PHYSICAL ACTIVITY AND EXERCISE AS A BASIC PREVENTIVE MEASURE (PRIMARY PREVENTION, PREVENTION AFTER RENAL TRANSPLANTATION)

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SUMMARY

Movement is an inseparable part of one's life, and has been a basic everyday activity through the history of mankind. However, a lack of physical activity and availability of food have resulted in a variety of serious health impairments. The 20th century has witnessed a steep rise of mortality from cardiovascular disease, increase in the prevalence of type-2 diabetes mellitus, malignant diseases, and dramatic increase in body weight initially in industrialized nations followed, in the last two decades of the last century, by the populations of third-world countries with all inherent consequences of this phenomenon.

Preventive programmes involving physical activity have also been on the list of top priorities of various materials issued by the World Health Organization.

Physical activity is one of the simplest non-pharmacological tools in the prevention of a plethora of diseases. The simplest physical activity, even for therapeutic purposes, is walking. We can walk any time, virtually anywhere, so walking is also the least expensive therapeutic option.

Key words: prevention, physical activity, exercise, transplantation

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INTRODUCTION

The life expectancy at birth is now 69 years, that is 6 years more than 20 years ago (1). The most common chronic diseases worldwide are cardiovascular diseases followed by malignancies, type-2 diabetes mellitus, respiratory diseases, and osteoarthritis. The prevalence of these diseases rises with increasing age. The most important modifiable risk factor is a lifestyle and physical activity in particular.

Prehistoric times and archaeological findings suggest that our predecessors had not faced the problem of overweight. On the contrary, excavations have indicated considerable "wear-and-tear" of the musculoskeletal system of man due to strenuous physical activity. On the other hand, our current lifestyle is associated with a host of adverse implications of low levels of physical activity in our industrialized society.

Cardiovascular disease is the the most common global cause of death of adults although it is preventable, with modifiable risk factors implicated in more than 90% of the risk of incident myocardial infarction (2).

In an effort to improve prevention and treatment of chronic diseases, the American College of Sports Medicine issued, as early as 1996, recommendations for everyday cumulative exercise for at least 30 minutes, resulting in an activity equivalent from 3–6 metabolic equivalents (METs), as the basis for a population-based strategy of preventive measures (3).

Throughout the history of mankind physical activity has been a natural and inseparable part of everyday life. Only the richest could have afforded to pursue physical activity also for pleasure (horse riding, falconry, just to mention a few). Physical fitness was also tantamount to prestige. Thus, physical activity was not perceived as a sport the way it is today but, rather, fitted the cultural pattern of behaviour within particular society.

For example, mortality from cardiovascular diseases within the Austro-Hungarian Empire in the early 20th century was just about 4%.

The lack of physical activity is associated with risks that may essentially increase the incidence of serious conditions.

Topping the list is overweight or obesity. Despite many objections and criticisms, the most frequent measure to diagnose this condition remains body mass index (kg/m^2).

The Institute for European Food Studies (IEFS) conducted a study designed to assess any potential relations between body weight, physical activity and health status. The study involved 15,339 individuals (about 1,000 from each member state). The study showed that the perception of the importance of physical activity varies among nations. While Finns rated physical activity as the most critical modifiable factor related to health (pursuit of sports self-reported by 92% of the population), Greeks ranked it seventh (with 60% of individuals practicing any sports) (4).

According to the World Health Organization, up to 66% of boys are satisfied with their body weight whereas up to 50% of girls would like to reduce their body weight (regardless of whether they are or not overweight).

The situation in the Czech Republic is not much different, with up to 66% of 15 year old girls intent to start a slimming diet. While the situation is better with boys of the same age, still 22% of them plan to lose weight (again with no need). However, no

data are available suggesting an increase in the physical activity of these adolescents (5).

Further information has been published about research into the effect of body weight on the incidence of cardiovascular events, with data obtained in the Health Professionals Follow-up Study (HPFS) (42,351 men aged 39–75 years) and the Nurses' Health Study (NHS) (76,703 women aged 39–65 years). During 16 years of follow-up a total of 2,771 events in men and 2,359 events in women were documented. The relative risk (RR) of cardiovascular disease (CVD) in individuals with a body mass index (BMI) ≥ 30 kg/m^2, as compared with individuals with a BMI of 18.5–22.9 kg/m^2, was 2.13 (95% CI 1.82–2.48) in men and 2.48 (95% CI 2.20–2.80) in women. The risk of CVD increased with increasing BMI regardless of the presence or absence of comorbidity. The most important finding of this research was that about 30% of cardiovascular events (irrespective of gender) occur in individuals with excessive body weight (6).

