Physical Activity, Exercise and Non-Communicable Diseases

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ABSTRACT

The modern environment has been explicitly engineered to reduce manual labor, increase physical comfort and afford passive entertainment. As a result, physical inactivity and sedentary pastimes have become ubiquitous features of the post-industrial world. Given the fact that human metabolic, cardiovascular and musculoskeletal systems evolved in an environment in which survival necessitated extraordinary amounts of physical exertion, it is not surprising that physical inactivity has induced a host of morbidities. Epidemiological evidence has demonstrated that inactivity has significant risks and severe consequences for all individuals independent of age, genetic endowment, personal history (e.g., past lifestyle), body composition and current behavior (e.g., diet, alcohol consumption, smoking). Physical inactivity accelerates the aging process and dramatically increases the frequencies of non-communicable diseases (NCDs) such as cardiovascular disease (CVD), type-2 diabetes (T2D) and other pathologies (e.g., frailty, osteoporosis, sarcopenia, and obesity). The relative risks of physical inactivity and mortality from NCDs begin in childhood and increase with advancing age. Nevertheless, physical activity (PA) and exercise have been demonstrated to delay and/or prevent the onset of NCDs and other pathologies associated with sedentary lifestyles and aging. This review surveys data from observational studies and randomized controlled trials (RCTs) that support the premise that PA and exercise are essential elements in the maintenance of health as well as the prevention and treatment of age-related maladies and NCDs.

Key words: epidemiology, health, sedentary, physical activity, chronic disease, exercise

Environmental Changes, Epidemiology, and Non-Communicable Disease

Humans are extremely adept at altering the environments in which they live. Over the past century, the evolution of the physical, social, and cultural milieu has proceeded extremely rapidly and humans are now immersed in a world explicitly engineered to reduce physical labor, increase physical comfort and afford passive entertainment. As a result, physical inactivity and sedentary pastimes (e.g., web-surfing, TV viewing) have become ubiquitous features of both developed and developing nations.

The confluence of passive transportation, spectator-based entertainment, decrements in occupational energy expenditure, and household (i.e., domestic) physical activity (PA) has engendered an increase in hypokinetically induced non-communicable chronic diseases; NCDs (e.g., cardiovascular disease (CVD), type-2 diabetes (T2D)) and mortality. Given the fact that human physiology evolved within an environment that obligated remarkable amounts of energy expenditure via physical exertion, it is not surprising that a lack of PA has induced a host of morbidities and increased risk for mortality.

Over the past five decades, a substantial accumulation of empirical evidence (both epidemiological and experimental data) has established that well-known, pervasive, and yet preventable behavioral risk factors such as physical inactivity and unhealthy diets exact an enormous toll as proximal elements in the causal

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pathway of NCDs. Fortunately, the loss of physiologic resources (e.g., strength, endurance) and increments in metabolic impediments (e.g., increased fat mass and insulin resistance) concomitant with sedentary lifestyles and aging are not inevitable. The evidence for the protective effects of PA and the importance of exercise in primary prevention as well as an empirically-supported treatment of NCDs is extensive and increasing. Accordingly, the World Health Organization, United Nations, American Heart Association, American Cancer Society, American Diabetes Association and the European Association for the Study of Diabetes have concluded that a sedentary lifestyle is a major modifiable risk factor for NCDs.

This review begins with a brief summary of the evolution of human physiology and the alterations of the socio-cultural and physical environments that have reduced the necessity of physical exertion and increased the prevalence of sedentary lifestyles. We then provide a survey of the evidence that human physiology requires a minimum amount of PA to maintain health, and that the adoption of a physically active lifestyle is now an essential component of health and wellbeing.

The Environment and the Evolution of Human Physiologic Resources

Humans evolved in an environment in which survival necessitated considerable amounts of physical exertion and energy expenditure. Extremes of temperature, altitude, terrain and other environmental features regularly challenged the physiology of early humans. Consequently, human metabolic, cardiovascular and musculoskeletal systems (i.e., physiologic resources) evolved to meet the demands of that milieu. It has been estimated that hunter-gathers expended greater than 80 kJ/kg/day (20 kcal/kg/day) in PA. In light of this, it becomes clear that it was not only an opposable thumb that allowed early humans to gain ascendency over other animals but the incomparable capacity to expend vast amounts of energy in sustained PA. The ability to stalk prey (i.e., persistence hunting) and gather resources over vast distances allowed early humans to effectively utilize and eventually to dominate their natural environment. Over millions of years, the confluence of socio-cultural evolution (i.e., the development of human society) and the progression of human physiologic resources allowed humans to meet the intense demands of their environment and become the preeminent species on Earth.

