Gerontology & Geriatric Medicine
Volume 5: 1–10

DOI: 10.1177/2333721418823604
journals.sagepub.com/home/ggm
SAGE

# Adherence to Exercise Programs in Older Adults: Informative Report

**Solymar Rivera-Torres, MS[1], Thomas D. Fahey, EdD[2], and Miguel A. Rivera, PhD[3]**

**Abstract**

This informative report focuses on filling information gaps regarding adherence to physical activity and exercise in the health care spectrum of older adults (OA) and an overview of the benefits of physical activity for OA. Healthy People 2000, 2010, and 2020 are public health programs from the U.S. Department of Health and Human Services that set national goals and objectives for promoting health and preventing disease. The programs include 10 leading health indicators that reflect major health problems, which concern OA. Exercise and physical activity are among the most important factors affecting health and longevity, but exercise adherence is a significant hindrance in achieving health goals in the OA. Exercise adherence in OA is a multifactorial problem encompassing many biopsychosocial factors. Factors affecting adherence in the OA include socioeconomic status, education level, living arrangements, health status, pacemakers, physical fitness, and depression. Improving adherence could have a significant impact on longevity, quality of life, and health care costs.

**Keywords**

geriatric medicine, health care, health professionals, exercise adherence

**Manuscript received:** January 24, 2018; **final revision received:** November 1, 2018; **accepted:** December 15, 2018.

## Introduction

Geriatric health care delivery is a major public health issue. Geriatrics refers to diagnosing and treating older adults (OA) with complex medical conditions and social problems. A recent report from the World Health Organization (WHO; 2010a) stated,

> OA are generally defined according to a range of characteristics including: chronological age, change in social role and changes in functional capabilities. In high-resourced countries older age is generally defined in relation to retirement from paid employment and receipt of a pension, at 60 or 65 years. With increasing longevity some countries define a separate group of oldest people, those over 85 years. In low-resourced countries with shorter life spans, older people may be defined as those over 50 years.

OA are the largest and fastest growing segment of the population, which present significant challenges to the health care system. Understanding the factors contributing to the health practices of OA is important for professionals, paraprofessionals, and paid and unpaid caregivers who need basic and continuing geriatric education to improve care. Adherence to physical activity and exercise programs is a critical but poorly understood area for promoting health and longevity. This informative report aims at filling information gaps in the health care spectrum of OA, regarding physical activity, exercise, and adherence to programs.

## Basic Components of an Exercise Program for OA

The terms *physical activity*, and *exercise* are often used interchangeably, but they are different. Physical activity involves movement produced by skeletal muscles that require energy from metabolism. It is grouped as occupational, sports, conditioning, household, or other activities. Exercise is a subset of physical activity that is planned, structured, and repetitive. It promotes health, fitness, and skill and the results of the program can be measured with specific tests (Caspersen, Powell, & Christenson, 1985; Fahey, Insel, & Roth, 2018).

[1]University of North Texas, Denton, USA
[2]California State University, Chico, USA
[3]University of Puerto Rico, San Juan, Puerto Rico

**Corresponding Author:**
Miguel A. Rivera, Department of Physical Medicine, Rehabilitation & Sports Medicine, School of Medicine, University of Puerto Rico, Main Building Office A-204, San Juan 00936, Puerto Rico.
Email: miguel.rivera10@upr.edu

The most accepted recommendations for health-related physical activity and exercise programs for OA are those provided by the American College of Sports Medicine and the American Heart Association (Nelson et al., 2007), and U.S. Health and Human Services (U.S. Department of Health and Human Services, 2008). The former was revised and updated by the National Institute of Aging (2009). These entities provided overlapping and similar recommendations with slight differences in terminology and exercise categories. Literature states that sustaining a physically active lifestyle and participating in exercise programs improve the current and future level of health and a state of well-being (Fahey et al., 2018). Those benefits come across as less disease and sickness are experienced.

Before initiating an exercise program, the participant should be given a detailed verbal and written description of the program. The description should include the frequency, intensity, time, type, volume, and progression of exercise (Fahey et al., 2018). A clear description of the program helps maintain motivation and adherence (Dalle Grave, Calugi, Centis, El Ghoch, & Marchesini, 2011).

Participation in four categories of exercise is required for full health-related benefits. These categories are cardiorespiratory endurance (aerobic exercise), muscular strength/endurance (resistive exercise), flexibility (stretching), and balance. The benefits of the program increase with the energy expenditure (Fahey et al., 2018).

The initial stages of a program should consist of low intensity and duration, in particular for OA highly deconditioned and/or functionally limited. Efforts should be taken to individualize the progression of activities according to the participant preferences and acceptance. In situations with very frail participants, muscular strength and endurance activities should precede the cardiorespiratory endurance training component (Lee, Jackson, & Richardson, 2017).

Cardiorespiratory endurance (aerobic) training: OA should perform 150 min of moderate-intensity activity per week (e.g., walking, dancing), 75 min of intense exercise (e.g., jogging, lap swimming), or a combination of both. Exercise duration should increase gradually from a minimum goal of 10 min per session to 30 to 60 min. Chronic adaptations to cardiorespiratory (aerobic) endurance training include decreased risk of cardiovascular disease, reduction in the rise in blood pressure during exercise, protective effect of age-related declines in bone mineral density in postmenopausal women, improved endurance, reduced resting and submaximal heart rate, increased mitochondrial density, reduced body fat, improved blood lipid profiles, and inflammatory markers (Fahey et al., 2018).