In our view, the most appropriate classification of physical activity for clinical purposes is that used by researchers at the lst Medical Faculty, Charles University in Prague (7).

- Short-term strenuous physical exercise;
- Regular lower-intensity activity.

In the long run, regular physical activity with its inherent benefits particularly for the cardiovascular system is more beneficial for the human body.

Regular physical activity is defined as one lasting uninterruptedly at least 30 minutes daily for a period of 6 weeks.

Regular physical exercise results in a favourable response by the body in the metabolism of:

- glucose (reduced insulin consumption, improved morning glycemia, reduced insulin resistance);
- lipids (decreased levels of low-density cholesterol and triglycerides, increased levels of high-density cholesterol).

Last, but not least, there is the beneficial effect on overall health resulting from the antidepressant action of physical activity. For better guidance and to enable analytical operations, exercise is classified by its intensity when evaluating the results of exercise testing:

- absolute intensity reflects the degree of energy output and is given in kilojoules (kJ), kilocalories (kcal), or METs;
- relative intensity is related to the percentage of maximal aerobic capacity and is commonly given as the percentage of maximum heart rate or percentage peak oxygen consumption (8).

In our report we show the results of two studies that dealt with physical activity. The first one examined the physical activity of probands from South and Central Bohemia, an important feature of the primary prevention of civilization diseases. The second study focused on physical activity in renal transplant patients as an important part of the complex treatment.

MATERIALS AND METHODS

Spontaneous Physical Activity in Primary Prevention

In our study focused on spontaneous physical activity in primary prevention a total of 986 volunteers were enrolled (males and females, mean age 35.61 ± 11.254 years), with permanent residence in the regions of South and Central Bohemia, and equally represented by individuals with identical levels of education and the same distribution of rural/urban populations. Assessable physical activity was defined as regular physical activity of 30 minutes per day.

Results: No physical activity was admitted by 24% of respondents (only 14% in South Bohemia, and 30% in Central Bohemia). The most common frequency of exercise was once per 10 days, 22% (21% and 22% in South and Central Bohemia, respectively). Daily exercise was self-reported by only 4% of examined individuals (4% in South and Central Bohemia each), whereas two sessions of exercise per week were reported by 12% of individuals (17% and 9% in South and Central Bohemia, respectively). The lowest BMI values were documented in individuals reporting exercise twice a week (BMI of 24.30 ± 4.981 kg/m^2, 22.083 ± 2.725 kg/m^2, South Bohemia; and 26.74 ± 4.434 kg/m^2, Central Bohemia).

Adherence of the Kidney Transplant Recipients to Exercise Training by Qualified Professionals

Patients undergoing transplantation of vital organs may take exercise up to one year before they can return to work, even if not developing postoperative complications and with good graft function. It goes without saying that transplantation poses a risk for the patient and many patients and their families find it difficult to cope with the stress. Despite this, patients with good graft function and a suitable job may return to work already during or after the first year post-transplant. However, in cases where the patients have not started to exercise, their performance is rather reduced and their problems may, quite paradoxically, only begin to escalate.

Group, Method

To be able to arrange an exercise programme supervised by qualified specialists and run during the first post-transplant year, we developed an individually modifiable plan for volunteer transplant recipients. The patients were willing to take part in the project under the supervision of a team composed of a rehabilitation therapist, nephrologist, cardiologist, and physiotherapists. The study was conducted from 1 October 2012 – 31 October 2013.

Inclusion into the exercise training programme was made at the discretion of a physician of the Department of Nephrology; those selected had bicycle ergometry (the Department of Preventive Cardiology) to determine possible workload and individualized exercise training programme (60 minutes once a week, the Department of Clinical Rehabilitation) was developed for each participant. All participants were advised about physical exercise in their home setting and distributed sport tester devices.

Patients

The patients were kidney transplant recipients in reasonable circulatory status, giving consent with their participation, residing within a perimeter of 20-minute car drive (urban traffic) from the hospital. They were both males and females (aged over 18). A total of 9 individuals were enrolled, 3 of them failed to take part in the programme (the low adherence in the first three patients was due to personal reasons and to deterioration, unrelated to the

programme, of the health status of another participant). Only 6 patients finished their planned training programme.

