking and running on uneven terrains, jumping, crawling, climbing, lifting and carrying heavy things, throwing and catching, unarmed fighting, and weapons training.

Civilized populations valued physical culture for sports as well. Records of athletic competitions exist from ancient Egypt, and of course, the ancient Greeks famously created the first Olympic Games. Not surprisingly, these early sports were all based on practical, natural movement skills and were fundamentally related to the preparedness needed for war – the Greeks strove to best each other in running (sometimes with armor and shield), jumping, throwing (javelin or discus), and fighting (striking and wrestling).

Under feudalism, the dominant social system in medieval Europe, only nobles and mercenaries underwent physical training for military service. Similarly to ancient times, their training centered on natural movements and martial skills. The rest of the population were mostly peasants obliged to live on their lord's land and work extremely hard in fields using rudimentary tools. Their "exercise" (better said "physical activity") came through hard labor.

Girolamo Mercurialis (1530–1606), an Italian physician, published *De Arte Gymnastica* in 1569. It was the culmination of his studies of classical and medical literature, particularly the ancient Greeks' and Romans' approach to hygiene, diet, and exercise, and their use of natural methods for the treatment of disease. Laying out the principles of physical therapy for the first time, and accompanied with beautiful illustrations, it is considered the first book on sports medicine, and strongly influenced the wave of physical education and training methods that started to emerge in Europe two centuries later. He was considered the most influential of the advocates of exercising the body. His *De Arte Gymnastica* has still being republished in early eighteenth century (15).

Ioannes Amos Comenius (1592–1670) was a Czech philosopher, pedagogue and theologian. He served as one of the earliest champions of universal education, a concept eventually set forth in his book *Didactica Magna*. He is considered the father of modern education. Movement is important for healthy development of the child. It shouldn't be forbidden but supported, supervised by and under leadership of the teacher: hiking, running, jumping, games (*Didactica magna*). Comenius was the innovator who first introduced pictorial textbooks, written in native language instead of Latin, applied effective teaching based on the natural gradual growth from simple to more comprehensive concepts. *Orbis Sensualium Pictus (Visible World in Pictures)* is a textbook for children. The book has 150 chapters and covers a wide range of subjects: inanimate nature, botanic, zoology, religion, humans and their activities, including children's physical activities and games. *Orbis Pictus* had a long-lasting influence on children's education. It was a precursor of both audio-visual techniques and the lexical approach in language learning.

In 19<sup>th</sup> century several pioneers of physical education appeared in Europe and America: Johann GutsMuths (1759–1839) and Friedrich Jahn (1778–1852) in Germany, Peter Henrik Ling (1776–1839) in Sweden, Francisco Amoros (1770–1848) in Spain and later in France,

Hippolyte Triat (1813–1881) in France, Archibald MacLaren (1871–1944) in England, Miroslav Tyrš (1832–1884) and Jindřich Fügner (1822–1866) in Bohemia etc. Dudley Allen Sargent (1849–1924) is considered to be the founder of physical education in the United States. Some of them promoted gymnastics, others advocated the practice of the traditional natural movements like running, balancing, jumping, climbing, marching drills, fencing, and various forms of weightlifting, and even massive gymnastics festivals. Their ideas spread throughout Europe and America.

In 1810 Friedrich Jahn (1778–1852) came on the physical culture scene. Known as “The Father of Gymnastics,” he was an essential pioneer of physical education, and his ideas spread throughout Europe and America. A German gymnastics educator and ardent nationalist who had lived through Napoleon’s invasion of his country, he felt the best way to prevent another such incursion was to help his people develop their bodies and minds. To this end, he led young men on fresh-air expeditions and taught them gymnastics and calisthenics to restore their physical and moral strength. In 1811, Jahn opened the first *Turnplatz*, or open-air gymnasium, in Berlin.

