ORIGINAL ARTICLE

TRENDS in
Sport Sciences
2018; **4**(25): 209-216
ISSN 2299-9590
DOI: 10.23829/TSS.2018.25.4-6

A movement intervention as a tool of the influence of physical fitness and health

VÁCLAV BUNC

Abstract

Introduction. The health benefits of PA are well established and include a lower risk of cardiovascular disease, hypertension, diabetes, and breast and colon cancer. Additionally, PA has positive effects on mental health, delays the onset of dementia, and can help the maintenance of a healthy body mass. Aim of Study. The aim of the study is to summarize the results of the application of appropriate PA based on walking on PF and health in non-trained Czech population differing in age. Material and Methods. The energy output on the level 950 to 2000 kcal (3971-8360 kJ) per week was respected by construction of individual moving programs for seniors, adults and children of both genders. The moving programs consisted of aerobic walking (min 80% of whole exercise) or cycling (min 10% of total exercise) at the level of 50 to 70% VO_{2max}. The duration of exercise session ranged from 20 to 50 min, and training was performed 3-5 times a week during 5 months. The functional variables were assessed on treadmill, body composition with help of bioimpedance analysis. The data were collected in children (142 boys and 124 girls; age 12.6 ± 2.3 years, BM = 36.9 ± 3.0 kg, height = 136.5 ± 2.6 cm, VO_{2peak} = 43.2 ± 3.1 ml·kg^{-1}·min^{-1}) in both men (n = 154) and women (138) of middle age (45.2 ± 7.0, 74.3 ± 3.9, 172.5 ± 2.6, 31.2 ± 3.9), and in seniors of both genders (men n = 71, women n = 112; 71.6 ± 3.6, 77.1 ± 4.1, 171.5 ± 2.9, 26.1 ± 3.1). Results. Interventions with an energy content of 2000 kcal in children, 1500 kcal in adults and 950 kcal in seniors can reduce body mass (about 10%), improve VO_{2peak} (~17%) and motor performance (~15%), reduce the systolic blood pressure (~7 mmHg) regardless of gender, starting values and age. It is also possible to significantly affect the amount of muscle mass (~8%). Conclusions. Reasonable PA is a prerequisite for quality lifestyle and active aging. For seniors, a higher level of PA and thus increased PF significantly affect the quality and progression of aging.

KEYWORDS: physical activity, physical fitness, health, energy output.

Received: 22 November 2018
Accepted: 13 December 2018

Corresponding author: bunc@ftvs.cuni.cz

Charles University, Faculty of Physical Education and Sports, Prague, Czech Republic

Introduction

Physical inactivity is pandemic, with over 30% of adults worldwide not meeting the sufficiency threshold [29, 31]. In spite of studies indicating an increase in leisure-time physical activity (PA) in high-income countries, the modern lifestyle in these countries is reducing physical energy expenditure in occupational, household, and transport domains.

The benefit of regularly practiced PA as a preventive tool to reduce the impact of current lifestyle is documented in a number of epidemiological studies. In 1953, Jeremy Morris [24] published a study which compared the occurrence of adverse cardiac events in the London double-decker buses employees. The classic duo transporting Londoners was composed of a sedentary driver and an active conductor, the latter going to and through and up and down the alleys and stairways. A second basic study about influence of PA on cardiovascular health state was publish at 1986 by Paffenbarger et al. [28] study of Boston dock workers and Harward graduates.

One of the research of Vancampfort et al. [37] considers PA as an important factor in assessing self-perception/

self-awareness and life satisfaction. While physical self-perception and perceiving were proved to be the strongest factor in the effect of physical activity on the perception and evaluation of the quality of life by young women (18-45 years).

Considerable research has evaluated the effects of exercise on cognitive function (including memory function) among older adults, as well as children and adolescents. Less research, however, has evaluated the effects of exercise on memory function among young and middle-aged adults. Systematic review provides evidence that, within this young to middle-aged adult population (including those with and without depression), both acute and chronic exercise may help to enhance several memory-related parameters. Although these findings are encouraging, this line of inquiry within this population is still in its infancy [20].