RESULTS

Adherence to exercise training during the year was 2.0, 9.8, 12.0, 22.2, 60 and 61.0% for the participants (average 27.83%). Calculation of standard deviation was merely a mathematical operation, of no practical importance.

During the one-year programme, sessions were attended only once by 4 participants, twice by 3, with only one female participant attending 18 sessions.

The programme was stopped as a complete failure after one year from its start as the patients disregarded, even after repeated educational sessions, the need for regular physical activity.

DISCUSSION

While awareness and information of the Czech non-medical public about the benefits of appropriate physical activity for general health is good in terms of theory (with a host of educational materials, at various levels of education, published by state institutions, non-profit organizations and associations, pharmaceutical companies, etc.), the reality is less optimistic (9).

Physical activity has been consistently shown to be inversely correlated with the development of CVD (10).

Given the continuously increasing life expectancy, physical activity should be regarded as an inherent part of life even in the elderly population. Problems related to physical activity have already societal implications (11). One report presented outcomes of an exercise training programme designed specifically for the elderly, those aged 65+ (12). The study included a programme comprised of 28 sessions (30–40 minutes, 4 times a week) in the treatment group. The control group behaved according to standard recommendations. The intervened group showed a decrease in the risk of developing CVD from moderate to minimal ($p < 0.001$).

A systematic review of more than 50 randomized trials of controlled intervention has confirmed that physical exercise represents an effective strategy for both the population at large and for high-risk groups (13). We followed up a total of 5,681 individuals aged over 65 in a preventive programme using monitored telephone interview (reported response rate of 61%). However, their adherence to recommendations was as low as 21%.

One in three people aged over 65 sustains at least one fall per year, and more than 30% of falls have some more serious consequences (14). Whilst it is just a guess how many of these falls are virtually the first clinically serious manifestation of higher-degree atrioventricular block, it is well known that exercise is the best type of prevention of falls and injuries in the elderly (15).

Another major risk factor for the development of CVD is type-2 diabetes mellitus; its prevalence is rapidly rising worldwide, and the risk of complications has been documented already in the pre-diabetes phase. The management of type-2 diabetes mellitus is estimated to make up to 10–15% of overall healthcare costs in industrialized countries (16). Exercise combined with a proper dietary regimen make up one of the main three components of management of the patient with diabetes.

The importance of comprehensive primary prevention was highlighted by the Finnish Diabetes Prevention Study showing, after 4 years, 11% cumulative incidence in the intervention group as compared with 23% in the control group ($p < 0.001$) (17).

Yet another major component in prevention is body weigh optimization. However, numerous studies involving restricted energy intake and increased physical activity have demonstrated only a short-term effect (not beyond 6 months and mere 5% body weight reduction (18).

Physical Exercise in Secondary Prevention of Cardiovascular Disease

A large meta-analysis demonstrated a positive association between regular physical activity of coronary patients and a 26% reduction of mortality (19). Several mechanisms potentially involved in the above finding were considered such as improved endothelial function, slowed progression of coronary lesions, reduced thrombogenic risk, and promoted development of collateral circulation (20). Also, regular physical activity has been shown to reduce the risk of arrhythmogenesis through optimized function of autonomic nerve activity (21). Several reports have shown a beneficial effect on decreasing or slowing the progression of risk factors for coronary heart disease (CHD), decrease in cholesterol levels, reduced obesity, and lower risk of developing non-insulin-dependent diabetes mellitus (22, 23). Additional reported effects included those on induction of intracardiac heat-shock proteins, elevation of endoplasmic reticulum stress proteins, increased NO production, improved function of mitochondrial ATP-sensitive K+ channels and reduced effect of cardiomyocyte apoptotic mechanisms (24). Additionally, regular physical activity seems to help relieve the anxiety related to the life-threatening disease and may improve the patient's self-confidence.

