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Bone Loss and Physical Activity - A Bio Anthropological Perspective

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Abstract

Increased life expectancy on the one hand and dramatically reduced physical activity in daily life on the other hand are characteristic features of postmodern life. Consequently Homo sapiens is increasingly confronted with the problems associated with accelerated bone loss, osteoporosis and osteoporosis related fractures. This is true of Industrialised countries as well as of threshold countries. A major risk factor of osteoporosis and low bone mass is physical inactivity. Up to now, bone loss and osteoporosis are mainly focused on from a clinical viewpoint. In the present review a bioanthropological perspective of the association between physical inactivity and osteoporosis is provided. The problem is discussed from the viewpoint of life history theory, but also from the viewpoint of evolutionary biology, especially evolutionary medicine and paleopathology.

Key words: Bone mass, Bone mineral density, Bone loss, Osteoporosis, Physical activity, Bioanthropology, Human evolution, Paleopathology, Human life history

Introduction

Bone loss resulting in reduced bone mass, reduced bone density and consequently the pathological conditions osteopenia and osteoporosis represent a significant health problem of the ending 20th and the beginning 21rst century. Osteoporosis enhances the risk of fatal fractures dramatically and is the most common human metabolic bone disease today [[1-5]. Hip fractures alone are projected to reach 6.3 million per years globally by 2050 [6].Therefore the World Health Organization (WHO) defined osteoporosis as a systemic skeletal disease characterized by low bone mass and micro-architectural deterioration of bone tissue, leading to an increased bone fragility and susceptibility to fracture risk [7]. It is estimated that one in three women and one in five men suffer from osteoporosis-related fractures in their lifetime [8]. Consequently accelerated bone loss contributes markedly to disability, mortality, and reduced health related quality of life among affected women and men, mainly in their late-life years [9]. Increasing life expectancy and the dramatically increased portion of elderly in Industrial countries as well as threshold countries made bone loss and osteoporotic fractures – first of all hip fractures - to a major public health problem with social and financial impact [10]. In order to prevent fatal consequences of accelerated bone loss it is absolutely necessary to analyze its etiology and to identify certain risk factors. During the last decades etiology and risk factors of bone loss and osteoporosis were mainly seen from a clinical view point. According to this medical approach osteoporosis originates in two ways: Menopausal osteoporosis is mainly found among postmenopausal women resulting from the decline of endogenous estrogen levels during and after menopausal transition. On the other hand senile or age related osteoporosis is caused by the gradual age related bone loss during old age. This condition is found in women but also in men[11]. Beside genetic factors, low levels of sex hormones, first of all a decline in estrogen levels, vitamin D3 deficiency, but also malnutrition, and physical inactivity were described as main risk factors [12]. These risk factors however, can also be analyzed from a bioanthropological view point.

In contrast to a clinical viewpoint, biological anthropology, provides a different approach to analyze the relation between physical activity patterns and bone loss. We have to note that biological anthropologists have a unique view of human phenomenon, based on physiological, biocultural, cross-cultural but primarily evolutionary perspectives [13]. In the present review the main focus lays on a bioanthropological analysis of physical inactivity as a major risk factor of osteoporosis. In detail bone loss and physical activity patterns are focused on from the perspective of human life history and human evolutionary biology.

Physical activity – a bioanthropological perspective

Physical activity is an essential part of human life. The physiological basis of physical activity is the ability to move. In a biomechanical sense physical activity summarizes all behaviors which involve bodily movements produced by skeletal muscles [14]. Consequently physical activity comprises all kinds of movements and locomotion essential for subsistence, tool making, occupation, work, play, exercise, and many other activities such as ritual behavior like dancing. From a bioanthropological viewpoint the ability to move and to be physically active was essential for surviving and reproducing. Physical inactivity in contrast, was identified as major risk factors for increased morbidity and mortality as well as for reduced health related quality of life[12, 15,16].

Negative consequences of physical inactivity were first described more than 2400 years ago by the Greek physician Hippocrates (460-366 BC), who associated a lack of physical activity with poor health [17]. More than 500 years later the Roman physician Galenos of Pergamon (129-200 AD) used physical activity as efficient treatment of obesity and metabolic symptoms [17].