There was strong, consistent evidence of favourable relationships between total PA and adiposity, several cardiometabolic biomarkers (cholesterol, BP, triglycerides, insulin resistance and fasting insulin, and fasting glucose), physical fitness (aerobic fitness, muscular strength, and endurance), and bone health. There was some support for favourable relationships between total PA and quality of life/well-being, motor skill development, and psychological distress, but evidence in relation to other health indicators (fat free mass, behavioural conduct/ pro-social behaviour, cognition/academic achievement, and selfesteem) was limited [5, 21]. Similar favourable relationships between PA of specific intensities (i.e., light PA – LPA, moderate – MPA, and vigorous – VPA) and health indicators were observed, but in general, higher intensities of PA (i.e., MPA and VPA) were more frequently examined and had both more consistent associations and larger effect sizes than lower intensity PA (i.e., LPA and MPA) [20].

Physical activity provides children with significant health benefits such as high bone density, good motor skills, physical fitness (PF) and healthy weight. In addition, physical activity promotes children's mental health, psychosocial skills and academic achievement [2].

The last but not least, the rise of healthcare cost is a difficult topic to avoid. It would make sense to adopt cost-effective (in the long term) lifestyle changes over expensive specialized and drug-based therapies, think along the lines of cholesterol, overweight and obesity, diabetes, vascular disease, musculoskeletal underuse pain syndromes, etc. But unfortunately the incentives are weak and the competition is too strong [38, 41].

The result of the lack of the movement load is reduced PF, which ultimately leads to the restriction of suitable PA choice and thus to the problems in the design of physical intervention. Only 60 to 70% of the children's population has no limitations by the selection of the movement activity. In subjects of middle age are without the problems with selection of movement activities about 30 to 40% of the adult population, and in seniors only 13-15% are currently able to implement without any complications the PA they would like to carry out [5].

Physical activity improves physical fitness and thus health state and predispositions for working and leisure time activities and thus quality of life in the population. However, despite these potential benefits, the majority of nowadays individuals do not exercise regularly.

The WHO makes good points in the Global Action Plan, when stressing the necessity to raise the awareness on collateral benefits of higher PA levels [41, 42].

Recent position statements have re-affirmed the benefits of an active lifestyle [3, 14, 40]. The current PA recommendation for adults, aged between 18-65 years, to promote and maintain health is to accumulate at least 30 minutes of moderately intense PA on at least five days of the week. Studies aiming to analyze the association between PF and quality of life in young people have been conducted in samples from moderate-to-vigorous physical activity is essential for disease prevention and health promotion. Emerging evidence suggests other intensities of PA, including LPA, may also be important, but there has been no rigorous evaluation of the evidence. WHO 2010 [40], recommend that children and youth spend a minimum of 60 min each day in moderate- to vigorous-intensity physical activity.

Promoting accumulative, lifestyle PA is an ideal approach to combat the high levels of inactivity evident in global populations [13, 21]. At present, the amount of the regularly performed physical load is still decreasing in virtually all age groups of the population. In the last two decades, the volume of regularly implemented PA in the Czech Republic has decreased by about 30% [5, 7].

The goal of all regime measures that use movement is to influence the quality of life, to change sedentary to active lifestyle. The sedentary lifestyle is currently found in more than 80% of the Czech population. Sedentary lifestyle induces mechanisms that lead to increased risk factors for chronic diseases of the noninfectious type and ultimately to premature death. This can be referred to as a sedentary lifestyle syndrome [4].

The result is an increase in overweight and obesity, which has already exceeded 50% in the adult population, 32% in children, with over 30% of adults being obese and 10-12% of children in obese children [8, 31]. Obesity is one of the basic medical and social problems of today's

world. In recent decades, obesity has dramatically increased worldwide (e.g. in the United States more than 35% and in Europe more than 20% of adults are obese) [18, 27, 41, 42]. It is a problem in both developing and developed countries.

Obesity is a multifactorial disease caused mainly by the interaction of genetic and environmental factors. Deficits in motivation, self-efficacy, and self-esteem, sedentary lifestyle, and psychosocial problems complicate treatments for obesity [20, 38]. Thus, a comprehensive management approach needs to address these issues as well. However, conservative weight-reduction programs often fail or patients regain weight initially lost because motivation for weight maintenance decreases [35].