The most common physical activity for patients in secondary prevention of CHD is regular aerobic physical exercise. Data available for patients with a chronic CVD do not allow exactly define the intensity of aerobic exercise throughout a week the way it is defined for healthy individuals. The intensity of exercise should be adjusted to the individual's clinical status, hence the need for categorizing patients according to the level of their clinical risk. Low-risk patients in secondary prevention of CHD may be encouraged to pursue moderate to vigorous physical activity (30 minutes) 3 to 5 times a week. In patients at moderate to high risk, the frequency and intensity of physical activity is individualized using their maximal exercise tolerance (25). The incidence of major cardiovascular events during exercise in patients stratified by their cardiovascular risk (and followed up accordingly) is low, ranging from 1/50,000 to 1/120,000 events/hours of exercise, with the frequency of fatal events being somewhere between 1/340,000 and 1/750,000 events/hours of exercise (26, 27). A similar incidence of events during exercise has been reported in patients with reduced left ventricular ejection fraction (treated according to the principles of evidence-based medicine). Additional benefits included improved exercise tolerance, cardiorespiratory fitness and wellbeing, even in elderly patients.

Regular physical activity in patients after a cardiovascular event should be taken up within 2–3 weeks post-discharge, preferably as a part of organized rehabilitation training programme, spa treatment or at least individual home-based training exercise.

This is a stabilization phase of 2–3 month duration including regular aerobic physical exercise designed to induce and reinforce lifestyle changes to be followed by a maintenance phase with continued regular aerobic physical exercise and minimal supervision by a healthcare professional.

The optimal exercise intensity is consistent with so-called training-induced heart rate determined ideally by spiroergometry using peak oxygen consumption or calculated stroke reserve or maximum heart rate, alternatively, symptom-limited heart rate can be used (e.g. the scale developed by Borga) (8).

One of the main benefits for the patient may be cardiac rehabilitation. Lavie et al. have found that proper rehabilitation led to improved performance by up to 35% (using METs). The authors also reported improvement of the lipid profile – decrease in total cholesterol by 5%, triglycerides by 15%, LDL-cholesterol by 2%, increase in HDL-cholesterol by 6%, reduction of inflammatory markers (CRP) by 40%, decrease in BMI by 1.5%, and improved overall health status (28).

Another risk factor for the development of CVD is metabolic syndrome affecting about 34% of the population of industrialized countries (29). The authors report the results of their survey involving 332 individuals participating in a 14-week controlled exercise training programme. Upon its completion, the incidence of metabolic syndrome declined from 22.3% to 13.5% ($p < 0.05$).

The last two decades have also seen a radical change in the approach to heart failure patients and their allowable physical activity; controlled physical activity has been a part of comprehensive management of chronic heart failure since the 1990s. Papers documenting the benefits of regulated exercise showed a reduction of mortality of exercising patients by up to 50%, while left ventricular systolic dysfunction (determined as left ventricular ejection fraction) correlated with exercise tolerance by patients (30). Exercise has been suggested to improve endothelial function and coronary flow while slowing progression of atherosclerotic lesions.

A physical activity widely regarded as suitable is exercise using the stationary bicycle or treadmill. The suitability of competitive sports (lawn tennis, volleyball etc.) should be considered for a given patient as the sports should be practiced without their stress-related component (for sympathetic nervous system activation). A statistically significant relation between physical activity and the risk for developing heart failure has been documented in individuals with a weekly MET/minute higher than 1,000; $p \leq 0.001$ (31).

A patient having or developing positive relation to regular physical activity is more likely to adhere also to other principles of secondary prevention of CHD (8).

Impressive findings were published by Norwegian investigators (32) reporting results of their survey following up physical activity in 43 heart transplant recipients. The patients were aged 18 and over, 4.0 ± 2.2 post-transplant, 67% of them were men.

These patients were offered to join an intensive exercise training programme and subsequently were compared with a group receiving standard care. The effect of exercise training was assessed using intravascular ultrasound (IVUS).

The study group showed a smaller increase in the size of atheromatous plaques compared with controls (0.9% × 2.5%; $p = 0.021$), with intima thickness being 0.02–0.01 mm vs. 0.05 mm ($p = 0.054$).

No differences were found between inflammatory markers and qualitative progression of atheromatous plaques.

Physical activity should be a daily routine since childhood. Exercise or sports are the best form of prevention of undesirable obesity, improving self-confidence and facilitating social contact. Physical activity should be perceived in the broad context of lifestyle adopted by the child primarily from their family (33).

In the Czech Republic as well as in other countries, cardiovascular disease has been the leading cause of death of adults for years. Many industrialized nations with traditionally good standard of health care report virtually the same figures as our country (e.g. Sweden, 49%) (34).