The clinical importance of physical activity is out of question until today. In case of bone health it is well known that physical inactivity due to continuous bed rest for a longer time but also staying in a microgravity environment of space results in atrophy of muscle mass and a reduction of bone mass and bone density. Excessive inactivity enhances rapid disruption of normal function in tissues, cells and gene expression [18,19]. During childhood and adolescence physical activity promotes the formation of dense and well-mineralized bones[19,20]. Mineral density and structural geometry are key elements to protect bones from mechanical stresses. A physically inactive life style however, accelerates bone loss and increases the risk of developing osteoporosis [21-23]. Additionally physical inactivity promotes muscle loss and the development of sarcopenia, the state of pathologically reduced skeletal muscle mass [21]. As bones, skeletal muscles are essential for locomotion and mobility, consequently sarcopenia leads to impaired functional performance, increased risk of falls and – in association with osteoporosis- an increased risk of fragility fractures [24,25]. Physical inactivity consequently increases frailty and the risk of fatal fractures.

Bone loss and physical activity – a physiological perspective

Efficient movements - locomotion as well as mastication – of adult humans are ensured by about 200 bones and 650 skeletal muscles [9]. Therefore the primary function of human bones is a mechanical one. Furthermore bones provide protection of soft tissues and organs such as the brain, heart or lungs. Additionally bone marrow plays a key role in hematopoiesis and bony tissue is essential for mineral homeostasis, because bones store about 97% of the body´s calcium, and phosphorus [9]. Macroscopically two types of bone can be classified: on the one hand trabecular bone, typical of vertebral bodies, pelvis and long bone epiphysis on the other hand cortical bone which dominates the diaphysis [26]. In contrast to other tissues, bones show an extraordinary high rate of remodeling. Once formed bone is exposed to a steady process of renovation and modification. Four fundamental types of bone cells can be distinguished: osteoblasts, osteocytes, osteoclasts and bone lining cells [18]. The complex interaction of these four cell types is the basis of bone modeling and remodeling. Mechanically induced bone remodeling represents a continuous renewal of bony tissue [27]. While osteoblasts lay down new bone matrix that becomes mineralized, osteoclasts eliminate mineralized bone from the surfaces of trabecular and cortical bone [18]. An imbalance in the activity of osteoblasts and osteoclasts may lead to accelerated bone loss. This imbalance is mainly due to increased proliferation, differentiation and activity of osteoclasts, while osteoblast function is reduced and do not fully balance the effect of osteoclasts. As a consequence bone loss occurs [1]. Bone loss is mostly interpreted in line of the general ageing process. In particular reduced stem cell population produces fewer osteoblasts, calcium absorption is disturbed and the Vitamin D levels decrease [8]. Furthermore hormonal changes such as menopausal transition in women lead to reduced estrogen levels which enhance osteoclast activity and bone turnover. Additionally some life style factors such as physical inactivity, malnutrition, nicotine and alcohol consumption but also low weight status, such as in case of Anorexia nervosa may promote bone loss [1, 28]. Severe underweight reduces biomechanical forces in the skeleton but also leads to reduced estrogen levels. Both may enhance bone loss. In contrast, moderate overweight -not obesity - seems to reduce bone loss [29-31]. On the one hand mechanical loading caused by weight bearing stress was postulated to have a protective effect of on bone density [32], on the other hand hormonal factors, such as increased levels of calcitonin, DHEA, DHEA-S, androstendione, testosterone and first of all estrogens among overweight women were discussed as mediators [30,33].

Physical activity has a major impact on bone tissue. As early as 1892 Julius Wolff recognized that the structural and geometrical properties of the bone could be described under the general principle of Wolff´s law, in which healthy bone adapts to the loads that impact it [34]. A lack of physical activity increases bone loss [35]. The impact of physical activity patterns on bone loss is mainly seen in the strong positive association between bone mass as well as bone density and skeletal muscle mass [36-40]. Skeletal muscle mass is one of the most powerful determinants of bone strength and bone density [41]. The strong relationship between bone and skeletal muscle was postulated and mainly viewed in the context of the mechanostat theory [42,43] and the theory of the functional muscle bone unit [44-46]. According to these theories bones respond to varying mechanical strains modulated by systemic effects such as hormones. Muscle contractions induce tension in the bone, which in turn activates bone modeling via osteocyte mechanoreceptors [47,48]. According to the theory of a functionally unified muscle bone system, a healthy skeleton is adapted to mechanical stress. As a consequences muscle tension leads to an increase in bone mass and strength [44]. Furthermore bone and muscle share a common embryogenesis and are regulated and controlled by the same hormones and genes [49-51]. Consequently the association between bone loss and muscle wasting are two sides of the same coin [51]. As a consequence we can conclude that physical inactivity reduces muscle contractions and so mechanical stress and leads therefore to accelerated bone loss.