Obesity, however, is a multifactorial phenomenon that requires more complex and dynamic analyses. The present studies are often limited in that no objective information was collected related to obesity such as actual nutritional intake and physical exercise. We also do not know about the subject's emotional state, especially those who experienced loss. Survey data did indicate some differences in diet and snack consumption but no differences in sports club participation nor duration of exercise.

Physical fitness is a term describing maximal aerobic capacity adjusted for body size and composition, and is an integrated measure of cardiorespiratory and neuromusculo-skeletal function, oxygen transport and delivery, and psychological drive. Accordingly, high PF requires that all these important body functions function normally, while low PF suggests malfunction of one or more of them. Epidemiological studies over the past 50 years have unanimously shown that low PA and PF are associated with high risk of cardiovascular and total mortality. Recent data also suggest that low PA and PF are followed by an increased incidence of diabetes mellitus and nonfatal cardiovascular diseases, an increase in mental illness, a deterioration in lifestyle [15, 31].

For seniors, a higher level of PA and thus increased PF significantly affect the quality and progression of aging – we are speaking about the antiaging effect [4, 7, 32].

Factor that is most important for physical independence of subjects mainly in seniors is the muscle strength [32]. Muscle strength is strongly dependent on muscle mass and in seniors it is a main reason of their dependency [34]. It is well documented that the decline of muscle strength with age has been quantified as about 10% per decade after the age about 40 [36]. From the limited research that has been done on elderly women, there seems to be a positive relation between activity level and muscle strength [e.g. 29].

One of the basic themes in the exercise science research has focused on the effect of PA on an improvement of PF, usually measured as maximum or peak oxygen uptake (VO_{2peak}). The actual PF state is not only the predisposition of a better physical performance, health state and quality life style but is a necessary prerequisite for well-being, good working performance and aging [1].

The required amount of realized PA can be expressed in different ways. Lately as the basic intervention resource utilized by walking. The 10,000 walking steps per day PA prescription that has been suggested to meet like the minimum recommendation for PA. Despite some research that supports walking regularly and completing 10,000 steps a day is enough activity to produce positive changes in lifestyle and certain aspects of PF and cardiovascular health, other research has shown limited effectiveness of walking programs and the long term durability of any observed changes has recently been questioned [9, 16, 17, 19, 23, 25, 26].

Both morphological and functional predispositions are essential for a successful physical intervention. The morphological predisposition for exercise may be assessed by the using of extracellular mass (ECM) body cell mass (BCM) and mainly by their relationship ECM/BCM. Coefficient ECM/BCM characterize the quality of muscles mass and can reflect the qualitative and quantitative changes like a result of imposed training [4, 6, 30].

The aim of this study is to summarize the results of the application of appropriate PA on physical fitness and health in non-trained Czech population differing in age. Recruitment was approved by the Faculty of Physical Education and Sports Charles University Ethics Committee.

Material and Methods

The energy output on the level 950 to 2000 kcal (3971-8360 kJ) per week was respected by construction of individual moving programs for seniors, adults and children of both genders. The programs consisted of aerobic walking (min 80% of whole exercise) or cycling (min 10% of total exercise) at the level of 50 to 70% VO_{2max} (HR ranged from 70 to 90% of HR_{max} or 130-190 beats·min^{-1}). The duration of exercise session ranged from 20 to 50 min, and training was performed 3-5 times a week. The time spent at exercise per week ranged between 85-250 min. Exercise training was performed 3-5 times a week during 5 months. Exercise was realized during the whole year.

The selected functional and morphological variables were assessed on treadmill by increased load, body composition with help of whole body bioimpedance

analysis by using of predicted equations that were adapted for the Czech population [5].

The followed variables were collected in children (142 boys and 124 girls; mean age 12.6 ± 2.3 years, BM = 36.9 ± 3.0 kg, height = 136.5 ± 2.6 cm, VO_{2peak} = 43.2 ± 3.1 $ml \cdot kg^{-1} \cdot min^{-1}$) in both men (n = 154) and women (138) of middle age (45.2 ± 7.0, 74.3 ± 3.9, 172.5 ± 2.6, 31.2 ± 3.9), and in seniors of both gender (men n = 71, women n = 112; 71.6 ± 3.6, 77.1 ± 4.1, 171.5 ± 2.9, 26.1 ± 3.1).