For example, the prevalence of obesity in the US and Canada is higher compared to the UK, the Netherlands or Australia, with obesity diagnosed in 26% of Americans aged 20–75 years (35).

The Lifestyle Heart Trial showed that an intensive lifestyle modification can result in regression of coronary atherosclerosis at one year, with patients willing to adopt and adhere to intensive lifestyle modifications (vegetarian diet, 10% of fat, aerobic exercise, smoking cessation, stress management), i.e. lifestyle changes showed a mean 37.8% decrease in LDL-cholesterol (36).

One in three people aged over 65 sustains at least one fall per year, with more than 30% of falls having some more serious consequences (14). It might be interesting to have data about falls related to conditions associated with the cardiovascular system (sick sinus syndrome, higher-degree conduction block), however, such data are not available.

The amount of physical activity of the general population, whether in terms of primary or secondary prevention, is not sufficient. This is attested by the increase in body weight of the Czech population (irrespective of CVD, type-2 diabetes mellitus, and metabolic syndrome).

According to the latest data from surveys conducted between 1985 and 2008/9 in a 1% randomized sample of the Czech population, BMI of males rose from 27 ± 4.0 to 28.5 ± 4.62 kg/m^2, with no significant difference found in females (27.3 ± 5.43 and 27.4 ± 6.0 kg/m^2) (37).

Individuals with low physical activity are prone to developing more serious forms of CHD and higher incidence of type-2 diabetes mellitus (38).

A study reported adherence to recommended physical activity at about 21% (14), a figure consistent with data from our surveys. This finding supports the notion that even the demonstrated beneficial effect of simple physical activity will not encourage our population at large to change a comfortable lifestyle, not even in secondary prevention or after transplantation of a vital organ.

As suggested by our data, low amounts of physical activity of the Czech population are consistent with results published by other authors. Durstine et al. reported that up to 77% of schoolchildren below 13 years of age do not exercise at all (1).

A clear benefit for cardiac patients can be seen already after 30–60 minutes of physical activity a day (if pursued for most days of the week) resulting in a decrease in overall mortality by 20%, cardiac mortality by 26%, non-fatal myocardial infarction by 21%, and the need for percutaneous coronary intervention by 19% compared to non-exercising individuals (39). Myocardial infarction survivors have been shown to increase their functional capacity by 11–36% after a 3–6 exercise training programme (40). The benefit of physical activity is also supported by the finding of a 43% reduction in the risk of ischaemic stroke in physically active patients (41). While patients may occasionally try to explain their

physical "inactivity" by their disability, an alternative to physical exercise gaining increasing popularity is Tai Chi, a sequence of slow flowing moves designed to engage various groups of muscles and help maintain stability making Tai Chi an ideal exercise even for the elderly seeking to improve their health status (42).

As the issue of physical inactivity is generally interrelated with socioeconomic factors, it requires a comprehensive and interdisciplinary approach, in particular of public health professionals. Although some 2,500 papers addressing the topic of physical activity have been reportedly entered into major databases to date (43), it still remains a serious issue.

Cardiovascular disease is particularly frequent in kidney transplant recipients, with the mortality rate of 38%. Despite the general advice given on an appropriate lifestyle, most transplanted patients lead a sedentary life which may result in overweight (44).

The association between low physical activity and cardiovascular and all-cause mortality in kidney transplant recipients was studied in a cohort of 540 patients (average age 51 years, 54% males) using validated questionnaires. Along the five-year follow-up, lower physical activity was strongly associated with increased risk for cardiovascular and all-cause mortality. Guidelines for patients with chronic kidney disease suggest an amount of physical activity of at least 30 minutes of moderate intensity activity five times per week (min. 450 MET – minutes/week) (45).

Our group of the transplanted patients was too small, so the statistical data are only informative, nevertheless, even these very seriously ill people underestimate the importance of physical activity for their overall health. Unfortunately, there are no legal sanctions against those failing to adhere to lifestyle modifications leaving educating and promoting public awareness as the only option in an effort to reverse the lamentably poor physical fitness of the general population.

However, we can also say that a little interest of our kidney transplanted patients in completely professionally secured exercises also testified about very good health status of our patients, who act distant to non-pharmacological treatment like the healthy population.

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