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Physical Activity for Health and Longevity

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Abstract

The aging process is commonly associated with declines in health, cognitive function and well-being. However, lifestyle factors like diet, alcohol consumption, smoking and physical activity were repeatedly highlighted as predictors of a healthy aging process. However, recent research has shown that physical activity is the strongest predictor of health in older adults. Recent studies have confirmed the strong effect of physical activity on cardiovascular, metabolic, musculoskeletal and mental health in this age group, while the World Health Organization and other bodies have published physical activity guidelines. Despite the overwhelming evidence of the positive effects of physical activity older adults around the globe tend to be inactive. An effective way to increase the physical activity levels in older adults is physician consultation, and this should be implemented widely.

Keywords: older adults, physical activity, exercise, health, longevity

Introduction

Physical activity (PA) appears to be one of the most used buzzwords when it comes to viable means to improve health and prevent diseases across all age groups (World Health Organization, 2010). Even though the literature basis concerning PA and health is increasing steadily, and in order to provide a precise picture about the health related effects and benefits of PA in especially older adults, as one of the core intentions of this paper it appears to be necessary to precisely define what this term means. For the purpose of this article and as used by most researchers PA refers to any bodily movement employing the skeletal muscles that results in increased energy expenditure compared with the resting rate. Exercise is a subcategory of PA as it incorporates planned, structured and repetitive movements that are performed in order to maintain or improve health and fitness (Caspersen, Powell, & Christenson, 1985; INSERM, 2008). The term sport describes another subset of PA and means that exercises are performed in a specialized and organized form in order to improve competitive performance (INSERM, 2008). The latter will not be of relevance for this article as its main goal is not health or well-being.

In this literature review the focus will be on PA and exercise as means to benefit older adults in terms of health and longevity.

Benefits of Physical Activity

The benefits of physical activity, including, but not limited to exercise are well documented in the scientific literature, starting from the seminal work of Morris and colleagues (1953) who reported positive association between work-related physical activities and lower risk of cardiovascular disease as well as all-cause mortality (Morris & Heady, 1953; Morris, Heady, Raffle, Roberts, & Parks, 1953). Recently, Warburton and his research group (2010, 2007, 2006) conducted extensive reviews on health benefits of PA in adults and found that regular

PA is associated with lower risks of all-cause mortality and useful in primary and secondary prevention of several diseases (Warburton, 2006; Warburton, Katzmarzyk, Rhodes, & Shephard, 2007; Warburton, Charlesworth, Ivey, Nettlefold, & Bredin, 2010).

According to the review by Warburton et al. (2010), drawing conclusions from 70 research studies, the relative risk of premature death can be reduced by a mean of 31% comparing the least active with the most active group, while emphasizing that greater benefits can be achieved with higher volumes and/or intensities of PA. However, also small increments have a marked effect. Another study by Blair et al. (1995) showed that unfit adults who implemented PA over a period of five years and therefore became physically fit had 44% lower relative risk of death compared to individuals who remained unfit, a finding highlighting elevated mortality benefits for people with initially low PA levels. Additionally, Myers, Prakash, Froelicher, Partington and Atwood (2002) examined the effects of PA on all-cause mortality in individuals with already existing chronic disease risk factors and found strong risk reductions among people who were active and/or more physically fit.

PA plays a major and independent role in the prevention of cardiovascular disease and was found to reduce the mean relative risk by 33%, which is similar to the effects of PA in terms of stroke (31%) and hypertension (32%) when comparing high active and low active individuals (Warburton et al., 2010). Patients in cardiac rehabilitation also benefit from PA (here in form of exercise) as it improves the disease process and reduces the occurrence of premature death (Taylor et al., 2004a).

There has been a tremendous amount of research activities regarding the primary as well as secondary prevention effects of PA concerning breast and colon cancer. Leisure and work related PA is responsible for mean relative risk reductions of 30% for breast and 20% for colon cancer (Warburton et al., 2010). Additionally, a study by Lee (2003) indicated that higher intensities are associated with greater risk reduction, but also lower PA levels have

significant benefits. The decrease of cancer related risk of death and recurrence of breast cancer through PA was observed in another trial with women diagnosed with the disease (Holmes, Chen, Feskanich, Kroenke, & Colditz, 2005).