The number of steps was evaluated for selected individuals using the pedometer Omron HJ 720IT and energy content was controlled by Caltrac and with help of Sporttester Polar. Qualitative data on realized PA were collected by a questionnaire. Recorded were all PA that lasted at least 5 minutes or longer.

Results

In children, adults and majority seniors of both genders (adults and a small part of seniors were fully employed) are able to realize daily number of steps from the 6900 to 12100 steps. The daily amount of steps in children must be higher because it is to be expected that children need to learn new movement skills. The recommended daily volume of steps in children is 10000-13000 steps [11, 15, 22]. In the Czech children we have monitored the amount of daily steps from 8000 to 12000 depending on offer and conditions.

In children (1842 boys and 1652 girls) we monitored the weekly energy content of imposed PA in the range of 1686 kcal (7048 kJ) to 2570 kcal (10742 kJ) (mean was 2011 ± 471 kcal – 8406 ± 1969 kJ). The mean daily amount of steps was 9441 ± 679 $steps \cdot day^{-1}$.

The real energy content of the exercise programs was in the range from 1095 kcal (4577 kJ) up to 2101 kcal (8782 kJ) (mean was 1403 ± 251 kcal – 5865 ± 1049 kJ) per week in both men and women of middle age. This energy content was realized by walking with the mean steps amount of 8080 ± 816 $steps \cdot day^{-1}$.

In seniors of both gender we found the weekly energy content of imposed PA in the range of 806 kcal (3368 kJ) to 1710 kcal (7148 kJ) (mean was 1201 ± 236 kcal – 8020 ± 1003 kJ). The mean daily amount of steps was 6930 ± 610 $steps \cdot day^{-1}$.

The using of extracellular mass (ECM) body cell mass (BCM) and mainly their relationship ECM/BCM for evaluation of physical exercise predispositions was confirmed by the significant dependence of VO_{2max} on this variable [1, 30]. The relationship between VO_{2max} and physical performance was often presented in literature (e.g. 1). In our group of subjects this dependence was significant too (ranged from $r = 0.812$, $p < 0.01$ in seniors to $r = 0.746$, $p < 0.01$ in children). In practice this coefficient could be used like one of important criterions of exercise program efficiency.

Movement on walk based interventions with an energy content of 2000 kcal in children, 1500 kcal in adults and 950 kcal in seniors can significantly increase of their movement regime (about 30%), significantly reduce body mass (about 10%), improve significantly aerobic fitness (about 17%) and motor performance (about 15%), reduce the systolic blood pressure (about 7 mmHg), can significantly reduce the LDL (approx. 5-10%) and increase HDL by about 20%, regardless of gender, starting values and age.

These programs can significantly affect the amount of muscle mass (about 8%) and thus improve the assumptions for exercise. If body mass reduction and increased PF together with morphological changes in muscles are achieved, this may lead to a prolonged life expectancy of about 7 years. In the case of seniors, movement interventions can greatly influence their aging – a functional shift to a lower age of about 5 years. Walking-based movement activities significantly affect the course of aging and may, in regular exercise, significantly affect the quality of life of seniors. It also shows that the active group is able to realize virtually all the necessary activities related to self-service and independence. Similarly, active seniors also carry out a significantly larger amount of leisure activities and are therefore better able to fill in possible leisure time.

Walking with the exercise intensity on the level of 70-90% of HR_{max} is able to cover the movement deficit in majority of the current population without the regular physical training.

The minimum training energy expenditure required to maintain an elevated VO_{2max} has not been clearly established [1, 5].

Reasonable PA is a prerequisite for quality lifestyle and active aging. For seniors, a higher level of PA and thus increased PF significantly affect the quality and progression of aging – the antiaging effect.

The minimum training energy expenditure required to maintain an elevated VO_{2max} has not been clearly established. For example, the most recent ACSM prescription guidelines (1995) have recommended a minimum energy expenditure of 300 kcal per an exercise session performed 3 days a week, or 200 kcal per an exercise session performed 4 days a week [13, 40].