Resistance training (RT): RT is any movement that causes the muscles to contract against an external resistance (e.g., body weight, elastic bands, water, weights, or weight machines). RT can build muscle strength, lean mass, bone mineral density, strength/endurance, and power; reduce body fat; and improve posture, in OA (Fahey et al., 2018). RT should be performed 2 to 3 days per week, with a rest day between sessions, and include exercises for all major muscle groups in the upper and lower body. The rest day applies to the RT modality and not to the rest of the modalities in the program. If OA choose daily RT, they must alternate the muscle groups to allow for recovery. Typically, RT programs emphasize high-load, slow-speed, strengthening exercise. RT in OA using high movement speeds and high external resistance or high movement speeds and low external resistance have demonstrated positive impact on muscle strength, power, muscle mass, muscle endurance, posture, functional tasks related to safety, climbing stairs, recovery when stumbling, and tasks such as moving the lower limb to keep from falling (Jiménez-García et al., 2018; Lacroix et al., 2016; Steib, Schoene, & Pfeifer, 2010).

Balance (stability) training: Balance is the ability to maintain the body in a stationary or upright position or moving stance. For OA, postural stability is a more specific description of human balance (Rogers, Page, & Takeshima, 2013; Ruffieux, Mouthon, Keller, Wälchli, & Taube, 2017). Balance training includes strengthening and stability exercises. The strengthening component of balance training includes mostly lower body exercises, performed 2 to 3 days per week. Stability training can, and sometimes should, be performed daily. OA at risk of falling should do balance training (Chodzko-Zajko et al., 2009) 3 or more days per week (U.S. Department of Health and Human Services, 2008). Balance training enhances adaptations of postural stability, dynamic balance, and static postural sway (Rogers et al., 2013; Ruffieux et al., 2017). Balance and strength training has shown to be safe in OA (Lacroix et al., 2016).

Stretching and flexibility exercises: Flexibility—the ability of a joint to move through a full range of motion is important for general fitness and wellness (Fahey et al., 2018). Stretching exercises improve flexibility, coordinated movements and posture, promote relaxation, reduce the risk of injury and falling, minimally increase strength, but do not improve endurance (Cherup et al., 2018). OA should perform stretching exercises after they have completed endurance and strength exercises (Chodzko-Zajko et al., 2009). If they do only stretching and flexibility exercises, they must warm up first with gentle movements or slow walking. Stretching exercises can be performed daily and should include shoulder, upper arm, calf, and thigh stretches.

Physical activity and exercise promote motor control through improved coordination—the ability to use all body parts together to produce smooth and fluid motion, agility—the ability to change direction quickly, reaction time—time required to respond to specific stimuli, speed—the ability to move rapidly, and power—the ability to generate force rapidly. Exercise enhances cognition, concentration, relaxation, and joie de vivre, perhaps by promoting endorphin release. Exercise programs could also facilitate social interactions between

participants, which could lead to the enhancement of social health (Picorelli, Pereira, Pereira, Felício, & Sherrington, 2014). The latter refers to the ability to interact well with people and the environment and to have satisfying personal relationships. From a holistic perspective, the setting provided by the exercise experience promotes mental, emotional, and spiritual health (Andrade et al., 2018).

### *Promoting Exercise Adherence (EA) in OA*

The adoption of an active lifestyle not only depends on individual behaviors and choices, but also on the interaction between individuals, environment, and public policies (Andrade et al., 2018). Age, sex, health status, self-efficacy, motivation, and genetics are associated with physical activity (U.S. Department of Health and Human Services, 2002). Genetic and epigenetic factors also influence the propensity for physical activity (Bauman et al., 2012). Twin and family studies provide further evidence that genetic factors contribute to variations in daily physical activity levels (Bouchard & Hoffman, 2011; den Hoed et al., 2013). Epigenetics, heritable changes in gene expression that do not change deoxyribonucleic acid (DNA) sequence, might influence adherence (Ursu et al., 2015). Exercise might lead to more exercise, whereas inactivity might have the opposite effect. An absence of evidence suggests the role of the human genome in adherence to exercise programs.

Abundant evidence shows that physical activity and exercise are among the most important factors influencing health status in the OA (Chodzko-Zajko et al., 2009). Regular exercise is associated with increased longevity and reduced risks for cardiovascular disease, stroke, cognitive decline, some cancers, type 2 diabetes, osteoporosis, hypertension, dyslipidemia, obesity, and osteoarthritis (Fahey et al., 2018). Exercise programs are also associated with improved psychological health and functional status, and reduced health care expenditures (Chodzko-Zajko et al., 2009). Physical activity is an elixir vita that promotes health and longevity better than any other lifestyle practice, but it is only effective if people do it. EA is a difficult problem for people of any age, but it is challenging in OA. Among the aims of Healthy People 2010 (U.S. Department of Health and Human Services, 1998) is that professionals, paraprofessionals, and paid and unpaid caregivers need basic and continuing geriatric education to improve care for OA.

## Relevance of Physical Activity and Exercise in OA

Prior to 1980, physical activity recommendations for the general population promoted vigorous exercise that largely reflected the physical fitness requirements of the military and athletes (Fahey & Fahey, 2014). Not until 1975 did advocate groups recommend exercise 3 to 5 days per week for 15 to 60 min at 50% to 85% of heart rate reserve plus resting heart rate (American College of Sports Medicine, 1975). For the first time, the exercise recommendations focused on the metabolic health and reduced risk of "diseases of civilization" in the general population. Following those recommendations, the body of knowledge and relevance of exercise on health and well-being had an exponential increase, leading to modifications of the exercise recommendations in 1978, 1998, 2007, and 2011 (American College of Sports Medicine, 1978, 1998; Garber et al., 2011; Nelson et al., 2007). Abundant research in the 1980s and 1990s showed that moderate-intensity exercise promoted health and longevity. The extent of such findings led to physical activity recommendations from the U.S. Surgeon General (SG) in 1996 (U.S. Department of Health and Human Services, 1996), the National Institute of Aging in 2009 (National Institute of Aging, 2009), a joint publication by the American Heart Association/American College of Sports Medicine in 2007 (Nelson et al., 2007), the WHO in 2010 (WHO, 2010b), and the American College of Sports Medicine in 2011 (Garber et al., 2011). The publication of the National Institute of Aging presented explicit recommendations for the promotion of physical activity and health for OA (National Institute of Aging, 2009), while that of the SG, in 2010, a Vision for a Healthy and Fit Nation (Benjamin, 2010). Key elements in those reports were the importance of regular physical activity and the novel finding that some physical activity is better than none. These reports stated that regular physical activity promoted health and prevented premature death and many diseases. Physical activity benefited people of all ages and racial and ethnic groups, including those with disabilities. The recommended levels of physical activity are associated with increased longevity, improved psychological health, functional status, and reduced health care expenditures. Those reports stated that the benefits of exercise and physical activity outweigh the risks.