Nevertheless, the socio-cultural evolution (i.e., alterations of the social and natural environment) that allowed modern humans to gain preeminence now threatens human health and wellbeing. The modern environment has evolved rapidly over the last century and is now explicitly designed to reduce physical labor, and for many people physical activity energy expenditure (PAEE) is now well below that which is necessary to maintain health. As a result, modern sedentary lifestyles have induced a host of pathologies in the form of NCDs. The evidence that humans suffer severe consequences from inactivity is extensive and increasing.

While the medical community has only recently begun to consider PA and exercise as modalities that improve health, there is a vast evidence base that suggests that in the modern environment, PA and exercise not only improve health once it is compromised, but are essential elements in its maintenance.

The evolution of the energy demands of survival.

Humans are social animals that have evolved within the context of highly developed communal structures and while a single human is remarkably unprepared to survive in the wilds, a social milieu obviates much of the physical burden and energy demands of survival. Consequently, the evolution of human socio-cultural evolution is inversely related to PAEE and the concomitant demands on the physiologic resources so essential to health. Early communal hierarchies allowed for the avoidance of predators and the sharing of hunting and gathering of food. By 7000 BCE, the development of agriculture facilitated the transition from foraging and persistence hunting (i.e., the “Neolithic revolution”) to a less energetically costly way of life. Attendant with this transition was a dramatic reduction in the energy
costs of survival.\textsuperscript{67} When humans toiled laboriously to survive, they expended sufficient energy in PA to tax physiologic resources and in doing so, forestall many of the NCDs that now befall modern man. In other words, the continuous and at times intense PA from hunting, farming and other ‘occupational’ activities was more than adequate to support health, and most people succumbed to infectious rather than chronic diseases. Nevertheless, as human societies progressed from hunting and gathering to agrarian to industrial and post-industrial (i.e., informational) economies, the PAEE obligated by the environment diminished significantly and reduced the demands on the metabolic, cardiovascular and musculoskeletal systems that are so vital to health.

\textit{The modern environment.}

Despite unconvincing claims that PA has not declined over the recent past,\textsuperscript{78} modern sedentary humans expend approximately 25-30\% of the calories that hunter-gatherer populations expended in PA (\textasciitilde{} 20 kJ/kg/day compared to \textgtrsim{} 80 kJ/kg/day respectively).\textsuperscript{5,67} This substantial reduction in PAEE is the result of numerous anthropogenic changes in the physical, social and cultural environments,\textsuperscript{79,87} and is one of the primary drivers of the recent increase in NCDs.\textsuperscript{17,23,24,26,28,63,79,86} Recent socio-cultural and environmental changes in transportation, occupation, domestic activity and entertainment have dramatically reduced PAEE. Over the past five decades, there has been a remarkable worldwide increase in the use of passive transport (e.g., private vehicles) and a concomitant substantial decline in active transport (e.g., walking, biking).\textsuperscript{9,56,87-95} The increased availability and use of labor-saving features in the urban environment (e.g., mass-transit, elevators, escalators and moving sidewalks) diminish PAEE as we move through modern cities.\textsuperscript{87,89,92,96,97} For example, present-day Americans take significantly fewer steps than individuals in traditional agricultural lifestyles such as the Amish (i.e., \textless{} 10,000 steps/day vs. \textgtrsim{} 15,000 /steps/day).\textsuperscript{98,99} Perhaps more importantly, there has been a substantial decrease in occupational EE as mechanization and a transition from manufacturing to informational labor have reduced the need for physical effort. The average person spends nearly 50\% of their waking hours (and therefore a large portion of their PAEE) at their job. Any decrement in physical exertion and/or the time spent in occupational PA will have dramatic impacts on health and obesity. It has been estimated that the working population in the United States has experienced a decrease in occupational EE via reductions in both the number of hours spent working\textsuperscript{13,100-102} as well as the physical effort obligated by occupation.\textsuperscript{11} Over the past 50 years, the estimated decrement in occupational EE via decreases in the physical effort obligated by occupations in the United States is greater than 420 kJ/day (\textgtrsim{} 100 kcal/day).\textsuperscript{11} This decrement in occupational EE approximates the ‘energy gap’\textsuperscript{103} necessary for the increase in bodyweight and obesity experienced in the US over the past 50 years.\textsuperscript{11}