Discussion

An important question when attempting to influence children's and adolescent's PA behavior is whether PA

behavior at a young age influences and is a predictor of PA behavior at an adult age. This process is called tracking and has been defined as the maintenance of relative rank or a position within a group over time [22]. Although tracking of sedentary behavior seems to be quite strong, tracking of PA from childhood to adulthood seems to be weak or moderate at best.

The current PA recommendation for adults, aged between 18-65 years, to promote and maintain health is to accumulate at least 30 minutes of moderately intense physical activity on at least five days of the week [40].

On the basis of our results, it appears that a daily volume of 10,000 steps can handle adults even at full workload. Large margin today is the use of walking as a means of transfer in fulfilling everyday tasks such as working leisure time activities – regeneration. Another success is the regularity (at least three times a week, at least 30 minutes and more) is preferable 10 to 20 minutes daily [9].

Studies in which physical education (PE) is part of a multicomponent intervention have generally shown modest effects in boys but less so in girls. There is a lack of longitudinal studies aimed at the long-term effects of PE and therefore to date, there is no evidence to assume that PE stimulates an active life style as an adult [22].

Physical exercise in the seniors is undoubtedly beneficial for health. It should be regular, frequent (at least 2-3 times a week, although best every day), of adequate intensity (mostly moderate and/or modified according to the criteria of physiological aging and to the degree of health and illness respectively), and of adequate duration (at least 15 minutes) [12, 25].

Physical exercise in the elderly should be adjusted to age, gender, health and functional ability, as well as to previous experience with PA or sports. Special attention must be paid to exercises in persons who have not practiced PA before but would like to. Priority should be given to activities that stimulate functional improvement of heart rhythm, blood flow, breathing – exercises of general endurance, that activate at least 1/7 of all skeletal muscles and about 50% of possible blood flow, lasting at least 5 minutes. Exercise must always be preceded by a warm-up (e.g. walking), and activities should be ended by gradually decreasing intensity [5, 14]. When choosing the exercise and appropriate intensity, one should be able to answer the following question: has the elderly person been engaged in PAs before, i.e. how long was the break? Load should be assessed, and each training must be dosed so that it remains the individual's wish to be active further on [6, 40].

The proposal for movement intervention in seniors must first of all respect the current state of health, the level of movement skills and the state of muscular groups providing the PA [6, 10, 40]. The design should first of all take into account the possible risks associated with the realization of the PA and only afterwards the benefits that the movement intervention brings. It should be remembered here that there is no absolutely safe PA. Basic walking activities can be clearly arranged for walking, yoga, swimming for general aerobic physical activities with a minimum of jumps and impacts [32].

Free fat mass (FFM) is significantly lower in elderly women than in younger women [30, 32], and it is estimated that FFM decreases on average 3 kg per decade in middle-aged to elderly sedentary healthy adults [12]. This loss is almost 1.5 times as great in men than in women, because men were found to lose FFM at the rate of 0.34 kg·year^{-1}, whereas women lost FFM at the rate of 0.22 kg·year^{-1} [12]. Between 40th and 80th years of age, men lose FFM at the rate of 5% each decade, whereas women lose about 2.5% FFM each decade [28]. At these rates, men and women lose approximately 20% and 10% of total FFM, respectively, between 40 and 80 years of age. Thus, while fat mass is increasing with age, FFM is decreasing [16].

The changes in VO_{2max} induced by the endurance walking program are practically consistent with those found by Vitiello et al. [39], who described a 14% increase in aerobic fitness, a significant increase in FFM, and a significant decrease in BF and total body mass in a group of senior men and women of a similar age.

While there is broad clinical consensus that immobility among hospitalized older adults contributes to functional decline and other adverse outcomes, evidence of exercise intervention effects is inconsistent. The previously cited Cochrane review [10], which included evaluation of three exercise-only interventions, concluded that: "for older patients who are admitted to hospital, exercise sessions may not lead to any difference in function, harms, length of stay in hospital, or whether they go home or to a nursing home or other care facility". Cumulative evidence from more recent studies on hospital exercise adds little more to this conclusion.

If body mass reduction and increased fitness are achieved, this may lead to a prolonged life expectancy of about 9 years. In the case of seniors, movement interventions can greatly influence their aging – a functional shift to a lower age of about 5 years.