Healthy People 2020 (U.S. Department of Health and Human Services, 2010), a governmental 10-year agenda for improving the Nation's health, promotes the physical activity compliance of Americans based on the Physical Activity Guidelines for Americans (U.S. Department of Health and Human Services, 2002). Over 80% of the general population do not meet physical activity guidelines for aerobic exercise and strengthening activities (Fahey et al., 2018). For OA, Healthy People 2020 aims to improve the health, function, injury prevention (e.g., falls), and quality of life. OA experience higher risk of chronic disease. Centers for Disease Control and Prevention's (CDC) reports indicate that 60% of OA managed two or more chronic conditions, including heart disease, cancer, chronic obstructive pulmonary disease, stroke, diabetes mellitus, and Alzheimer's disease (Ward, Schiller, & Goodman, 2014). Healthy People 2020 attempts to educate people about the relevance of physical activity and increase the proportion of Americans who meet the physical activity guidelines. Strategies include

improving community infrastructures by increasing the availability of sidewalks, bike lanes, trails, and parks and promoting legislation to improve access to facilities that promote physical activity. Facilities should be accessible to people with disabilities.

## What Is Adherence, EA, and How Is It Measured?

The WHO defines adherence as the extent to which a person's behavior corresponds to the recommendations of a health care provider (WHO, 2003). These behaviors include taking medications, following a diet, and executing lifestyle changes such as increased physical activity. The WHO stated that "measurement of adherence provides useful information that outcome-monitoring alone cannot provide, but it remains only an estimate of a patient's actual behavior" (p.5). No single measurement strategy has been deemed optimal. A multimethod approach that combines feasible self-reporting and reasonable objective measures is the current state of the art in measurement of adherence behavior (WHO, 2003). The WHO further stated that (a) poor adherence to treatment of chronic diseases is a serious worldwide problem; (b) the impact of poor adherence grows as the burden of chronic disease grows worldwide, where the poor are disproportionately affected; (c) the consequences of poor adherence to long-term therapies are poor health outcomes and increased health care costs; (d) improving adherence also enhances patients' safety; (e) adherence is an important modifier of health system effectiveness; (f) increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments; (g) health systems must evolve to meet new challenges; (h) patients should be supported, not blamed. Factors, which make up the health care environment in which patients receive care, have a major effect on adherence; (i) adherence is simultaneously influenced by several factors (social and economic factors, the health care team/system, the characteristics of the disease, disease therapies, and patient-related factors); (j) providers need to develop means of accurately assessing not only adherence, but also those factors that influence it (i.e., patient-tailored interventions); (k) adherence is a dynamic process to be followed up; (l) health professionals be trained in adherence; (m) family, community, and patients' organizations are a key factor for success in improving adherence; and (n) a multidisciplinary approach toward adherence is needed.

EA, simply stated, is a participant bond to an exercise program. However, to truly adhere to exercise, a person would have to maintain a regular habit for a lifetime. Nonetheless, in the exercise-related literature, EA is ill-defined and ambiguous. Available definitions usually rely on four measures: (a) Completion/retention adherence, (b) Attendance adherence, (c) Duration adherence, and (d) Intensity adherence. A very recent systematic review of the exercise-related literature examined those definitions of adherence to exercise sessions in OA (Hawley-Hague, Horne, Skelton, & Todd, 2016). Completion/retention adherence is the retention/completion of an exercise program session and attendance. In one instance, adherence (completion) implied full completion of the required attendance and presence in the last session (Sullivan-Marx et al., 2011). In another study, attendance adherence referred to the number of exercise sessions attended over a follow-up period (Hawley-Hague et al., 2014). A good number of studies define adherence based on absolute attendance while others utilize the percentage of classes attended (Hawley-Hague et al., 2016). It relates to note that percentage was calculated by different ways. Duration adherence considers for how long a participant exercises at each exercise session. Duration of exercise has been determined in an assortment of ways, which include self-reports of exercise performed within and outside the classes, physical activity questionnaires, surveys, and records of minutes physically active, among others (Hawley-Hague et al., 2016). Intensity adherence refers to the specified level of effort (intensity) expected to be attained. Reported intensities can be summarized: at least 20 min of continuous exercise at 55% to 70% of maximum heart rate, "moderate intensity" as per the prescribed exercise regime, and times participants exercised: three times a week for 30 min at 60% to 80% of maximum heart rate. Conceptually, EA is related to biological adaptations as improvements in functionality are associated with fulfilling the prescribed plan. From an operational perspective, EA is the extent to which a person meets the advised interval, exercise dose, and exercise-dosing regimen (Dorgo, King, & Brickey, 2009). The unit of measure for EA is the performed exercise doses per defined period of time reported as a proportion of prescribed exercise doses performed at the prescribed time interval. However, such views of EA are not highly prevalent.

The most common measures of adherence to exercise programs for the OA (Pavey et al., 2012; Picorelli et al., 2014) are as follows:

1. Proportion of participants completing exercise programs;
2. Proportion of exercise sessions attended;
3. Average number of home exercise sessions completed per week;
4. Class attendance expressed as a proportion of participants reaching certain cutoffs;
5. Total sessions attended;
6. Number of weeks in which home exercise was undertaken;
7. Proportion of days on which home exercise was undertaken;

8. Number of minutes walked;
9. Proportion of participants meeting physical activity guidelines; and
10. Proportion of participants exercising regularly.