Type 2 diabetes is one of the strongest increasing chronic diseases globally (Wild, Roglic, Green, Sicree, & King, 2004) and can be demonstrably prevented with healthy lifestyles, incorporating aerobic and resistance activities, that are significantly more effective than Metformin treatment a medication commonly given to people at risk (Knowler et al., 2002). The mean relative risk reduction as shown by Warburton et al. (2010) is 42% comparing least active with highly active groups. Specifically, each weekly 500kcal increase in energy expenditure accounts for a 6% risk reduction (Helmrich, Ragland, Leung, & Paffenbarger Jr, 1991) implying that even small changes in PA behavior are associated with positive effects, a finding most relevant to at-risk individuals. The health risks related to obesity, one of the most relevant precursors of type 2 diabetes can be buffered with regular PA even without significant changes in body weight (He & Baker, 2004). Furthermore, premature death of patients suffering from type 2 diabetes can be reduced by 39% (any cause) and 34% (cardiovascular disease) by walking for two hours weekly compared with no walking activity (Gregg, Gerzoff, Caspersen, Williamson, & Narayan, 2003).

Despite the various effects of PA in terms of somatic health its associations with mental health outcomes are of emerging interest. A literature review by Penedo and Dahn (2005) found significant positive relationships between aerobic exercise and improvements in depression compared to psychotropic treatment. The same review also indicated improved mood, reductions of symptoms of depression and anxiety through PA. Small effects of PA on global self-esteem and mental health-related quality of life are further indications of the importance of an active lifestyle in terms of mental health (Warburton et al., 2007).

In short, PA has a significant impact in the prevention of premature death, the risk reduction and secondary prevention of several chronic diseases as well as improved mental status and well-being. Generally, the amount of PA is associated with the quality of the specific benefits, whereas small increments are also effective (Blair et al., 1995), a fact that should encourage especially people with low PA and existing risk factors who benefit markedly from increased activity levels.

The aging process

Aging cannot be explained by a single cause, but as a complex process that depends on the interaction of intrinsic (genetic), extrinsic (psychosocial and environmental) and stochastic factors (random damage of vital molecules) (Weinert & Timiras, 2003). Hence, aging can be experienced differently by different individuals. To accommodate this notion Gremeaux et al. (2012) highlighted the existence of three theoretical profiles of aging, which are important for adequately addressing question related to aging. Regular or normal aging refers to gene-determined declines in physiological functions and processes, whereas cardiorespiratory and musculoskeletal changes are most important.

In advanced age aerobic fitness decreases faster than the usual rate of 5%-10% per decade in untrained individuals implying reduced oxygen carrier capacity of the cardiovascular system that was found to decline more than 20% every ten years for individuals in their seventies and beyond (Fleg et al., 2005). Geriatric sarcopenia is a common syndrome among older adults showing a prevalence of 5%–13% in people aged 60-70 years and 11%-50% in individuals aged 80 years and older (Morley, 2008), and is defined as declining muscle mass and muscle strength or performance (Cruz-Jentoft et al., 2010) as a result of the aging process itself as well as lifestyle factors or diseases etc. (Doherty, 2003). Both conditions (among others), even though considered as normal, have strong influences on

quality of life, functional independence and mortality of older adults (Chodzko-Zajko, Proctor, Singh, Salem, & Skinner, 2009; Gremeaux et al., 2012).

Pathological aging is associated with accelerated aging processes and is mostly related to diseases. The predicate successful aging, as the gold standard for aging, and accounts for only about 8.5% of the non-institutionalized European and Israeli population over 50 years (Hank, 2011) and means the “[...] avoidance of disease and disability, maintenance of high physical and cognitive function, and sustained engagement in social and productive activities” (Rowe & Kahn, 1997, p. 439).