Although it was not required in all cases reached the steps amount ranged from 7000 to 10,000 steps a day [19], it can be concluded that the proposed steps amounts in the Czech Republic may be handle without major disruption

to the existing lifestyle in majority of population. Still, keep in mind that the great advantage of priority intervention program that uses of the walking, is the use of movement activities associated with everyday activities [17, 25].

The changes in VO_{2max} induced by endurance walking program are practically consistent with those found by Proper et al. [29], who found in group of senior men and women of similar age 14% increase in aerobic fitness, and significant increase in FFM and significant decrease in BF and total body mass. These results were confirmed by our data but the changes in BC variables were not so high.

There is evidence to show that the magnitude of the increase in VO_{2max} is dependent on total energy expenditure of exercise, and thus on frequency, and duration of exercise as a number of previous investigations have shown improvement to be in direct proportion to the number of weekly sessions [1, 4, 13]. According to the results of previous studies, VO_{2max} as measured either in laboratory or in field has generally improved during the first months of conscription among non-trained subjects [1, 13].

Promoting accumulative, lifestyle PA is an ideal approach to combat the high levels of inactivity evident in global populations. For example the most recent ACSM prescription guidelines recommended minimal energy expenditure of 300 kcal per exercise session performed three days a week or 200 kcal per exercise session performed four days per week [40]. Preserving adequate physical performance is an essential element of a healthy and productive life among the non-trained population.

There is a lack of longitudinal studies aimed at the long-term effects of PE and therefore to date, there is no evidence to assume that PE stimulates an active life style as an adult. This can ultimately take to mean significant improvements in well-being and reduction of psychological stress for most subjects [41].

Walking is a viable form of PA that research has shown to be an effective intervention in the population without of regular physical training, producing both physical and psychosocial benefits. However, there are many barriers to PA for these non-trained subjects, including safety issues, access, support, and health concerns. Community mall walking programs have the potential to address several of these barriers, particularly safety and social support needs.

Functional fitness age and/or actual development state (mainly described like a biological age) is a measure of functional age that reflects a person's overall physical ability and thus the working capacity to complete daily tasks such as preparing meals and performing various household chores [16].

For the prevention of diseases and especially functional deficits and thus the independency in old age, PA is a simple, practicable and successful method. With increasing age and frailty or in rehabilitation training, these activities have to be more and more individualized and medically supervised.

An important physiological concept of exercise in rehabilitation and/or conditioning is the type of work that the body is performing [11]. Dynamic work of endurance character like running, walking, swimming and cycling requires the movement of large muscle masses and requires a high blood flow and increased cardiac output. From these activities the walking is probably the most easily accessible, and often underestimated as a way to increase a subject's overall level of fitness and/or for moving rehabilitation in non-trained subjects or in selected groups of patients. The person's adaptation to walking is the highest from the all form of PA that may be used for these goals [41].

Major advantage with walking over running is that it has a lower frequency of injuries and that in a group of patients the probability of exceeding of security level is lower than in running. The strain on ligaments and joints by walking is far less than for comparable running exercises. By application of walking like a group exercise form it is very important that exercised subjects are able to communicate during the exercise, what can contribute to the wellness of these subjects.

Conclusions

Extensive research during the past 50 years strongly indicates that PF and changes in fitness are causally related to quality of life style and long term health. The main objective of sports science is now finding methods to influence regular PA implementation so as to achieve their primary and secondary preventive effect to respect of intervention subject's individuality. Walking with the exercise intensity on the level of 70-90% of HR_{max} is able to cover the movement deficit in majority of the current population without the regular physical training. Preserving adequate physical performance is an essential element of a healthy and productive life among the non-trained population. The greater the maximal performance in physiological components such as muscle strength, power and endurance, the greater is the reserve capacity for the physical performance of activities of daily living and the potential for quality life and the continuation of independent life during increasing of age.

Acknowledgments

The study was supported by a grant from the Charles University Q41.

This manuscript is an expanded version of work presented at International Conference of Sport, Health and Physical Education, Ústí nad Labem, Czech Republic, October 25-26, 2018.