Bone loss and physical activity – a Human life history perspective

According to life history theory each species has its own patterns of ontogeny, that is, the process of growth, development, maturation and ageing of the individual organism from conception to death [52]. The stages of the human life cycle are as follows: prenatal period from fertilization to birth, neonatal period from birth to 29 days, infancy from second month to the end of lactation, childhood from end of lactation to the eruption of the first permanent molar at about six years, juvenile from the eruption of the first permanent molar to puberty onset, adolescence from sexual maturation to the end of growth at about 20 years. Younger adulthood starts at about 20 years and lasts until the end of childbearing years, among females menopause is a physiological markers of the end of younger adulthood. Later adulthood is also termed old age and starts with the end of childbearing years and ends with the death [52].

Bone development and bone loss are strongly associated with specific stages of human life history. On the one hand prenatal and subadult life phase are essential for reaching peak bone mass, on the other hand postmenopause and old age are the typical stages of increased bone loss. Bone development starts at prenatal, in particular during embryonic period. At this time position and shape of various skeletal elements are determined by expression of regulatory genes and growth factors. The mineralization of bone is influenced by mechanical strain [19]. Beside genetic factors the intrauterine environment has a strong influence on prenatal bone development but also on bone mass and bone density during adulthood [19]. Especially maternal undernutrition and nicotine consumption result not only in low birth weight but also in reduced mineralization and lower bone density after birth [19]. During subadult life phase skeletal growth is mainly regulated by growth hormone and Growth factors. The balance of cellular activity is in favor of net bone formation and at peak bone mass the amount of osteoclastic bone resorption is exactly matched by the amount of osteoblastic new bone formation.

There is a growing body of evidence that nutritional factors but also physical activity patterns, especially regular exercise, influence bone mass during childhood and adolescence growth [18,20,21]. Especially high impact and weight bearing activity in early childhood and prepuberty appear to be most beneficial in improving bone mass [16,19,20] and support the theory of a functional muscle bone unit during subadult life stage [44-46,53]. During adolescence after pubertal growth spurt, the growth rate declines, the consolidation of skeletal mass however, continues. Increasing levels of sex hormones enhance bone growth but stress factors such as extremely low body weight as in case of malnutrition, starvation or restrictive eating disorders, low physical activity levels, smoking or alcohol consumption but also medication such as cortisone treatment reduce bone growth during adolescence and early adulthood. Peak bone mass, which is an essential factor of the development of osteoporosis in later life, is the maximal amount of bone mineral accrued within bone during childhood, adolescence plus the consolidation hat continues beyond the attainment of final height [19]. In general, peak bone mass is achieved at the end of the third decade of life. A reduction of physical activity during childhood and adolescence caused by changing activity patterns during leisure time such as watching TV, playing with computers instead of playing outside but also a reduction of sportive activity during subadult phase lead to reduced bone mass, lower peak bone mass and an increased risk of accelerated bone loss during later life [20-22,54].

Starting with the fourth decade of life both sexes start to lose bone mass, a process which accelerates after menopause in women. Menopause induced bone loss as well as age related decline in bone mass and bone density are influenced by decreasing sex hormone levels [23,41,55-57], but also body composition parameters [38] and weight status [58].