His gymnastics organization, then called the *Turnverein*, spread rapidly throughout the country, and in 1816 he published *Die Deutsche Turnkunst (The German Gymnastic Arts)* dedicated to his gymnastics system. Although the apparatus gymnastics developed to an independent kind of sport, and so the gym activities were not only limited to simple physical exercises, he emphasized: “Going, running, jumping, throwing, carrying are free exercises, everywhere applicable, as free as fresh air. The country can expect them from everyone, poor, average and rich people, because everyone needs them” (10).

In addition to these contributions to physical culture, Jahn invented the pommel horse and horizontal and parallel bars, and promoted the use of gymnastic rings. The physical culture festivals he sponsored attracted as many as 30,000 enthusiasts, but the essence and end goal of his gymnastics and calisthenics methods were above all practical and functional, not artistic. He advocated the practice of the traditional natural movements like running, balancing, jumping, climbing, and so on.

At the very beginning of the 20th century Frenchman Georges Hebert (1875–1957) developed and promoted his “*Methode Naturelle*” (“*Natural Method*”). He published his first book, *L’Education Physique ou l’Entraînement Complet par la Methode Naturelle (Physical Education or Complete Training by the Natural Method)*, in 1912, followed by many other works on the same subject.

Another Frenchman, Edmond Desbonnet (1867–1953), managed to make physical exercise and strength training fashionable through the publication of fitness journals (he used photography to capture male and female athletes). He opened his first physical culture center in Lille in 1885. That same year he made the first rules for the sport of weightlifting. A couple of things he introduced include adding press, snatch and jerk into competitive lifts, setting up table of records and introducing referees (1). He also opened a chain of exercise clubs. This laid a strong foundation for physical culture in Europe, but also for “fitness” as an industry.

The Industrial Revolution was the transition to new manufacturing processes in the period from about 1760 to sometime between 1820 and 1840. This transition included

going from hand production methods to machines, new chemical manufacturing and iron production processes, improved efficiency of water power, the increasing use of steam power, the development of machine tools and the rise of the factory system. The onset of the Industrial Revolution is the most important event in the history of humanity since the domestication of animals and plants. The First Industrial Revolution evolved into the Second Industrial Revolution in the transition years between 1840 and 1870, when technological and economic progress continued with the increasing adoption of steam transport.

The mass of human experience is sometimes split up into epochs with consistent themes. These we associate with the five civilizations. Each civilization began with the introduction of a new dominant cultural technology. The first civilization began with systems of primitive or ideographic writing; the second, with alphabetic writing; the third, with printing; the fourth, with electronic technologies of communication; and, the fifth, with computer technology. These civilizations appear to be worldwide.

Our recent epoch – transition between fourth and fifth civilization – brings more and more scientific information and widespread awareness about the importance of regular physical activity for human health. We understand more about how the human body works and responds to physical training than we ever have before. However, the general population has never been so physically sedentary and out-of-shape.

Cardiorespiratory fitness (CRF) is not only an objective measure of habitual physical activity, but also a useful diagnostic and prognostic health indicator for patients in clinical settings. Although compelling evidence has shown that CRF is a strong and independent predictor of all-cause and cardiovascular disease mortality, the importance of CRF is often overlooked from a clinical perspective compared with other risk factors such as hypertension, diabetes, smoking, or obesity. Several prospective studies indicate that CRF is at least as important as the traditional risk factors, and is often more strongly associated with mortality. In addition, previous studies report that CRF appears to attenuate the increased risk of death associated with obesity. Most individuals can improve their CRF through regular physical activity. Several biological mechanisms suggest that CRF improves insulin sensitivity, blood lipid profile, body composition, inflammation, and blood pressure. Based on the evidence, health professionals should encourage their patients to improve CRF through regular physical activity.

Physical inactivity dominates most developed nations around the world, and is among the leading causes of disease burden and death worldwide. It is a major public health problem, and compelling evidence suggests that it is a contributing factor in numerous chronic diseases and conditions. Physical inactivity alone has led to a collection of problems and conditions, which eventually lead to premature death. Sedentary death syndrome threatens millions of people with this sedentary lifestyle (12, 16).