References

1. Astrand PO, Rodahl K. Textbook of Work Physiology. New York: McGraw Hill; 1986.
2. Biddle SJH, Gorely T, Stensel D. Health-enhancing physical activity and sedentary behaviour in children and adolescents. J Sports Sci. 2004; 22(8): 679-701. doi: 10.1080/02640 410410001712412
3. Blanchard J, Conrad KA, Harrison GG. Comparison of methods for estimating body composition in young and elderly women. J Geront Biol Sci Med Sci. 1990; 45: B119-1124.
4. Bunc V, Hráský P, Skalská M. Body Composition and Aerobic Fitness like a Result of 6 Months Walking Program in Senior Women. JMED Research. 2014; 14: Article ID 950910, pp. 10. doi: 10.5171/2014.950910
5. Bunc V, Skalská M. Using walking as a Tool for Fitness and its Influence on Obesity and Overweight Individuals. Jacobs J Obesity. 2015; 1(1): 1-10.
6. Bunc V, Štilec M, Moravcová J, Matouš M. Body composition determination by whole body bioimpedance measurement in women seniors. Acta Univ. Carol. Kinathropologica. 2000; 36(1): 23-38.
7. Bunc V. Walking like a tool of physical fitness and body composition influence. Antropomotoryka. 2012; 22(57): 63-72.
8. Catenacci VA, Hill JO, Wyatt HR. The obesity epidemic. Clin Chest Med. 2008; 30(3): 415-444. doi: 10.1016/j.ccm.2009.05.001
9. Choi BC, Pak AW, Choi JC, et al. Daily step goal of 10,000 steps: a literature review. Clin Invest Med. 2007; 30(3): E146-15l.
10. de Morton NA, Keating JL, Jeffs K. Exercise for acutely hospitalised older medical patients. The Cochrane Database of Systematic Reviews. 2017; (1): CD005955.
11. Dumith SC, Gigante DP, Domingues MR, Kohl HW. Physical activity change during adolescence: a systematic review and a pooled analysis. Int J Epidemiol. 2011; 40(3): 685-698. doi:10.1093/ije/dyq272
12. Fisher KJ, Li F. A community-based walking trial to improve neighborhood quality of life in older adults: a multilevel analysis. Ann Behavior Med. 2004; 28: 186-194.
13. Haskell W, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, Macera CA, Heath GW, Thompson PD, Bauman A. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exercise. 2007; 39: 1423-1434.
14. Haskell WL, Lee IM, Pate RR, Powell KE, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation. 2007; 116: 1081-1093.
15. Herrmann SD, Willis EA, Honas JJ, Lee J, Washburn RA, Donnelly JE. Energy intake, nonexercise physical activity, and weight loss in responders and nonresponders. Midwest Exerc Trial 2. 2015; 23(8): 1539-1549.
16. Karasik D, Demissie S, Cupples LA, Kiel DP. Disentangling the genetic determinants of human aging: Biological age as an alternative to the use of survival measures. J Geront. 2005; 60(5): 574-587.
17. Kelley GA, Kelley KS, Tran ZV. Walking, lipids, and lipoproteins: a meta-analysis of randomized controlled trials. Prev Med. 2004; 38: 651-661.
18. Kohl HW, Craig CL, Lambert EV, et al. The pandemic of physical inactivity: global action for public health. Lancet. 2012; 380: 294-305. doi: 10.1016/S0140-6736(12)60898-8
19. Le Masurier GC, Sidman CL, Corbin CB. Accumulating 10 000 steps: Does this meet current physical activity guidelines? RQES. 2003; 74(4): 389-394.
20. Loprinzi PD, Frith E, Edwards MK, Sng E, Ashpole N. The Effects of Exercise on Memory Function Among Young to Middle-Aged Adults: Systematic Review and Recommendations for Future Research. Am J Hlth Prom. 2018; 32(3): 691-704.
21. Macera CA, Ham SA, Yore MM, Jones DA, Ainsworth BE, Kimsey CD, Kohl HW. Prevalence of physical activity in the United States: Behavioral Risk Factor Surveillance System, 2001. Prev Chron Disease. 2005; 2: A17.
22. Malina RM. Physical activity and fitness: pathways from childhood to adulthood. Am J Hum Biol. 2001; 13(2):162-172.
23. Mori N, Armada F, Willcox DC. Walking to school in Japan and childhood obesity prevention: New lessons from an old policy. Am J Publ Hlth. 2012; 102(11): 2068-2073.
24. Morris JN, Heady JA, Raffle PA, Roberts CG, Parks JW. Coronary heart-disease and physical activity of work. Lancet. 1953; 265: 1053-1057.
25. Murphy MH, Nevill AM, Murtagh EM, Holder RL. The effect of walking on fitness, fatness and resting blood pressure: a meta-analysis of randomised, controlled trials. Prev Med. 2007; 44: 377-385.