Factors influencing health of older adults and the aging process

The aging profile and the health of older adults can be significantly impacted by so called lifestyle factors as they influence the occurrence of chronic disease and the risk of premature death. According to World Health Organization modifiable lifestyle factors are tobacco use, alcohol consumption, diet and PA (plus sedentary behavior) (World Health Organization, 2013). A review by Södergren (2013) on the predictors of healthy aging in men reported that extended life expectancy accompanied by good health condition and lower probability of disability is strongest associated with PA and non-smoking behavior, while the impact of dietary pattern and alcohol consumption is either not yet fully understood or not as relevant as PA and smoking (Södergren, 2013). Hazard ratios for all-cause mortality in older women were assessed in a large scale European study. The results clearly indicate the trailblazer role of PA in the prevention of premature death from any cause as the hazard ratio was 0.63 (CI: 0.55-0.72) and therefore lower than those associated with smoking (0.65; CI: 0.57-0.75), diet and moderate alcohol consumption (Knoops et al., 2004).

Drawing from the aforementioned studies, PA is an integral, non-pharmaceutical way to benefit health and expand quality lifespan in older adults (Chodzko-Zajko et al., 2009;

Vogel et al., 2009). In order to provide a more comprehensive picture concerning the association between health and PA in elderly the following chapter will introduce the current evidence on that matter.

Physical activity and mortality in older adults

One of first longitudinal cohort studies reporting on the association between physical activity and mortality that included older adults (age range: 35-74 years) was conducted by the pioneer of physical activity and longevity research Ralph Paffenbarger and colleagues (1986) in a sample of 16,936 male Harvard alumni who enrolled between 1916 and 1950. The research team found a steady decline of death rates associated with increasing energy expenditure from less than 500 to 3500 kcal per week. Even with adjustment for other risk factors mortality among active alumni was significantly lower, leading to a mean additional life span of one to more than two years (Paffenbarger Jr, Hyde, Wing, & Hsieh, 1986). Lee and Paffenbarger (2000) further collected data on the same group and published the results from the period between 1977 and 1992. The analysis of the data collected in the study cohort that consisted then of subjects above 50 years revealed that age adjusted mortality declined with increasing energy expenditure. The most active elderly added a mean of 1.5 years (95%CI: 0.85-2.15) to their lives compared to the least active group.

These results from the Harvard alumni health research were confirmed in several other studies. A research group from the United States found a significant relationship between the weekly amount of PA and mortality risk reduction of up to 40% in older adults with a mean age of 73 years (Fried et al., 1998). Another study examined the relation between different levels of PA and total life expectancy in older adults which increased proportionally with higher activity levels. Individuals with moderate or high activity levels enjoyed an extended lifespan of more than 1.3 and 3.5 years respectively (Franco et al., 2005).

Furthermore, a recent study by Fortes et al. (2013) investigated the role of walking on longevity in the very old in Italy. After a follow-up of 10 years the researchers concluded that subjects who walked four times per week for about 15 minutes had halved the risk of mortality compared to those who did either not walk or walked significantly less frequent.

Physical activity and cardiovascular health in older adults

There is a large amount of evidence confirming the positive effects of PA for cardiovascular health in older adults. Older study participants in higher activity groups were found to live 1.1 to 3.2 years longer without a cardiovascular disease compared to low activity groups. Additionally, participants with a cardiovascular disease enjoyed a longer life if they were moderately to vigorously active (not significant) (Franco et al., 2005). Similarly, a review and meta-analysis by Taylor et al. (2004) reported that exercise-based cardiac rehabilitation programs reduced the cardiac and total mortality in older adults about 36% and 20% respectively. Mortality effects were consistent across a number of coronary heart diseases. Effects of a 6 months aerobic exercise program on cardiorespiratory health were also found in adults aged 80 years and older who were more prone of declining functional capacity. After the intervention period, oxygen consumption and peak oxygen pulse increased significantly compared to pre-intervention measures (Vaitkevicius et al., 2002). Finally, Mazzeo and Tanaka (2001) highlighted in an earlier review that older individuals who have been very inactive benefit greatly from light to moderate PA in terms of cardiovascular health, whereas active individuals are required to increase exercise intensities for further health gains.

Vogel et al. (2009) and other research groups emphasized the benefits of PA and exercise in terms of the lipid profile, body composition, type 2 diabetes and hypertension as metabolic risk factors for cardiovascular diseases (Mazzeo & Tanaka, 2001; Petrella, Lattanzio, Demeray, Varallo, & Blore, 2005).