Systematic reviews indicate that the proportion of OA completing group exercise programs ranged from 65% to 86%, the proportion of sessions attended fluctuated from 58% to 77%, and the average number of home exercise sessions completed per week ranged from 1.5 to three times per week (Pavey et al., 2012; Picorelli et al., 2014).

## Factors Associated With Adherence to Exercise in OA

Factors associated with adherence to exercise in OA include

1. Higher socioeconomic and educational levels (Forechi, Mill, Griep, Santos, & Molina, 2018);
2. Marital status (Courneya et al., 2012; Osuka et al., 2017);
3. Good health (measured by fewer health conditions, better self-rated health, fewer medications) and low body mass index (Picorelli et al., 2014);
4. People with pacemakers, reflecting desire for self-preservation (Iliou, Blanchard, Lamar-Tanguy, Cristofini, & Ledru, 2016; Sparling, Howard, Dunstan, & Owen, 2015). Often, pacemakers are also defibrillators and are set to discharge above a given heart rate;
5. Better physical ability (Picorelli et al., 2014);
6. Fewer depressive symptoms (depression, loneliness, low scores on Mental Status Test, psychoactive medication use, and a higher perceived risk of falling; Picorelli et al., 2014);
7. Genetic factors influencing physical activity (Bouchard & Hoffman, 2011; Ursu et al., 2015);
8. Extrinsic motivators, such as cash incentives and smartphone applications (Finkelstein, Brown, Brown, & Buchner, 2008; Helbostad et al., 2017);
9. Supervised programs (Lacroix et al., 2016; Pavey et al., 2012; Picorelli et al., 2014);
10. Better cognitive ability (Picorelli et al., 2014).

The hypothesis that adherence is generally higher in supervised programs of OA has been corroborated by systematic reviews (Courneya et al., 2012; Lacroix et al., 2016; Pavey et al., 2012; Picorelli et al., 2014). Supervised exercise programs for OA also demonstrates a lower incidence or absence of training-related injuries, higher training effects, lower dropout rates, and overall effectiveness of the programs (Courneya et al., 2012; Lacroix et al., 2016; Pavey et al., 2012; Picorelli et al., 2014). The greater effects of supervised programs could be a higher quality in the execution of exercises due to supervision. It is well known that a higher rate of exertion brings about a greater adaptation (Lacroix et al., 2016). In most cases, personal interactions between participant and supervisor, during training sessions, are known to have a positive overall effect on the participant. That could facilitate social interactions leading to the enhancement of social health, promoting mental and emotional health, as well as feelings of well-being (Picorelli et al., 2014).

**Table 1.** Factors Associated With Physical Inactivity.

| |
|---|
| Demographic factors |
| Older age |
| Female gender |
| Non-White race/ethnicity |
| Low socioeconomic status |
| Health-related and clinical factors |
| Chronic illnesses |
| Poor general health and physical function |
| Overweight/obesity |
| Cognitive and psychological factors |
| Greater perceived barriers to physical activity |
| Lack of enjoyment of physical activity |
| Low expectations of benefits from physical activity |
| Poor psychological health |
| Low self-efficacy for physical activity |
| Low self-motivation for physical activity |
| Lack of readiness to change physical activity behaviors |
| Poor fitness level |
| Behavioral factors |
| Prior physical activity |
| Smoking |
| Type A behavior[a] |
| Social factors |
| Lack of cohesion in exercise group |
| Lack of physician influence/advice for physical activity |
| Lack of social support for physical activity |
| Program-related factors |
| High physical activity intensity |
| Long physical activity duration |
| Environmental factors |
| Lack of access to facilities/parks/trails |
| Lack of neighborhood safety |

*Source.* Reprinted/adapted by permission from Springer Nature: Allen and Morey (2010).
[a]Type A behavior associated with poorer adherence in supervised exercise programs but greater overall physical activity levels.

Table 1 shows a compendium of factors associated with physical inactivity (Allen & Morey, 2010). There is a high probability that nonadherers to exercise programs or nonparticipants in vigorous physical activity or exercise programs in community-based or living facilities settings will comply with at least one factor in Table 1. The absence of evidence suggesting the role of the human genome in adherence to exercise programs do not preclude findings linking daily physical activity levels and the inclination for physical activity with genetic components (Bauman et al., 2012; Bouchard & Hoffman, 2011).

## How Is Adherence Promoted?

Adherence is promoted by the belief that an intervention will be effective (i.e., the outcome expectancy) and the individual can follow the intervention (i.e., the efficacy expectancy; Flegal, Kishiyama, Zajdel, Haas, & Oken, 2007). People with greater adherence may engage in other health promoting behaviors. Adherence may be a marker for a personality type or related to motivation or goal-directed behaviors.

Self-efficacy, or the perceived confidence in one's ability to accomplish a specific task, is another relevant factor in promoting adherence (Flegal et al., 2007). It might relate to motivation. Self-efficacy affects exercise adoption and maintenance (Mikolaizak et al., 2018). Intervention programs should develop and nurture this characteristic to enable individuals to continue with a program. The reviewed studies suggest that strategies to promote adherence should include making instructions to subjects simpler and less demanding, addressing cognitive motivational factors such as self-efficacy and health beliefs, offering social support and reinforcement, and providing reminders (Flegal et al., 2007). Appropriate activities should be carefully planned before program implementation to best suit the specific needs of OA. Good communication and continuous motivation might also increase participation (Sjösten et al., 2007). An exercise program should also address behavioral motivation, and social and environmental contexts, to raise commitment to exercise among a largely sedentary population of OA with their multiple illnesses and functional deficits (Stineman et al., 2011; Sullivan-Marx et al., 2011).