From life history perspective menopausal transition is a main factor of accelerated bone loss among ageing females. Menopausal transition is characterized by a dramatic decline in estrogen levels [11,59], resulting in estrogen deficiency which enhances bone loss. From a bioanthropological viewpoint menopause is clearly a biological phenomenon and not a disease per se [60]. Menopause is a universal, one-time life event, which marks the transition from reproductive to post-reproductive life in human females. Reproductive ageing characterized by a decline of sex steroid levels and a reduced probability of successful reproduction is also found among several free living social mammals [61], an obligatory post-reproductive life stage of 30 years and more however, is exclusively found among human females [62]. The majority of women in developed countries experience menopause usually between 47 and 55 year of life [62]. Considering an average life expectancy of about 80 years among females in developed countries, female post-reproductive phase lasts thus on the average 30 years. Since the 1970ties several evolutionary scenarios of human menopause were proposed to explain the phenomenon of menopause. We can distinguish between the adaptive hypotheses such as the grandmother hypothesis or the good mother hypothesis and the so called by-product hypotheses [62,63].The by-product hypothesis is based on the assumption the in our past women did not live long enough to experience menopause. Consequently menopause is nothing else than a by-product of increased life span and therefore a very recent phenomenon [62]. Therefore women did not suffer from menopause related bone loss or osteoporosis because they did not live long enough. On the other hand there is some evidence that menopause occurred first about 1.8 million years ago at the time when Homo erectus lived [62,63]. At this stage of hominid evolution growth patterns and encephalisation made a long dependency of offspring necessary and leads to life history patterns comparable to those of Homo sapiens [63]. According to the adaptive hypotheses menopause is an adaptive feature. Menopausal transition however is associated with many health hazards and with increased bone loss resulting in increased bone fragility and increased risk of fatal fractures. How could this feature be adaptive and selected positively? The explanation that menopausal transition associated bone loss has not been a major health problem because life expectancy was quite low and only few females reached menopause [60] would support the by-product hypothesis. On the other hand we have to consider the life style of our hominid ancestors. We can assume high levels of physical activity even among postmenopausal females and this life style may have decreased bone loss and the risk of osteoporosis. This interpretation may be corroborated by the observations of postmenopausal Hadza women by Kirsten Hawkes [64]. Even elderly Hadza women are highly physically active. Symptoms of osteoporosis are not described for this contemporary hunter gatherer society [64].

Bone loss and physical activity – an evolutionary perspective

According to Theodosius Dobzhansky "Nothing in biology makes sense except in the light of evolution" [65]. Consequently from a biological or bioanthropological viewpoint each condition should be explained not only by proximate i.e. physiological factors but also by ultimate i.e. evolutionary factors [66]. The physiological aspects of bone loss are described above therefore in this section focuses on the evolutionary perspective of bone loss and physical activity patterns. In order to discuss bone loss and osteoporosis from an evolutionary viewpoint we have to focus on the following topics: Human evolution, paleopathology and evolutionary medicine.

Human evolution with special respect to physical activity patterns

All recent people are members of the species Homo sapiens which first appeared in Eastern Africa about 150000 years ago [67]. Homo sapiens is the only surviving species of Genus Homo, which appeared first about 2.4 million years ago in an Eastern African savanna habitat [67], which is consequently the adaptively relevant environment of Genus Homo and in particular of the species Homo sapiens. The appearance of our ancestor Homo erectus about 2 million years ago, has been linked with the evolution of typical key features such as rapid encephalisation, long distance mobility, advanced hunting technology, the ability of making stone tools, but also increased meat consumption and marked changes in human life history patterns such as the introduction of menopause [52,68]. From an anatomical viewpoint obligatory bipedalism, increased body size and modern body proportions enabled Homo erectus to walk and run long distances. Long legs, relative small feet with short toes, plantar arch, long spring-like tendons, such as the Achilles tendon and an enlarged gluteus maximus provided stabilization for a biped locomotion [67, 69]. On the other hand the loss of body fur and an increasing number of eccrine sweat glands enhances thermoregulation and protected humans from overheating [69-71]. Consequently our ancestors were adapted to running, especially endurance running, which became absolutely necessary for successful scavenging or hunting [72-75]. From this viewpoint physical activity was absolutely necessary for survival, and consequently successful reproduction. Physical activity was not only typical of adult male hunters, even females, children and elderly person had to be physically active, just to survive. Consequently from an evolutionary point of view, humans are clearly designed for movement and physical activity [76-79].

A high degree of physical activity remain important when our own species modern Homo sapiens left tropical Africa and colonized with the exception of Antarctica the whole world about 100 000 years ago. Consequently modern Homo sapiens has adapted to widely different habitats and showed a huge developmental plasticity to survive and reproduce successfully under widely different environmental circumstances [67]. Life style patterns of late paleolithic Homo sapiens were still characterized by high mobility, a subsistence still based on hunting and gathering and a generally high degree of physical activity. Daily activities included walking and running in order the gather foods, hunt, following wounded prey, flight or migrate to a new base camp or water whole. Furthermore carrying game, meat, children or gathering goods, but also tool making, meat butchering, digging roots were typical subsistence activities requiring a high degree of physical activity. Physical activity was still the key factor to survive and reproduce successfully. The motivating factors for a physically active life style however, were not a desire for activity, but hunger, thirst and danger [77,78,80,81]. Therefore physical activity can be interpreted as an adaptive behavior. While physical activity had a positive impact on bone formation and bone health, the migration of Homo sapiens from tropical Africa to northern parts of Eurasia and America had negative effects on bone health. Vitamin D, which is essential to facilitate calcium absorption and therefore important for bone health, depends on exposure to sunlight. When Homo sapiens left Africa sunshine became unreliable and Vitamin D deficiency - leading to rickets, osteomalacia and osteoporosis - a major health burden [9]. After migration to northern latitudes Vitamin D deficiency was compensated by depigmentation and by the adoption of new diets rich in ocean fishes. Furthermore the domestication of cattle, goats and sheep in course the Neolithic transition about 10 000 years ago led to the invention of diary herding and the consumption of calcium rich milk products even after weaning. Consequently natural selection favored lactose tolerance in northern latitudes [82].