The effects of PA adoption in late life on metabolic risk factors were assessed in a 10 years follow-up study (Petrella et al., 2005). Individuals who had an at least 80% program compliance (3 times 30-45min aerobic exercise per week) enjoyed a significantly better lipid profile than the inactive group. HDL cholesterol increased by 9% in the active and decreased 18% in the inactive group, whereas LDL cholesterol increased in both groups but to a lesser extent in active individuals. The same study also found positive effects in terms of body composition as the mean waist circumference of active subjects increased significantly less than that of inactive participants (2.12% vs. 10.66%). Moreover, a position paper from the American College of Sports Medicine noted that the total body fat mass can be reduced by up to 3.4% via moderate to vigorous resistant activities and up to 4% can be lost with aerobic exercise training over a trainings period of 2 to 9 months, while highlighting that higher intensities account for stronger effects (Chodzko-Zajko et al., 2009).

The prevention of diabetes type 2 can also be achieved via aerobic PA or exercise. Greater leisure time PA (gardening and cycling) was found to be associated with a lower plasma glucose concentration and lower prevalence of glucose intolerance in non-diabetic men between the ages 60 and 89 over a five year period (van Dam, Schuit, Feskens, Seidell, & Kromhout, 2002). Furthermore, higher aerobic exercise intensities seem to improve glucose utilization to a greater extend compared to low or moderate intensity levels, which are effective as well, in before inactive elderly women (DiPietro, Dziura, Yeckel, & Neuffer, 2006). Subjects already suffering from impaired glucose tolerance experienced reduced risk of diabetes incidents of up to 65% when they increased leisure time PA from moderate to vigorous within 4.1 years compared to individuals with lower activity levels (Laaksonen et al., 2005).

Studies on PA and hypertension in older populations are scarce and the evidence is less consistent compared to the evidence in younger age groups (Vogel et al., 2009).

However, a study by Braith et al. (1994) found a significant decrease in systolic and diastolic blood pressure in an intervention group after a 6 months walking exercise program compared to a control group. Another, more recent study discovered only a reduction in resting systolic blood pressure, but not in diastolic blood pressure after 6 months aerobic exercise training in men and women with a mean age of 84 years (Vaitkevicius et al., 2002).

Physical activity and musculoskeletal health in older adults

Muscle strength, power or performance are declining in older age leading to a higher probability of falls, fractures and other health threatening conditions including sarcopenia (Mazzeo & Tanaka, 2001). Resistance exercise training was found to be an effective way to counteract these muscle related losses. Such training lead to increases in muscular strength that were reported to be between 25% and greater than 100% according to a recent review (Chodzko-Zajko et al., 2009). Muscular power is stronger related to functional performance in older adults than muscle strength (Foldvari et al., 2000; Reid & Fielding, 2012) and can be substantially increased with resistance training. Pereira et al. (2012) observed significant improvements in muscular power, especially for the one repetition maximum in bilateral bench press (68.1%) after a 12 weeks high speed power training in older women (Pereira et al., 2012). Furthermore, old and young individuals increased muscle quality, defined as the muscle performance per unit muscle volume or mass, in similar ranges (Ivey et al., 2000). The effects of resistance training in terms of muscle endurance in older adults are not well studied yet, but a few studies found that moderate to high training intensities lead to improvements between 34% and 200% (Chodzko-Zajko et al., 2009).

The influence of aerobic PA on bone health of older adults is minimal. The American College of Sports Medicine reviewed research on the effects of aerobic exercise training in postmenopausal women. The researchers indicated that low intensity activities like walking

can counteract the age-related bone loss in postmenopausal women that was 0.5%-1% per year in sedentary controls. Higher intensity activities like stairs climbing or jogging lead to better results in terms of bone health (Bloomfield, Little, Nelson, & Yingling, 2004). These positive effects are usually only found in the bones directly involved in the particular activity (Todd & Robinson, 2003). In contrast, strength training shows significantly stronger effects on bone mineral density (BMD) (Cussler et al., 2003) while another study showed that BMD increases, even though minimal, is related to increases in muscular strength (Stewart et al., 2005). Generally, high intensity resistance training can preserve or improve BMD with a direct relation between muscle and bone adaptations (Chodzko-Zajko et al., 2009).