In addition to decrements in transport and occupational EE, there have been substantial decreases in PAEE in almost every other component of daily life. For example, labor-saving devices have dramatically changed how housework is performed.\textsuperscript{14,104} The physical effort necessary in the performance of domestic activity and housework have been on the decline since the middle of the 20\textsuperscript{th} century and most estimates suggest that women are performing 10-15 hrs less housework per week than in the 1960s.\textsuperscript{12-14,100,101,105} As the time spent doing housework decreased, the amount of time in sedentary behaviors (e.g., TV viewing and web surfing\textsuperscript{13,101,106}) has increased dramatically. American adults now spend over 16 hours per week watching television and additional time in front of their computers.\textsuperscript{13,100,101,106,107} The estimated change in energy expenditure from active housework (e.g., washing the dishes and sweeping the floor) to sedentary pastimes (e.g., using a dishwasher while watching TV) is the equivalent of more than 4,200 kJ/week (\textgtrsim{} 1,000 kcal/week). The decrement in PAEE from these findings suggests that the recent rise in bodyweight and obesity experienced in the US is due to decreases in PA alone. Given the fact that PA is the major modifiable component of total daily energy expenditure (TDEE),\textsuperscript{108} the substantial decrement in total PAEE from all activities (e.g., transport, occupational and housework) may be so large that current levels of obesity would be
considerably higher if energy intake (EI) levels had increased. In agreement with other sources,\textsuperscript{109-111} these PA data suggest that EI has either diminished or remained static in some groups over the recent past.

**The Necessity of PA for Health**

*Ancient wisdom.*

The importance of PA for health has been recognized for millennia and the detrimental effects of a sedentary lifestyle were observed well before the 21\textsuperscript{st} century. As human societies evolved, the emergence of a leisure (i.e., sedentary) class supported by slave and/or peasant economies gave rise to the earliest instances of sedentarism and hypokinetically induced NCDs. Sushruta, the famous Indian surgeon from Kashi and father of Ayurvedic medicine (i.e., knowledge of life), practiced around 600 BCE.\textsuperscript{112,113} His keen sense of observation led to the discovery that his most inactive/sedentary clients suffered from a number of classic hypokinetic diseases.\textsuperscript{113,114} Sushruta chronicled numerous NCDs such as madhumeha or “honey-like urine” (i.e., diabetes); vataraka (i.e., hypertension) and medoroga (i.e., obesity) in his ancient text *The Sushruta Samhita*.\textsuperscript{112,115}

*Modern evidence.*

Since the 1950s, there has been a substantial accumulation of epidemiological evidence on the primacy of PA in the maintenance of health. Some of the compelling modern evidence of the health sustaining effects of PA is provided by two classic studies: the College Alumni Study (CAS)\textsuperscript{116} and the Aerobics Center Longitudinal Study (ACLS).\textsuperscript{117} The CAS examined PA and all-cause mortality in over 36,500 men from their college entrance documents (1916-1950) and other public records. The work of Paffenbarger and colleagues revealed an inverse dose-response relationship between PA and all-cause mortality. Greater levels of PA were associated with a lower risk of death, and men expending > 8,400 kJ per week (2000 kcal/wk) in PA had a 27% lower risk of mortality compared with men expending < 8,400 kJ per week (2000 kcal/wk).

While the CAS was a seminal and landmark study, one of its greatest limitations was the use of self-reported PA. Since people tend to over-report their PA levels, there is an attenuation of relationship between PA and health.\textsuperscript{118} As such, we have been able to extend earlier work on PA and health outcomes by objectively measuring cardiorespiratory fitness (CRF) by a maximal exercise test, which is primarily determined by a person’s PA during a few months before the test.\textsuperscript{120} The ACLS has produced compelling evidence on the relationship between PA, CRF and health.\textsuperscript{23,55,117,119-125} In our first report on CRF and mortality, we followed over 13,000 healthy men and women for more than 8 years of follow-up (a total of 110, 482 person-years of observation). The age-adjusted all-cause mortality rates for men increased from a low of 18.6 per 10,000 person-years in the most-fit quintile to 64.0 per 10,000 person-years in the least-fit quintile. The corresponding values for women were 8.5 per 10,000 person-years in the most fit to 39.5 per 10,000 person-years in the least fit. This strong inverse trend remained after correcting for age, smoking, systolic blood pressure (SBP), cholesterol levels, family history of CVD and fasting serum glucose levels. Higher levels of CRF delay all-cause mortality through lower rates of NCDs (e.g., CVD and cancer). Our results clearly demonstrate that a sedentary life style engenders a reduced CRF, which leads to accelerated aging, and an increased risk for NCDs and premature mortality.\textsuperscript{28,55,117}