26. Nies MA, Chruscial HL, Hepworth JT. An intervention to promote walking in sedentary women in the community. Am J Hlth Beh. 2003; 27: 524-535.
27. Ogden CL, Yanovski SZ, Carroll MD, Flegal KM. The epidemiology of obesity. Gastroenterology. 2007; 132(6): 2087-2102. doi: 10.1053/j.gastro.2007.03.052
28. Paffenbarger RS, Hyde R, Wing LA, Hsieh CC. Physical Activity, All-Cause Mortality, and Longevity of College Alumni. New Eng J Med. 1986; 314: 605-613.
29. Proper KI, Koning M, Beek AJ van der, Hildebrandt VH, Bosscher RJ, van Mechelen W. The effectiveness of worksite physical activity programs on physical activity, physical fitness, and health. Clin J Sport Med. 2003; 13(2): 106-117.
30. Roche AF, Heymsfield SB, Lohman TG: Human body composition. Champaign: Human Kinetics; 1996.
31. Sallis JF, Hinckson EA. Reversing the obesity epidemic in young people: building up the physical activity side of energy balance. Lancet Diabetes Endocrinol. 2014; 2(3): 190-191. doi:10.1016/S2213-8587(13)70193-1
32. Spirduso WW. Physical dimensions of aging. Champaign: Human Kinetics; 1995.
33. Stanton JM, Arroll B. The effect of moderate exercise on mood in mildly hypertensive volunteers: A randomized controlled trial. J Psychosom Res. 1996; 40(6): 637-642.
34. Stewart AL, Verboncoer CJ, McLellan BY, Gillis DE, Rush S, Mills KM, Ritter PL, Brown BW. Physical activity outcomes of CHAMPS II: A physical activity promotion program for older adults. J Geront Ser A – Biol Sci Med Sci. 2001; 58(8): M465-470.
35. Teufel M, Stephan K, Kowalski A, Kaesberger S, Enk P, Zippfel S, Giel K. Impact of Biofeedback on Self-efficacy and Stress Reduction in Obesity: A Randomized Controlled Pilot Study. Appl Psychophysiol. 2013; 38(3): 177-184.
36. Vandervoort M, McComas AJ. Contractile changes in oppositing muscles of the human ankle joint with aging. J Appl Physiol. 1986; 61: 361-367.
37. Vancampfort D, Richards J. Stubbs B, Akello G, Gbiri CA, Ward PB, Rosenbaum S. Physical Activity in People With Posttraumatic Stress Disorder: A Systematic Review of Correlates. J Phys Act Hlth. 2016; 13(8): 910-918.
38. Van Sluijs EMF, Kriemler S. Reflections on physical activity intervention research in young people – dos, don'ts, and critical thoughts. Int J Behav Nutr Phys Act. 2016; 13(1): 25. doi: 10.1186/s12966-016-0348-z
39. Vitiello MV, Wilkinson CW, Merriam GR, Moe KE, Prinz PN, Ralph DD. Colasurdo EA, Schwartz RS. Successful 6-month endurance training does not alter insulin-like growth factor-I in healthy older men and women. J Geront Ser A – Biol Sci Med Sci. 1997; 52(3): M149-154.
40. World Health Organization. Global Recommendations on Physical Activity for Health [Internet]. Geneva, Switzerland: WHO; 2001. Available from: apps.who.int/iris/bitstream/10665/44399/1/9789241599979_eng.pdf.
41. World Health Organization. Global action plan for the prevention and control of noncommunicable diseases. Geneva, Switzerland: WHO; 2013.
42. World Health Organization. Global action plan on physical activity 2018–2030: more active people for a healthier world. Geneva, Switzerland: WHO; 2018.