The effects of physical activity and exercise in terms of bone health are often attributed to the prevalence of fractures (Bloomfield et al., 2004). A trial by Feskanich, Willet and Colditz (2002) compared the effects of hormone therapy and physical activity with regard to the risk of hip fractures in older women. The most active group reduced the hip fracture risk about 67% (no hormone use) and 71% (hormone use) respectively compared to the least active group without any hormone treatment.

Physical activity and the immune system in older adults

Organ resistance decreases with advancing age leading to functional declines of the immune system. That in turn leads to more infectious diseases and a weaker response to vaccination in older adults (Goodwin, Viboud, & Simonsen, 2006). Apart from surgeries and other immunotherapeutic procedures that are commonly applied in generally healthy people, lifestyle factors including PA seem to influence the immune system in older adults.

Adaptations to regular, moderate PA have been associated with improved antioxidant defence mechanisms. The higher production of free radicals, which are responsible for tissue damage, through exercise is in itself not positive but these free radicals are partly responsible

for beneficial exercise adaptations (Sachdev & Davies, 2008). Impressive effects of PA have been found in relation to leukocyte telomere length, the most important marker of biological aging because it acts as an indicator of morbidity and mortality (Simpson et al., 2012). A study by Cherkas et al. (2008) reported a 200 nucleotides difference in telomere length in very active compared to the least active adults with a mean age of 49 years (previous 12 months leisure PA). This difference in length suggests that inactive individuals are biologically 10 years older than their active counterparts. The dose-response relationship in older individuals (50-70 years) was investigated by Ludlow et al. (2008). The research team discovered that long term energy expenditures less than 990 kcal and more than 3541 kcal per week are significantly associated with shorter telomere length compared to expenditures that are common in moderate activity, thus suggesting an inverted U relationship between PA intensity and telomere length. Telomerase as a result of PA was not observed.

Viral infections like influenza and secondary infections are a common health threat for older adults. Martin, Pence and Woods (2009) reviewed the literature on PA and respiratory viral infections in the general population and found that acute or chronic moderate exercise is supportive in its prevention. Exercise also reduces the symptoms of viral infections and increases viral clearance. On the contrary, vigorous exercise showed negative results. Additionally, exercise improved the vaccine efficiency in older people, which is important because the effects of vaccines are significantly weaker in this age group (young adults: 70-90% vs. older adults: 17-53%) leading to higher risks of infections (Goodwin et al., 2006). Greater increase in antibody titer to H1N1 and H3N2 after immunization was observed in moderately exercising adults compared to inactive controls after (Kohut et al., 2004). Furthermore, the association between age-related chronic inflammation and long-term physical activity was investigated in a large scale (n=368) randomized controlled trial by Beavers, Hsu and Ismon (2010). The researchers compared the effects of a 12 months

moderate PA program with an education program. Significant reductions of the biomarker interleukin-8, which is involved in the recruitment of leucocytes in inflamed areas, were found in the PA compared to the education group. After adjustment for multiple comparisons there were no significant effects of PA on any inflammatory markers, a finding that requires more in-depth investigation.

Physical activity and the cognitive system in older adults

Cognitive decline in its various forms is a normal age-related process leading to many problems and diseases, like Alzheimer which is responsible for dementia, in older age. So far, pharmaceutical therapies are only modestly effective, while modifiable lifestyle factors having a strong impact on the respective prevalence rates (Barnes & Yaffe, 2011). Promising results concerning the association between PA, exercise and cardiorespiratory fitness, and brain health in later life were found in a recent review conducted by Erickson, Gildengers and Butters (2013).

An early study by Spirduso (1975) could already show that older adult athletes outperform more sedentary peers in many cognitive tasks. Another trial indicated that PA earlier in life predicts better cognitive performance and less cognitive impairment in older age. Especially teenage PA lead to less cognitive impairment with an odds ratio of 0.73 (95%CI: 0.58-0.92) (Middleton, Barnes, Lui, & Yaffe, 2010). A meta-analysis concluded that the effects of aerobic fitness on cognitive domains are general and specific, because many domains improved after several months while executive functions were significantly more enhanced than controlled, visuospatial or speed functions (Colcombe & Kramer, 2003). For example, the increment of PA over 3 to 6 months lead to increased general cognitive performance of 0.5 SD (Colcombe & Kramer, 2003) while another study on older adults

discovered increased executive functions like planning, scheduling, inhibition and working memory but no effects in other domains (Kramer et al., 1999).