**PA and mortality.**

We recently examined the attributable fractions of deaths in the ACLS population.\textsuperscript{28} Attributable fractions are based on the strength of a particular risk factor with mortality and on the prevalence of the risk factor in the population being examined. Figure 1 depicts the results of these analyses. The attributable fractions are the estimated number of deaths in the population that are due to a specific risk factor. Each risk factor is adjusted for possible confounding factors, including age, examination year, and each of the other risk factors in the figure. Low CRF is estimated to cause ~16% of deaths, which is far higher than any other risk factor, with the possible exception of hypertension in men, and is greater than the combined deaths due to obesity, diabetes, and smoking in both women and men.
attributed to five major risk factors (i.e., high blood pressure, tobacco use, high blood glucose, physical inactivity and overweight/obesity). As global patterns of PA and consumption changed, the increasing prevalence of these well-known, pervasive and yet preventable major risk factors has exacted an enormous toll as the proximal element in the causal pathway of NCDs (e.g., CVD, T2D, stroke, cancer and chronic respiratory diseases). In concert with the 2009 WHO report, the United Nations General Assembly formally recognized that the spread of NCDs represents a global crisis, and that men, women, and children in all countries and in all income groups are at risk.

Direct costs.

The confluence of physical inactivity and the aging of the global population has lead to a dramatic increase in NCDs and their attendant costs. The increasing burden of NCDs represents a significant threat to human, societal and economic development throughout the world. NCDs are currently responsible for over 65% of all deaths worldwide (i.e., > 36 million fatalities) and are projected to cause over 75% of all deaths by 2030. In post-industrial nations, more than 85% of all deaths are due to NCDs. It is important to note that in the US, 20% of the population smokes yet 40% are inactive. This suggests increasing PA may be the most effective solution to the global pandemics of obesity and NCDs.

The failure to reduce NCDs will result in heavy losses in terms of both human life and economic production. Two of the major risk factors, obesity and physical inactivity have both direct and indirect effects on the mortality and morbidity associated with NCDs via other risk factors (e.g., high blood pressure, high blood glucose). Globally, approximately 2.8 million adults die annually as a result of being overweight or obese, and roughly 10% of all NCD mortality is due to insufficient PA. In the United States, obesity and physical inactivity account for nearly 20% of all deaths (i.e., > 400,000 deaths annually), and a substantial portion of the burdens (i.e., disability and mortality) from certain cancers, diabetes and CVD are directly attributable to inactivity-induced low levels of

**Figure 1** Attributable fractions (%) for all-cause deaths in 40,842 (3,333 deaths) men and 12,943 (491 deaths) women in the Aerobics Center Longitudinal Study. The attributable fractions are adjusted for age and each other item in the figure. * = cardiorespiratory fitness determined by a maximal exercise test on a treadmill. (Reprinted by permission of the Br J Sports Med)

Over the past 50 years, the evidence base continues to accrue via modern epidemiological studies, and it demonstrates a strong, inverse dose-response relationship between PA and NCDs, especially CVD. The health benefits of PA are irrefutable, and even small increments in PA via reductions in sedentary behavior are beneficial, given that each is an independent risk factor for CVD. The maintenance of health, reduced mortality and improvements in metabolic function, body composition, hemodynamics, musculoskeletal, and psychological functioning are a few of the myriad benefits of PA. Active individuals have lower rates of all-cause mortality, CVD, high blood pressure, stroke, T2D, metabolic syndrome, colon cancer, breast cancer, depression, enhanced cognitive functioning, better quality sleep and health-related quality of life (QoL).

The Economic and Societal Costs of Inactivity

**Risk factors for NCDs.**

In 2009, the World Health Organization (WHO) reported on the leading global risk factors for mortality. More than one third of all deaths were attributed to five major risk factors (i.e., high blood pressure, tobacco use, high blood glucose, physical inactivity and overweight/obesity). As global patterns of PA and consumption changed, the increasing prevalence of these well-known, pervasive and yet preventable major risk factors has exacted an enormous toll as the proximal element in the causal pathway of NCDs (e.g., CVD, T2D, stroke, cancer and chronic respiratory diseases). In concert with the 2009 WHO report, the United Nations General Assembly formally recognized that the spread of NCDs represents a global crisis, and that men, women, and children in all countries and in all income groups are at risk.