Paleopathology

From a bioanthropological viewpoint the analysis of skeletal remains may provide insights in physical activity patterns but also in pathological conditions such as osteoporosis. Up to now no evidence for osteoporosis was found among upper Paleolithic skeletal remains. Osteological analyses reveal that our Upper Paleolithic ancestors showed a higher skeletal robustness than recent skeletons indicating an active life style [79,83,84]. Subsistence, nutrition, and mobility patterns however, changed dramatically with Neolithic transition, a process which started about 15 000 years ago in the area of the fertile crescent [85,86]. The shift in subsistence patterns away from hunting and gathering towards agriculture resulted in a reduction in general mobility and overall physical activity levels [84], a dramatic reduction of skeletal robusticity however, could not be proved [87]. The domestication of animals and plants enabled humans to give up their mobile lifestyle. The reduction in dietary breadth, the explosion to a variety of new pathogens as a result of the close proximity of humans to domesticated animals and higher population density resulted in an increased frequency of infectious diseases and a general worse health situation [86]. Consequently an increased incidence of stress markers such as Harris lines, Cribra crania and enamel hypoplasia are found among Neolithic skeletons [82,86].The Neolithic transition has consequently led to the so called first epidemiologic transition [88]. Changes in physical activity were especially true of males. With the Neolithic transition male activities changed from hunting affords such as walking endurance running and meat butchering to activities in agriculture such as field preparation, planting, digging, weeding, harvesting, conversion of crops to food, feeding animals, milking, building huts and stables. Late Paleolithic females in contrast, showed a wide range of physical activities mainly digging, picking, cutting and carrying [80]. This kind of physical activities is more or less equal to female activities after Neolithic transition [89]. Consequently sexual size dimorphism and sexual dimorphism in skeletal robustness decreased [89]. Although physical activity patterns changed with Neolithic transition, physical activity was still essential in subsistence [76-78]. These kinds of physical activity patterns established during Neolithic transition remained more or less stabile until Industrial Revolution starting at the end of 18th century. Up to the first half of the 20th century a high degree of physical activity was still necessary for the majority of people even in industrialized countries.

After World War II however, physical activity patterns changed dramatically. On the one hand physical afford in work and occupation decreases steadily. Cars, public transportation, elevators, sedentary jobs, labor-saving household technologies internet shopping and the trend of cocooning promote a sedentary lifestyle. On the other hand the daily energy effort to gather and prepare enough food is reduced nearly to zero, since only few individuals are working in food production. A sedentary and consequently physically inactive life style prevails in all industrialized postmodern societies. While 26% of 8 to 16 year old US children watched TV for at least 4 hours per day and 67% watched TV for at least 2 hours per day, only 19% of high school students were physically active for 20 minutes or more in daily physical education classes. 60% of US adults are not regularly active and 25% are not active at all [90]. Modern Homo sapiens exhibits an extremely low physical activity level in comparison to free-ranging mammals [91]. This kind of life style clearly leads to a reduced peak bone mass and an accelerated bone loss. In combination with new life history patterns such as a prolonged postmenopausal phase and a generally increased life expectancy (mentioned above) the prevalence of osteoporosis rises.

Evolutionary medicine

Considering the marked changes in life style and physical activity patterns mentioned above from the viewpoint of evolutionary medicine, the high rates of osteoporosis and osteoporosis related fracture can be clearly interpreted as a mismatch between the environment of evolutionary adaptedness and our present environment.