Recognition of the health and functional hazards of a sedentary way of life has led numerous groups to promulgate public health recommendations for physical activity. Current public health recommendations for physical activity are for 30 min of moderate-intensity activity each day, which provides substantial benefits across a broad range of health outcomes for sedentary adults. Persons who get 30 min of moderate-intensity

exercise per day are likely to achieve additional health benefits if they exercise more. In addition to aerobic exercise, people should engage in resistance training and flexibility exercises at least twice a week, which will promote the maintenance of lean body mass, improvements in muscular strength and endurance, and preservation of function, all of which enable long-term participation in regular physical activity and promote quality of life. Despite the wide array of physical and mental health benefits, few people get the recommended level of physical activity to achieve these benefits. Current research on physical activity has not, as of yet, been successful for the development of effective exercise interventions (3, 5).

A recent World Health Organization report indicates that life expectancy in the U.S. dropped for first time since 1993. The health of modern people is declining, despite highly advanced medical technologies, and in spite of the thriving health and fitness industry. There are lot of warning data regarding health state of population in Czech republic: statistical data indicate that 20% of children 7 to 12 years old, 60% of adult men and 47% of adult women are overweight, many of them obese, 840 thousands citizens have diabetes, mostly type II (and another 250 000 don't know yet about it), about 2 millions people are hypertonic (one third of them doesn't know about their illness), about 800 thousands of patients are registered by general practitioners with diagnosis ischemic heart disease etc. Really warning data compared to total 10.5 million inhabitants in the country. Despite of increasing life expectancy even in Czech Republic and other industrial countries similar trend like in USA could be sooner or later expected. Recent statistical data indicate that life expectancy in Czech sepublic stagnates already.

There is one more important factor playing the role in fitness level of a man – genetics. Genetic evolution has been wholly unable to match the rapidity of cultural change and our genes remain adapted for conditions that existed during their selection by Darwinian mechanisms. This discordance between our contemporary lives and our genetic makeup has important pathophysiological implications: epidemy of non-communicable diseases.

The best available estimates of energy expenditure as physical activity for humans (males and females averaged) living in the late Paleolithic 25.000 years ago, center approximately 5.4 MJ (1240 kcal)/d or near 91.3 kJ (21.8 kcal)/kg for a 57kg composite individua. These values contrast with an estimated 2.3 MJ (555 kcal)/d or 36.4 kJ (8.7 kcal)/kg energy expenditure spent during daily physical activity by a hypothetical 64kg male/female contemporary American. Stone Age exertional activities covered a broad spectrum: walking while gathering, during hunting trips and on visits to neighboring campsites; running after wounded prey; carrying children, game meat, gathered plant foods or firewood; erecting shelters; flint knapping and making composite tools; digging for roots or tubers; butchering and cleaning game animal carcasses; shelling nuts; breaking open crania and long bones for brains and marrow; dancing for simple recreation or as part of religious ceremonies; vigorous play and so forth (9).

From a genetic standpoint, humans living today are Stone Age hunter-gatherers displaced through time to a world that differs from that for which our genetic constitution was selected. Unlike evolutionary maladaptation, our current discordance acts as a potent

promoter of chronic illnesses: atherosclerosis, essential hypertension, many cancers, diabetes mellitus, and obesity among others. These diseases are the results of interaction between genetically controlled biochemical processes and a numerous biocultural influences – lifestyle factors – that include nutrition, exercise, and exposure to noxious substances. Although our genes have hardly changed, our culture has been transformed almost beyond recognition during the past 10,000 years, especially since the Industrial Revolution. There is increasing evidence that the resulting mismatch fosters “diseases of civilization” that together cause 75 percent of all deaths in Western nations, but that are rare among persons whose lifeways reflect those of our preagricultural ancestors (8).

Principle changes in lifestyle habits must occur to be able to affect this cheerless development. Physical activity must be integral part of living in every modern human since childhood until advanced age, especially when we know that easily available activities as walking, stair-climbing, swimming, biking, rope jumping, games, hiking and many other recreational activities separately and/or in combination effectively lower the risk of specific cardiovascular and many other disease occurrence. Physical activity benefits all types – old and young; men and women; hypertensive and normotensive; short and tall; fat and lean; subjects with normal or abnormal lipoprotein profile; and subjects who never smoked cigarettes, ex-smokers, and light, heavy and very heavy smokers (17).