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CRF and increased obesity. Additionally, NCDs often result in slow painful deaths after extended periods of disability. As such, NCDs diminish not only the quality and quantity of life, but also deprive the local community of economic production and independence.

As the prevalence of the major risk factors increases, the costs of inaction will amplify and the failure to reduce NCDs will result in heavy losses in terms of both human life and economic production while threatening health systems and economic progress in both the developed and developing world. In addition to the human losses, the economic costs associated with the lifestyle-related antecedents (i.e., major risk factors) of NCDs are staggering. In the US, the cost of CVD & diabetes alone account for $750 billion annually and are increasing. In other countries the costs are equally burdensome: China $558 billion; India $237 Billion; and Britain $33 Billion.

The Human Cost of Sedentary Lifestyles

Loss of Physiologic Resources.

It is well established that age and sedentary lifestyles diminish the physiologic resources (e.g., strength, CRF) necessary for humans to meet environmental demands (e.g., stair climbing, housework, personal care) while decreasing QoL and increasing morbidity and mortality. Inactivity has significant risks for all individuals independent of age, genetic endowment, personal history (e.g., past lifestyle), body composition and current behavior (e.g., diet, alcohol consumption and/or smoking). Sedentary lifestyles have severe consequences for all individuals since the relative risks of physical inactivity and mortality from NCDs begin in childhood and increase with advancing age. A lifetime of physical inactivity attenuates peak aerobic capacity, skeletal muscle strength and bone density while predisposing individuals to a host of morbidities in later life such as T2D, osteoporosis, sarcopenia, CVD, frailty, cancer, and fatty liver disease. Not surprisingly, the prevalence of nonalcoholic fatty liver disease (NAFLD) has increased in parallel with the rise in childhood sedentarism and hypokinetically-induced childhood obesity. NAFLD is now one of the leading global causes of chronic liver disease in children and adolescents.

Premature aging.

In 2008, more than nine million of the deaths attributed to NCDs occurred before the age of 60. These "premature" deaths are strong evidence of the acceleration of both aging and mortality from inactivity as well as other risk factors such as smoking. In developing nations, the risk of premature death (< 60 yrs of age) from NCDs is 300% greater than in post-industrial nations.

In elderly populations, the major inactivity-induced NCDs are often comorbid with other pathologies associated with sedentary lifestyles (e.g., osteoporosis, sarcopenia, obesity) as well as poor nutrition. The co-occurrence of these pathologies denotes a phenotype of accelerated aging indicated by decrements in the ability to perform activities of daily living (ADL) and a reduced QoL. These impairments are engendered by alterations in energy metabolism (e.g., dysglycemia), body composition (e.g., loss of lean body mass, bone mass, and increments in fat mass), musculoskeletal dysfunction (e.g., loss of muscle quality, volume, force development), decrements in CRF and other indices of functional capacity. The relationship between age, inactivity-induced decrements in physiologic resources and morbidity are causal and not merely incidental. For example, body composition explains > 80% of the variation in energy metabolism (e.g., glucose disposal, E1 expenditure and storage). Skeletal muscle mass (SMM) is responsible for ~70-80% of insulin-mediated glucose uptake and post exercise, SMM is responsible for dramatic increases in non-insulin mediated glucose uptake (NIMGU). Low SMM from aging and inactivity is linked with insulin resistance and frailty, while exercise training-induced increases in muscle volume, quality and/or function improve insulin sensitivity, sarcopenia and health.
Exercise as Treatment for NCDs and other Inactivity-induced Morbidities

The loss of physiologic resources and increments in metabolic impediments (e.g., increased fat mass, insulin resistance) concomitant with sedentary lifestyles and aging are not inevitable.46,48 Lifestyle modifications (e.g., increases in PA) have been empirically examined for over 30 years,216-220 and have been demonstrated to improve the metabolic risk factors (e.g., inflammation, insulin resistance) for a number of NCDs: Hypertension, T2D, cancer and CVD.15,57,120,221 A considerable accumulation of data from randomized trials suggest that exercise interventions (EXs) may prove both efficacious and cost-effective in the prevention as well as treatment of numerous NCDs.17,28,53,57,218,222-228 EXs enhance physiologic resources (e.g., strength, CRF), ameliorate or even reverse the underlying pathologies that inhibit the ability to meet environmental demands (e.g., stair climbing) and halt progression along the continuum from inactivity to disability and death.