## Adherence to Exercise Programs and Preventing Falls

Falls are the leading cause of injury and death from injuries among OA (Bergen, Stevens, & Burns, 2016). According to those CDC records in 2014, older Americans experienced 29 million falls causing seven million injuries and costing an estimated US$31 billion in annual Medicare costs. Fall injury rates are almost 7 times higher for OA with poor health than for those with excellent health. Increased inactivity, reduced muscle strength, more severe chronic health conditions, and increased use of prescription medications are risk factors for falls among OA. Full adherence to a fall prevention program brought significant benefits to participants, such as fewer falls and less utilization of health care resources (Mikolaizak et al., 2018). A systematic review assessed the effects of fall prevention programs and reported a pooled estimate of adherence across studies of 0.74 (95% confidence interval [CI] = [0.67, 0.80]; McPhate, Simek, & Haines, 2013). Yet, the predictors of adherence in fall prevention programs are poorly understood, and few predictors have been identified. These include a person's beliefs about the possibilities to prevent falls by the activities of the program and home modifications to prevent falling. OA at high risk of falling have the highest attendance in these programs due to their higher intrinsic motivation to prevent catastrophic accidents. Such findings support the health belief model (HBM; Champion & Skinner, 2008). The HBM addresses the relationship between a person's beliefs and behaviors. It provides a way to understanding and predicting how OA will behave in relation to his or her health and how he or she will comply with health care therapies.

## Exercise Programs and Preventing Falls: High-Intensity Exercise Training (HIET)

The best exercises for preventing falls have not been identified. OA lose Type II motor units with age. These structures respond best to high-speed overload training (Power et al., 2016). High-intensity training is associated with increased patient adherence and is suitable for implementation in both healthy and "at-risk" populations (Reitlo et al., 2018). High-speed overload training commonly used in OA programs include modifications of traditional aerobic exercise (cardiorespiratory endurance) and RT programs. Traditional aerobic exercise consists of moderate-intensity continuous training (MICT). HIET involves repeated high-intensity exercise bouts of 30 s to several minutes, separated by 1 to 5 min of recovery. An advantage of HIET over MICT is the shorter time required to perform the same energy expenditure. High-intensity interval training brings about equal or greater benefits than MICT across age-groups including OA. In OA, HIET improves aerobic capacity (Robinson et al., 2017), mechanical efficiency (Jabbour, Iancu, Mauriège, Joanisse, & Martin, 2017), glucose tolerance and reduced blood pressure (Izadi, Ghardashi, Asvadi, & Babaee Bigi, 2018; Lithgow & Leggate, 2018), inflammation in osteo- and rheumatoid arthritis (Bartlett et al., 2018; Keogh, Grigg, & Vertullo, 2018), and a reduced risk of falls (Jiménez-García et al., 2018). Reitlo et al. (2018), in a 1-year study in OA (70-77 years), showed that adherence to HIET was consistently higher than MICT in exercise programs involving cycling, resistance exercise, jogging, or swimming. Others (Jiménez-García et al., 2018; Lacroix et al., 2016; Steib et al., 2010) indicated that, in OA, HIET enhances functional chores related to safety, climbing stairs, recovery when stumbling, and tasks such as moving the lower limb to keep from falling.

## Public Health, Environmental, and Policy Interventions

A brief look back at the issue of physical inactivity leads us to draw attention to several publications. The WHO stated in 2003 that the problem of physical inactivity was universal, so large-scale, population-based strategies were important for intensive individualized and small

group interventions (WHO, 2003). Initial evaluations of the problem stated that public health, environmental, and policy strategies to enhance physical activity adherence can range from very simple, low-cost interventions to complex policies involving budget allocations and transportation restructuring (Marcus, Owen, Forsyth, Cavill, & Fridinger, 1998; Sallis, Bauman, & Pratt, 1998; WHO, 2003). Fifteen years later, we are still confronting such a public health issue. Mass media educational approaches seem to have little influence on physical activity levels within communities (Marcus et al., 1998). Other types of environmental and policy interventions, however, have shown promising results (Blamey, Mutrie, & Aitchison, 1995; WHO, 2003). These interventions have included posting signs in public areas to encourage the use of stairways, adding bicycle trails, organizing activity clubs, and providing additional exercise facilities in the community. While community- and population-based strategies are important for facilitating physical activity, the costs of implementation are often a significant barrier (Brownson et al., 2007; WHO, 2003).

## Summary

EA in OA is a multifactorial problem encompassing many biopsychosocial factors. The range of predictors of EA underscores the need for health services administrators and providers to consider this information in designing strategies to enhance EA in OA. Exercise programs attendance and adherence are important predictors of health status and well-being. Health care professionals should understand the variables influencing adherence to exercise in OA and its consequences on health service delivery and outcomes. Health services administrators and providers should know that low adherence rates will limit the benefits of the exercise program at their facilities. For example, poor attendance and nonadherence are risk factors leading to health service complications in long-term care programs. Administrators of long-term care programs should consider adherence predictors in the projection of expected outcomes, future program needs, and evaluations.

In conclusion, it is imperative that health care professionals received training in the conceptual and operational applications of exercise and adherence. The need of physical activity and exercise as preservative for well-being across the life span needs to be reinforced across social strata. The literature on EA in OA is confusing and inconsistent, and few studies measured adherence the same way. Several studies reported high adherence, but adherence was generally higher in supervised programs. Factors associated with greater adherence included higher socioeconomic status, married status, better health status, better physical ability, better cognitive ability, and fewer depressive symptoms. Sustaining a physically active lifestyle and participating in exercise programs improve the current and future level of health and a state of well-being. Those benefits come across as less disease and sickness are experienced.

### Authors' Note

The authors declare that the views expressed in the present article are their own and not an official position of their respective institutions. Also, appreciate the reviewer's thorough suggestions.

### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

### Supplemental Material

Supplemental material for this article is available online.

### References

Allen, K., & Morey, M. C. (2010). Physical activity and adherence. In H. Bosworth (Ed.), *Improving patience treatment adherence: A clinician's guide* (pp. 9-38). New York, NY: Springer. doi:10.1007/978-1-4419-5866-2_2

American College of Sports Medicine. (1975). *Guidelines for graded exercise testing and exercise prescription* (1st ed.). Philadelphia, PA: Lea & Febiger.

American College of Sports Medicine. (1978). Position statement on the recommended quantity and quality of exercise for developing and maintaining fitness in healthy adults. *Medicine & Science in Sports & Exercise*, *10*(3), vii-x.

American College of Sports Medicine. (1998). Position stand: The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Medicine & Science in Sports & Exercise*, *30*, 975-991.

Andrade, A. C. d. S., Mingoti, S. A., Fernandes, A. P., Andrade, R. G. d., Friche, A. A. d. L., Xavier, C. C. . . Caiaffa, W. T. (2018). Neighborhood-based physical activity differences: Evaluation of the effect of health promotion program. *PLoS ONE*, *13*(2), e0192115. doi:10.1371/journal.pone.0192115

Bartlett, D. B., Willis, L. H., Slentz, C. A., Hoselton, A., Kelly, L., Huebner, J. L., . . . Huffman, K. M. (2018). Ten weeks of high-intensity interval walk training is associated with reduced disease activity and improved innate immune function in older adults with rheumatoid arthritis: A pilot study. *Arthritis Research & Therapy*, *20*, Article 127. doi:10.1186/s13075-018-1624-x

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C. F., Loos, R. J., & Martin, B. W. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, *380*, 258-271. doi:10.1016/S0140-6736(12)60735-1

Benjamin, R. M. (2010). The surgeon general's vision for a healthy and fit nation. *Public Health Reports*, *125*, 514-515. doi:10.1177/003335491012500402

Bergen, G., Stevens, M. R., & Burns, E. R. (2016). Falls and fall injuries among adults aged ≥ 65 years—United States, 2014. *Mortality and Morbidity Weekly Reports*, *65*, 993-998. doi:10.15585/mmwr.mm6537a2

Blamey, A., Mutrie, N., & Aitchison, T. (1995). Health promotion by encouraged use of stairs. *British Medical Journal*, *311*, 289-290. doi:10.1136/bmj.311.7000.289

Bouchard, C., & Hoffman, E. P. (Eds.). (2011). *The Encyclopaedia of Sports Medicine: Vol. XVIII. Genetic and molecular aspects of sports performance*. Hoboken, NJ: John Wiley & Sons. doi:10.1002/9781444327335

Brownson, R. C., Ballew, P., Dieffenderfer, B., Haire-Joshu, D., Heath, G. W., Kreuter, M. W., & Myers, B. A. (2007). Evidence-based interventions to promote physical activity: What contributes to dissemination by state health departments. *American Journal of Preventive Medicine*, *33*(Suppl. 1), S66-S73. doi:10.1016/j.amepre.2007.03.011

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Reports*, *100*, 126-131.

Champion, V. L., & Skinner, S. S. (2008). The health belief model. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health behavior and health education: Theory, research, and practice* (pp. 45-65, 4th ed.). San Francisco, CA: Jossey-Bass.

Cherup, N., Roberson, K., Potiaumpai, M., Widdowson, K., Jaghab, A. M., Chowdhari, S., . . . Signorile, J. (2018). Improvements in cognition and associations with measures of aerobic fitness and muscular power following structured exercise. *Experimental Gerontology*, *112*, 76-87. doi:10.1016/j.exger.2018.09.007

Chodzko-Zajko, W. J., Proctor, D. N., Fiatarone Singh, M. A., Minson, C. T., Nigg, C. R., Salem, G. J., & Skinner, J. S. (2009). American College of Sports Medicine position stand: Exercise and physical activity for older adults. *Medicine & Science in Sports & Exercise*, *41*, 1510-1530. doi:10.1249/MSS.0b013e3181a0c95c

Courneya, K. S., Karvinen, K. H., McNeely, M. L., Campbell, K. L., Brar, S., Woolcott, C. G., . . . Friedenreich, C. M. (2012). Predictors of adherence to supervised and unsupervised exercise in the Alberta physical activity and breast cancer prevention trial. *Journal of Physical Activity and Health*, *9*, 857-866.

Dalle Grave, R., Calugi, S., Centis, E., El Ghoch, M., & Marchesini, G. (2011). Cognitive-behavioral strategies to increase the adherence to exercise in the management of obesity. *Journal of Obesity*, *2011*, Article 348293. doi:10.1155/2011/348293

den Hoed, M., Brage, S., Zhao, J. H., Westgate, K., Nessa, A., Ekelund, U., . . . Loos, R. J. (2013). Heritability of objectively assessed daily physical activity and sedentary behavior. *American Journal of Clinical Nutrition*, *98*, 1317-1325. doi:10.3945/ajcn.113.069849

Dorgo, S., King, G. A., & Brickey, G. D. (2009). The application of peer mentoring to improve fitness in older adults. *Journal of Aging and Physical Activity*, *17*, 344-361. doi:10.1123/japa.17.3.344

Fahey, T. D., & Fahey, M. W. (2014). Nutrition, physical activity, and the obesity epidemic: Issues, policies, and solutions (1960s-present). In T. R. Oliver (Ed.), *U.S. health and health care policy* (pp. 363-374). Los Angeles, CA: SAGE. doi:10.4135/9781452270746.

Fahey, T. D., Insel, P., & Roth, T. (2018). *Fit & well* (13th ed.). New York, NY: McGraw Hill.