The evidence reveals a noticeable picture. First, it seems that some brain regions and networks, especially those supporting executive functions, are more sensitive to PA than other areas (specificity). This is important because the brain shrinks about 1% to 2% per year from the age of 55, especially in the prefrontal cortex and hippocampus, the regions responsible for memory and executive functions (Raz et al., 2005). Second, the brain seems to be modifiable well into late adulthood (plasticity) which can be detected in improved cognitive functions (Colcombe & Kramer, 2003; Erickson et al., 2013).

With this, researchers observed more brain volume in active older adults (aerobic exercise only) than in inactive older adults (Colcombe et al., 2006). Additionally, higher hippocampal volume of up to 2% was associated with higher fitness levels, while people with higher baseline PA levels showed reduced loss of hippocampal volume (Erickson et al., 2009; Erickson et al., 2011). Finally, increased hippocampal volume was reported to significantly influence memory functions in the elderly (Erickson et al., 2011). The mentioned benefits of PA also apply to sedentary older adults who become active (Colcombe et al., 2006). In short, it can be highlighted that regular PA has consistent and robust effects on the brain which leads to improvements in cognitive performance (Erickson et al., 2013) and reduced impairment (Laurin, Verreault, Lindsay, MacPherson, & Rockwood, 2001).

Physical activity and mental health in older adults

In 2013 the World Health Assembly published their first action plan for global mental health. This shows a growing relevance for mental health issues, while urging member states to act towards a better mental health state of their populations with the best scientific evidence (World Health Assembly, 2013). Although the meaning of the term mental health is still

under debate, mental disorders like depression, dementia and anxiety, which are highly prevalent in older adults (Yasamy, Dua, Harper, & Saxena, 2013), indicate disturbances of mental health. Mental health is an integral part of general health and means to preserve a healthy mental state are under research (Almeida, Norman, Hankey, Jamrozik, & Flicker, 2006). Smoking and a sedentary lifestyle have been reported to contribute significantly to negative mental health and also well-being (as a part of mental health) in older adults (Yasamy et al., 2013).

Almeida and colleagues (2006) (Almeida et al., 2006) investigated the impact of PA in terms of mental health in 601 men in their 80's. The research group found that successful mental health aging was directly associated with vigorous and non-vigorous PA over a period of five years with reduced risks of 89% and 50% for dementia and depression respectively. Further, the longitudinal case-control study by Pasco et al. (2011) found physical activity to be protective against the likelihood of depressive and anxiety disorders (OR = 0.55, 95% CI 0.32–0.94, $p = 0.03$) in adults aged 60 and older after a mean follow-up of 4.1 years. Older people with already existing major depressive symptoms were examined in another study that tested the antidepressant efficacy of exercise and pharmaceutical treatment (Blumenthal et al., 1999). After the trial period of 16 weeks the results indicated good antidepressant efficacy of the exercise, medical treatment and the combination of both, with no differences between the groups. PA was proposed to also influence general life satisfaction and well-being via improved self-efficacy, self-esteem and affective/emotional experiences which mediate the effects of PA (Elavsky et al., 2005). A 6 months walking program with 174 adults with a mean age of 66.7 years revealed that PA has significant direct effects on self-efficacy, self-esteem and affect after one year follow-up, whereas after 5 years PA influenced self-esteem and affect significantly (Elavsky et al., 2005). In conclusion, PA, also in light intensity influences mental health considerably and is equally effective as antidepressant medication.

Physical activity in the very old

Centenarians live about 50% longer than the world average and this group increases 8% while the world population increases only 1% annually (Perls, Levenson, Regan, & Puca, 2002). Therefore, this age cohort seems to be an excellent group to study the secrets of longevity (Venturelli, Schena, & Richardson, 2012). Even though genetic factors play an important role in terms of lifespan, the impact of modifiable lifestyle factors cannot be underestimated (Perls and Terry, 2003).