CVD.

In 2011, a Cochrane systematic review allowed an analysis of 47 studies which included 10,794 CVD patients randomized to either exercise-based cardiac rehabilitation or usual care.229 With 12 months or more of follow-up, exercise-based cardiac rehabilitation reduced all-cause and CVD mortality significantly: RR 0.87 (95% CI 0.7 to 0.99) and 0.74 (95% CI 0.63 to 0.87), respectively. In 70% of these studies, there was evidence of a significantly higher self-reported QoL with the exercise treatment compared to usual care. Given these and other results, the prescription of PA and exercise is now an essential, but all too often underutilized component of the treatment of CVD.15,230

Metabolic disorders: diabetes, dysglycemia and insulin resistance.

A meta-analysis in 2006231 demonstrated that exercise significantly improves glycemic control and reduces visceral adipose tissue and plasma triglycerides. In 2010, a meta-analysis of 13 RCTs showed that resistance training (RT) reduced glycosylated hemoglobin (HbA1c) by 0.48% (95% CI -0.76 to -0.21; p = 0.0005), total fat mass by 2.33 kg (95% CI -4.71 to 0.04; p = 0.05) and SBP by 6.19 mmHg (95% CI 1.00 to 11.38; p = 0.02). Thus, RT had both a clinically and statistically significant effect on multiple metabolic risk factors (e.g., obesity, HbA1c levels, and SBP).232

A more recent review and meta-analysis of 47 RCTs (duration > 12 weeks) examined a total of over 8,500 patients.233 Structured exercise training (e.g., aerobic exercise, RT or both combined) was associated with a decline in HbA1c levels of -0.67% (95% CI, -0.84% to -0.49%) compared with control participants. The combination of both aerobic and RT was the most effective, resulting in HbA1c decrements of -0.51% (95% CI, -0.79% to -0.23%) when compared with control participants.

These results clearly support exercise as an efficacious treatment of CVD and the reduction of numerous metabolic risk factors.

Summary

Rapid and dramatic alterations of the natural and socio-cultural environments over the past century have PAEE below that which is necessary for health and wellbeing69,70 and as a consequence, increased the prevalence of NCDs. Over the past 50 years, a substantial accumulation of epidemiological and experimental evidence has established a causal relationship between NCDs and preventable behavioral risk factors such as sedentary lifestyles and unhealthy diets.15,16,24,26,27 As such, physical inactivity leading to low levels of fitness is a leading cause of morbidity and mortality in the world.16,17,26,63,130 Nevertheless, there exists a lack of appreciation of the necessity of PA and exercise in the maintenance of health as well as a lack of implementation of PA interventions in the primary prevention and treatment of NCDs.

It is our hope that the vast accumulation of evidence on the relationship between the health-sustaining benefits of PA and exercise is recognized and appreciated so that future generations do not suffer the consequences of inactive lifestyles.
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現代の環境は、明らかに、肉体労働を減らし、身体的な心地よさを高め、受動的な娯楽を楽しむ余裕を作り出すように設計されている。その結果、身体的不活動と体を動かさない娯楽は、脱工業化社会のいたるところで見られるようになった。人間の代謝、循環、筋・骨格システムは、生き残るために相当な身体活動を要する環境の中で進化してきた。このことを考えると、身体的不活動が多くの病気の原因となっていることは驚くにあたらない。疫学研究のエビデンスによれば、身体的不活動は重大なリスクであり、年齢、遺伝的要因、これまでの過ごし方（例えば、生活習慣）、体組成、現在の生活習慣（例えば、食事、アルコール消費、喫煙）などとは独立して、すべての個人に対して重大な健康上の問題を引き起こす。身体的不活動は加齢変化を加速させ、心血管疾患、2型糖尿病、他の病的変化（例えば、衰弱、骨粗鬆症、サルコペニア、肥満）などの非感染性疾患の頻度を増加させる。身体的不活動による非感染性疾患死亡率の相対危険度の上昇は、小児期より認められ、年齢とともに上昇する。しかし、身体活動・運動は非感染性疾患、あるいは座業がちな生活と加齢による他の病的変化の発症を遅らせる、あるいは予防する。本総説では、健康維持、加齢に関連する疾患、非感染性疾患の予防に身体活動・運動が欠かせない要素であることを支持している観察研究および無作為化比較試験（RCT）を概説する。