Finkelstein, E. A., Brown, D. S., Brown, D. R., & Buchner, D. M. (2008). A randomized study of financial incentives to increase physical activity among sedentary older adults. *Preventive Medicine*, *47*, 182-187. doi:10.1016/j.ypmed.2008.05.002

Flegal, K., Kishiyama, S., Zajdel, D., Haas, M., & Oken, B. (2007). Adherence to yoga and exercise interventions in a 6-month clinical trial. *BMC Complementary and Alternative Medicine*, *7*, Article 37. doi:10.1186/1472-6882-7-37

Forechi, L., Mill, J. G., Griep, R. H., Santos, I. F. P., & Molina, M. (2018). Adherence to physical activity in adults with chronic diseases: ELSA-Brasil. *Revista De Saude Publica*, *52*, 31. doi:10.11606/S1518-8787.2018052000215

Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I.-M., . . . American College of Sports, M. (2011). American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Medicine & Science in Sports & Exercise*, *43*, 1334-1359. doi:10.1249/MSS.0b013e318213fefb

Hawley-Hague, H., Horne, M., Campbell, M., Demack, S., Skelton, D. A., & Todd, C. (2014). Multiple levels of influence on older adults' attendance and adherence to community exercise classes. *The Gerontologist*, *54*, 599-610. doi:10.1093/geront/gnt075

Hawley-Hague, H., Horne, M., Skelton, D. A., & Todd, C. (2016). Review of how we should define (and measure) adherence in studies examining older adults' participation in exercise classes. *BMJ Open*, *6*(6), e011560. doi:10.1136/bmjopen-2016-011560

Helbostad, J. L., Vereijken, B., Becker, C., Todd, C., Taraldsen, K., Pijnappels, M., . . . Mellone, S. (2017). Mobile health applications to promote active and healthy ageing. *Sensors*, *17*(3), E622. doi:10.3390/s17030622

Iliou, M. C., Blanchard, J. C., Lamar-Tanguy, A., Cristofini, P., & Ledru, F. (2016). Cardiac rehabilitation in patients with pacemakers and implantable cardioverter defibrillators. *Monaldi Archives for Chest Disease Cardiac Series*, *86*(1-2), 756.

Izadi, M. R., Ghardashi, A. A., Asvadi, F. M., & Babaee Bigi, M. A. (2018). High-intensity interval training lowers blood pressure and improves apelin and NOx plasma levels in older treated hypertensive individuals. *Journal Physiological and Biochemistry*, *74*(1), 47-55. doi:10.1007/s13105-017-0602-0

Jabbour, G., Iancu, H. D., Mauriège, P., Joanisse, D. R., & Martin, L. J. (2017). High-intensity interval training improves performance in young and older individuals by increasing mechanical efficiency. *Physiological Reports*, *5*(7), e13232. doi:10.14814/phy2.13232

Jiménez-García, J. D., Hita-Contreras, F., de la Torre-Cruz, M., Fábrega-Cuadros, R., Aibar-Almazán, A., Cruz-Díaz, D., & Martinex-Amat, A. (2018). High-intensity interval training using TRX lower-body exercises improve the risk of falls in healthy older people. *Journal of Aging and Physical Activity*, *39*, 1-26. doi:10.1123/japa.2018-0190

Keogh, J. W., Grigg, J., & Vertullo, C. J. (2018). Is high-intensity interval cycling feasible and more beneficial than continuous cycling for knee osteoarthritic patients?

Results of a randomised control feasibility trial. *PeerJ*, *6*, e4738. doi:10.7717/peerj.4738

Lacroix, A., Kressig, R. W., Muehlbauer, T., Gschwind, Y. J., Pfenninger, B., Bruegger, O., & Granacher, U. (2016). Effects of a supervised versus an unsupervised combined balance and strength training program on balance and muscle power in healthy older adults: A randomized controlled trial. *Gerontology*, *62*, 275-288. doi:10.1159/000442087

Lee, P. G., Jackson, E. A., & Richardson, C. R. (2017). Exercise prescriptions in older adults. *American Family Physician*, *95*, 425-432.

Lithgow, H. M., & Leggate, M. (2018). The effect of a single bout of high intensity intermittent exercise on glucose tolerance in non-diabetic older adults. *International Journal Exercise Science*, *11*, 95-105.

Marcus, B. H., Owen, N., Forsyth, L. H., Cavill, N. A., & Fridinger, F. (1998). Physical activity interventions using mass media, print media, and information technology. *American Journal of Preventive Medicine*, *15*, 362-378. doi:10.1016/S0749-3797(98)00079-8

McPhate, L., Simek, E. M., & Haines, T. P. (2013). Program-related factors are associated with adherence to group exercise interventions for the prevention of falls: A systematic review. *Journal of Physiotherapy*, *59*, 81-92. doi:10.1016/S1836-9553(13)70160-7

Mikolaizak, A. S., Lord, S. R., Tiedemann, A., Simpson, P., Caplan, G., Bendall, J. C., . . . Close, J. (2018). Adherence to a multifactorial fall prevention program following paramedic care: Predictors and impact on falls and health service use: Results from an RCT a priori subgroup analysis. *Australasian Journal on Ageing*, *37*, 54-61. doi:10.1111/ajag.12465

National Institute of Aging. (2009). *Exercise & physical activity: Your everyday guide from the National Institute on Aging*. Retrieved from https://www.nia.nih.gov/health/exercise-and-physical-activity-getting-fit-life

Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., . . . Castaneda-Sceppa, C. (2007). Physical activity and public health in older adults: Recommendation from the American College of Sports Medicine and the American Heart Association. *Circulation*, *116*, 1094-1105. doi:10.1249/mss.0b013e3180616aa2

Osuka, Y., Jung, S., Kim, T., Okubo, Y., Kim, E., & Tanaka, K. (2017). Does attending an exercise class with a spouse improve long-term exercise adherence among people aged 65 years and older: A 6-month prospective follow-up study. *BMC Geriatrics*, *17*, Article 170. doi:10.1186/s12877-017-0554-9