Although it is well known that physical activity prevents and ameliorates a large number of conditions and chronic diseases, physical inactivity is becoming more prevalent. This paradox has led some to suggest that genetic/biological factors influence activity levels as opposed to the classical notion that voluntary activity is solely regulated by environmental factors. Several recent data show that there is considerable genetic influence on activity levels in both humans and animals and emerging evidence suggesting potential genomic locations for those genetic factors. Some genes playing the role in regulation of physical activity were already found, with several other potential candidate genes only partially supported. Efforts to identify additional candidate genes, that are involved in the regulation of physical activity, and to investigate the mechanisms by which these genes and genetic factors regulate activity, must continue (4, 7, 13, 19).

Individuals with low CRF had a substantially higher risk of all-cause mortality and CVD events compared with individuals with moderate and high CRF. Moderate to high levels of CRF and improvement in CRF are associated with a lower risk of mortality from all-causes and CVD in both men and women regardless of age, smoking status, body composition, other risk factors, method of CRF assessment, and study design. CRF appears to attenuate the higher risk of death associated with obesity. Including CRF in clinical examinations along with traditional evaluations such as blood pressure measurement and blood chemistry analyses may contribute to chronic disease prevention and longer life span (11).

Compared to normal weight-fit individuals, unfit individuals had twice the risk of mortality regardless of BMI. Overweight and obese-fit individuals had similar mortality risks as normal weight-fit individuals. Researchers, clinicians, and public health officials should focus on physical activity and fitness-based interventions rather than weight-loss driven approaches to reduce mortality risk (2).

Therefore, increasing the cardiorespiratory fitness through physical activity is the most effective way not only how to increase life expectancy but also how to add active years to individual lifespan. How to reach this target in majority of population will be subject of scientific interest for many future decades. Let's hope that next human generations will not be called *homo sedentarius*.

## SUMMARY

Six million years ago the story of human evolution began. About 40,000 years ago anatomically modern humans, *Homo sapiens sapiens*, emerged. To survive in a harsh environment full of natural and human obstacles and enemies, early man had to know how to keep fit to survive. From a genetic standpoint, humans living today are Stone Age hunter-gatherers displaced through time to a world that differs from that for which our genetic constitution was selected. Unfortunately, physical inactivity dominates most developed nations around the world, and is among the leading causes of disease burden and death worldwide. It was suggested that besides environmental factors also genetic/biological factors influence voluntary physical activity. It is recommendable to seek the ways how to achieve improvement of recently prevailing sedentary life-style, otherwise rising prevalence of sedentary death syndrome could be expected.

## *Pohybová aktivita a lidská evoluce*

## SOUHRN

Dějiny lidské evoluce se začaly psát před šesti milióny let. Náš přímý předchůdce, *Homo sapiens sapiens*, se na Zemi objevil před 40 000 let. Aby přežil v drsných podmínkách prostředí, plného přírodních překážek i lidských nepřátel, musel prvotní člověk nezbytně umět udržet si dobrou tělesnou kondici. Z genetického hlediska jsou dnešní lidé totéž, co lovci-sběrači doby kamenné, přemístění přes celá tisíciletí do světa zcela odlišného od toho, na který je nastavena jejich původní genetická výbava. Bohužel ve většině vyspělých zemí světa dnes dominuje nedostatek pohybové aktivity. Sedavý způsob života je celosvětově jednou z hlavních příčin nemocnosti a předčasného úmrtí. Ukazuje se, že vedle faktorů okolního prostředí ovlivňují vztah k zájmové pohybové aktivitě i faktory genetické. Je třeba hledat cesty, jak dosáhnout zlepšení v současnosti převažujícího sedavého životního stylu; v opačném případě lze očekávat zvyšující se prevalenci chorobného souboru, označovaného jako „sedentary death syndrome“.

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