The first studies on centenarians were conducted more than 100 years ago and the importance of the lifestyle factor PA was already mentioned in the early research. Currently, some scientists even argue that PA is the most important lifestyle factor in terms of disease prevention and health in centenarians (Venturelli et al., 2012). Ozaki and colleagues (Ozaki, Uchiyama, Tagaya, Ohida, & Ogihara, 2007) found health in centenarians to be significantly correlated with PA and recommended regular PA for the very old. With this, cardiorespiratory fitness and handgrip strength have shown to influence health and independence in centenarians considerably (Franke, Margrett, Heinz, & Martin, 2012; Paterson, Govindasamy, Vidmar, Cunningham, & Koval, 2004). However, more research is necessary to come to a firm conclusion in terms of PA and healthy longevity, especially in the very old because a recent study could not proof a correlation between PA habits and longevity when independent very old people were compared with the normal population of very olds (Rajpathak et al., 2011).

Physical activity recommendation for older adults

Based on the evidence of the beneficial health effects of PA for older adults and due to the low PA levels in this population the American College of Sports Medicine and the American Heart Association published PA recommendations for people aged 65 years or older (Nelson et al., 2007). It is recommended that older adults perform either 30min of moderate aerobic exercise on at least five days per week or 20min of vigorous aerobic activity on three days weekly. Compared to the guidelines for adults under the age of 65 the intensity of the activities for older adults is not absolute but subjective because of great individual differences in functionality and fitness. Further, it is advised that older adults engage in moderate to high intensity muscle-strengthening exercise using the major muscle groups on at least two nonconsecutive days per week. Flexibility and balance exercise should be performed on a regular basis as well (about two days per week for 20min) in order to improve functionality and prevent falls. Finally, it is emphasized that greater amounts of PA also come with more health benefits (Nelson et al., 2007).

The World Health Organization (WHO) also highlighted the positive health effects of regular PA when they published their document on global PA recommendations for older adults in 2010 (World Health Organization, 2010). These guidelines are similar to the aforementioned. Additionally, the WHO mentions that even smaller amounts of PA are beneficial for health and that it is therefore advisable to take a gradual stepwise approach towards initiation and maintenance of PA based on individual capabilities (Chodzko-Zajko et al., 2009; Taylor et al., 2004).

Physical activity participation in older adults

Despite the global release of PA guidelines and the widespread promotion of PA participation in older age PA prevalence rates indicate a threatening picture. For England Taylor et al. (2004) reported that only 13% of men and 10% of women between 65 and 85+ years are walking brisk for at least 15min per day, while a strong decline was observed with increasing age. Further, only about 10% are active at recommended levels with the strongest PA drop at 74 years. Data from the U.S. display a similar picture with older adults are generally less active than younger groups (Chodzko-Zajko et al., 2009). Troiano et al. (2008) measured PA with accelerometers in a large cohort and found that activity counts declined with age with the lowest amount for people who are 60 years or older. Additionally, mean time spent in vigorous intensity activities did not differ from zero, while moderate activities ranged from 6 to 10 minutes per day. Finally, only 2.4% of older adults adhered to the PA guidelines mentioned earlier.

Low activity levels of older adults are not only present in global north countries as shown by Abouzeid, Macniven and Bauman (2008) in their comprehensive work on the PA levels in Asia-Pacific. Of the 24 countries that collected PA data of older adults 20 indicated that PA declines with age and, that older adults are the least active group (data from China was contradictory, but some surveys confirmed this trend). Surveys from Japan, Singapore, Taiwan and Tokelau did not confirm this general trend.

Barriers and motivators of physical activity in older adults

The lack of PA in older adults and the associated consequences necessitated and still necessitates research on barriers and enablers of PA participation in order to develop sustainable promotion approaches. These factors or predictors are partly unique to older adults and cannot be directly translated from other age groups. A comprehensive overview on barriers and motivators of PA in older adults comes from a paper by Schutzer and Graves

(2004). While health issues, the environment, existing knowledge, self-efficacy, prompts and certain demographic variables are strong predictors for PA participation in older adults the researchers highlighted the key role of physicians in promoting PA among a population that has frequent contact with their doctors (Schutzer & Graves, 2004).