But what means evolutionary medicine? More than 150 years ago Charles Darwin (1809-1882) introduced not only the terms biological evolution, natural and sexual selection in science [92,93] but also considered evolutionary explanations for behavior and disease. The concept of evolutionary medicine in a recent sense was first formalized by the evolutionary biologists George C. Williams and psychiatrist Randolph Nesse [94,95] and represents a valuable perspective that utilizes evolutionary theory to understand the ultimate causation of recent diseases [94-97]. In particular the mismatch between the environment of evolutionary adaptedness and the present environment in which we find ourselves is focused on [94]. Furthermore evolutionary medicine tries to understand how changing living conditions but also processes of modernization and acculturation influenced health and disease [97,98]. In case of osteoporosis evolutionary interpretations have been provided [9,26,99] and we can assume that pathologically accelerated bone loss, i.e. osteoporosis may be the result of a mismatch between recent living conditions and the environment in which our ancestors evolved [76,100-103].

However, we should not forget, that accelerated bone loss and osteoporosis did not emerge in the recent environment of the late 20th century. Despite all methodological problems, it is possible to analyze bone density in skeletal remains from archeological sites [104]. Osteological analyses by bioanthropologists revealed accelerated bone loss among a 6700 year old Neolithic female skeleton from Portugal [105], among Neolithic males and females from Turkey [106] and among 4000 year old skeletons from Kentucky [107]. Accelerated bone loss was also found among 4000 year old Bronze Age skeletons from Austria [108,109]. Osteoporosis was also diagnosed among four Egyptian mummies dating between 1550 BC and 395 AD [110]. Reduced bone mass was found among Nubian skeletons [111] and skeletons from Imperial Roman area [112]. Increased bone loss was also documented for skeletons from medieval cemeteries in Great Britain [113] and Norway [114], but also for American Indians from the 16th century [115]. Bone loss and osteoporosis are not new phenomenon of the late 20th or early 21rst century, among historical populations however only few individuals were affected. Osteoporosis – the fragility of bones - was first described 1751 by the French physician Joseph Guichard Duverney (1648-1730), the term osteoporosis was introduced 1820 by the French pathologist Johann Lobenstein (1777-1835) [26]. However it can be assumed that only few people suffered from osteoporosis. The paleopathological analysis of female skeletons from Christ Church cemeteries, Spitalsfields, London dating between 1729 and 1852, revealed only a low bone loss among these poor population in comparison to recent females [116]. It can be assumed that the high rate of physical work and consequently a high degree of physical activity had a positive impact on bone tissue.

Bone loss and physical activity - a cross-cultural approach

Cross-cultural analysis is also a main part of Biological Anthropology. Considering recent foragers but also traditional horticulturists, pastoralists and farmers provide information regarding physical activity patterns and bone health. The few remaining contemporary forager populations such as the Hadza in Tanzania, the ! Kung of Namibia and Botswana, Ache of Paraguay, Efe of central Africa or Australian aborigines but also ethnographic studies carried out during the 1960s and 1970s provided information about life style, in particular diet and physical activity patterns in a foraging societies [117,118]. The traditional life style of hunter-gather populations is still a physically active one, characterized by walking long distances, digging for tuber, eggs and water deep below the surface, copping with a stone axe, gathering and carrying firewood. In addition hunter gatherer women often had to carry their children for long distances. The average hunter gatherer mother carried her child until he or she was about 4 years old, covering upwards of 3500 kilometres with the child on her back or in her arms during this interval of time [81]. Physical activity among contemporary hunter gathers such as Ache, Hadza, !Kung, Lamalera, and Meriam is also associated with increased reproductive success [117,119-121]. A high level of physical activity is also found among traditional horticulturalists, and farmers [122,123]. Osteoporosis or osteoporosis related fractures are not reported for these physically highly active populations following a traditional life style. Homo sapiens is clearly adapted to a life style like this [124,125].

Conclusion

Today we are confronted with a dramatic mismatch between current environment and the environment in which human body evolved. 99% of our evolutionary history, we have spent as hunter-gatherers following a highly mobile life style in small groups. Thousands of years we spent as subsistence farmers and only less than 200 years in an industrialized society. Our gene pool was shaped by natural and sexual selection towards an optimal adaptation to environments and life circumstances, which nowadays no more exist. We are clearly adapted to a physical highly active life style, but living in urban environments has physical activity diminished dramatically even among children and adolescents. On the other hand life expectancy still increases resulting in an increasing number of people suffering from bone loss, osteoporosis and osteoporosis related fractures. In order to reduce the economic but also social burden of osteoporosis related invalidity we have to increase physical activity during childhood, adolescence and adulthood. We have to be aware that we are born to move, to walk, to run. Today however, there is no need to run, to climb up trees or mountains or even to walk in order to procure food or shelter. Therefore our only chance to increase physical activity is sportive activity during leisure time

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