Pavey, T., Taylor, A., Hillsdon, M., Fox, K., Campbell, J., Foster, C., . . . Taylor, R. (2012). Levels and predictors of exercise referral scheme uptake and adherence: A systematic review. *Journal of Epidemiology & Community Health*, *66*, 737-744. doi:10.1136/jech-2011-200354

Picorelli, A. M. A., Pereira, L. S. M., Pereira, D. S., Felício, D., & Sherrington, C. (2014). Adherence to exercise programs for older people is influenced by program characteristics and personal factors: A systematic review. *Journal of Physiotherapy*, *60*, 151-156. doi:10.1016/j.jphys.2014.06.012

Power, G. A., Allen, M. D., Gilmore, K. J., Stashuk, D. W., Doherty, T. J., Hepple, R. T., . . . Rice, C. L. (2016). Motor unit number and transmission stability in octogenarian world class athletes: Can age-related deficits be outrun? *Journal Applied Physiology*, *121*, 1013-1020. doi:10.1152/japplphysiol.00149.2016

Reitlo, L. S., Sandbakk, S. B., Viken, H., Aspvik, N. P., Ingebrigtsen, J. E., Tan, X., . . . Stensvold, D. (2018). Exercise patterns in older adults instructed to follow moderate- or high-intensity exercise protocol—The generation 100 study. *BMC Geriatrics*, *18*, Article 208. doi:10.1186/s12877-018-0900-6

Robinson, M. M., Dasari, S., Konopka, A. R., Johnson, M. L., Manjunatha, S., Esponda, R. R., . . .Sreekumaran, K. (2017). Enhanced protein translation underlies improved metabolic and physical adaptations to different exercise training modes in young and old humans. *Cell Metabolism*, *25*, 581-592. doi:10.1016/j.cmet.2017.02.009

Rogers, M., Page, P., & Takeshima, N. (2013). Balance training for the older athlete. *International Journal of Sports Physical Therapy*, *8*, 517-530.

Ruffieux, J., Mouthon, A., Keller, M., Wälchli, M., & Taube, W. (2017). Behavioral and neural adaptations in response to five weeks of balance training in older adults: A randomized controlled trial. *Journal of Negative Results in Biomedicine*, *16*, Article 11. doi:10.1186/s12952-017-0076-1

Sallis, J. F., Bauman, A., & Pratt, M. (1998). Environmental and policy interventions to promote physical activity. *American Journal of Preventive Medicine*, *15*, 379-397. doi:10.1016/S0749-3797(98)00076-2

Sjösten, N. M., Salonoja, M., Piirtola, M., Vahlberg, T. J., Isoaho, R., Hyttinen, H. K., . . . Kivelä, S.-L. (2007). A multifactorial fall prevention programme in the community-dwelling aged: Predictors of adherence. *European Journal of Public Health*, *17*, 464-470. doi:10.1093/eurpub/ckl272

Sparling, P. B., Howard, B. J., Dunstan, D. W., & Owen, N. (2015). Recommendations for physical activity in older adults. *British Medical Journal*, *350*, h100. doi:10.1136/bmj.h100

Steib, S., Schoene, D., & Pfeifer, K. (2010). Dose-response relationship of resistance training in older adults: A meta-analysis. *Medicine & Science in Sports & Exercise*, *42*, 902-914. doi:10.1249/MSS.0b013e3181c34465

Stineman, M. G., Strumpf, N., Kurichi, J. E., Charles, J., Grisso, J. A., & Jayadevappa, R. (2011). Attempts to reach the oldest and frailest: Recruitment, adherence, and retention of urban elderly persons to a falls reduction exercise program. *The Gerontologist*, *51*(Suppl. 1), S59-S72. doi:10.1093/geront/gnr012

Sullivan-Marx, E. M., Mangione, K. K., Ackerson, T., Sidorov, I. M. G., Volpe, S. L., & Craik, R. (2011). Recruitment and retention strategies among older African American women enrolled in an exercise study at a PACE program. *The Gerontologist*, *51*(Suppl. 1), S73-S81. doi:10.1093/geront/gnr001

U.S. Department of Health and Human Services. (1996). *Physical activity and health: A report of the surgeon general*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion.

U.S. Department of Health and Human Services. (1998). *Healthy people 2010 objectives: Draft for public comment*. Washington, DC. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1114345/pdf/1513.pdf

U.S. Department of Health and Human Services. (2002). *Physical activity fundamental to preventing disease*. Washington, DC. Retrieved from https://aspe.hhs.gov/basic-report/physical-activity-fundamental-preventing-disease

U.S. Department of Health and Human Services. (2008). *Physical activity guidelines for Americans*. Washington, DC. Retreived from https://health.gov/paguidelines/pdf/paguide.pdf

U.S. Department of Health and Human Services. (2010). *Healthy people 2020*. Washington, DC. Available from https://www.healthypeople.gov/

Ursu, R. I., Badiu, C., Cucu, N., Ursu, G. F., Craciunescu, I., & Severin, E. (2015). The study of the rs9939609 FTO gene polymorphism in association with obesity and the management of obesity in a Romanian cohort. *Journal of Medicine and Life*, *8*, 232-238.

Ward, B. W., Schiller, J. S., & Goodman, R. A. (2014). Multiple chronic conditions among U.S. adults: A 2012 update. *Preventing Chronic Disease*, *11*, Article 130389. doi:10.5888/pcd11.130389

World Health Organization. (2003). *Adherence to long-term therapies: Evidence for action*. Geneva, Switzerland: Author.

World Health Organization. (2010a). *Definition of an older or elderly person*. Retrieved from http://www.who.int/healthinfo/survey/ageingdefnolder/en/index.html

World Health Organization. (2010b). *Global recommendations on physical activity for health*. Geneva, Switzerland: Author.