The role of physicians in promoting PA in older adults

In 2010, a study by Hsiao, Cherry, Beatty and Rechtsteiner found that on average every U.S. American visits his/her physician three times annually. The amount of visits is higher among older adults (Rattay et al., 2013). The regular contact or care continuity for a variety of health and even personal issues creates positive interaction and communication, and it generates a relationship of trust. Particularly, older adults seem to value such a relationship (Pandhi & Saultz, 2006). Hence, the physician who reaches many health-advice-seeking people can influence lifestyle parameters, because patients consider their general practitioner (GP) as the most trusted source for health information (Kreuter, Chheda, & Bull, 2000). Consequently, physicians or other clinicians can and should play a key role in promoting PA in the general population and especially in older adults who greatly benefit from more PA (Pinto, Goldstein, Ashba, Sciamanna, & Jette, 2005).

Yet, only about one third of adult patients received counseling from their GPs to increase PA (Eakin, Brown, Schofield, Mummery, & Reeves, 2007; Glasgow, Eakin, Fisher, Bacak, & Brownson, 2001). A German study that examined the frequency of PA advice given to older adults came to similar results as only one third of the 1937 patients reported any PA counseling from their GP (Hinrichs et al., 2011). This study also confirmed earlier findings highlighting that PA counseling is mostly given to patients who have health problems (Eakin et al., 2007). Thus, the potential preventive impacts of PA are underestimated among physicians.

Reasons for the low frequency of PA advice given by physicians are reported in various research articles. Most prevalent barriers are:

- Lack of time for PA advice during consultation
- Lack of PA consultation skills, training and/or knowledge
- Lack of institutional support
- Little or no reimbursement for PA consultation
- Competing demands of providing a broad range of preventive and non-preventive services
- Preference of patients for drug-treatment (Hinrichs et al., 2011; Tulloch, Fortier, & Hogg, 2006; Wee, McCarthy, Davis, & Phillips, 1999)
- PA topics under recognized in medical journals (Dupen, Bauman, & Lin, 1999)

These reasons are compelling, but so is the success of physical activity counseling interventions carried out in primary care. The impact of PA counseling in the general population was examined in a review by Tulloch, Fortier and Hogg (2006). The research group found that 50% of the interventions that were based solely on physicians' advice changed PA behavior positively in short- and also long-term. Better results were reported when the intervention was carried out by a health care professional or when physicians' advice was combined with a health care professional intervention. For example, the effects of a brief PA advice by physicians was compared with an extended PA advice intervention that included face-to-face counseling with a health educator, tailored PA prescription, counseling phone calls and mailed tip sheets in adults aged 65 years or older (Pinto et al., 2005). Objective and subjective measures of PA indicated a significantly stronger increase of PA

after 3 and 6 months in the group that received the extended PA advice intervention. But also the group that received only a brief PA advice for about 3 minutes increased their PA levels considerably (e.g. 16.60 min/week increase compared to baseline). Thus, even low cost and short time interventions can lead to desirable PA increments in older adults (Pinto et al., 2005), while more comprehensive approaches seem to be more successful. Increasing PA in older adults was also observed in a trial carried out in New Zealand that implemented a system that allows physicians to prescribe PA (Green Prescription) (Kerse, Elley, Robinson, & Arroll, 2005). Individuals who received a PA prescription that included individual PA counseling with an exercise specialist, regular phone calls and newsletters increased their leisure time PA and energy expenditure significantly after 12 months compared to a usual care group. On average leisure time PA increased 40min per week, an effect that is modestly stronger than in younger individuals.

In short, the evidence displays a relatively clear picture about the effectiveness of PA counseling in primary care for older adults. Herein, PA advice from the personal physician who has strong credibility marks the first step in raising PA levels and should become a routine (Nelson et al., 2007). Furthermore, in order to effectively utilize the potential of PA consultation a multidisciplinary team needs to be involved in the counseling process to reduce the burden of the physicians and to increase sustainability via individual tailoring and follow-up (Tulloch et al., 2006).

Conclusion

Physical activity is one of the strongest predictors of health and longevity in older adults. Effects of PA are not limited to physiological outcomes, but also affect cognitive and mental domains. The evidence clearly indicates that moderate to vigorous activities are best associated with health and extended life span in older adults, whereas increases of PA up to a certain level are responsible for elevated benefits. Individuals with low PA levels do also benefit from less intense activities. Aerobic exercise appears to be the most important factor for overall health, whereas strength training specifically improves the health of the musculoskeletal system. Finally, PA and exercise are effective non-pharmaceutical and cost effective means to promote successful aging and specific PA counseling should become routine in primary care.

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