Activity Tracking and Improved Health Outcomes

Daniel V. Gaz, Thomas M. Rieck and
Nolan W. Peterson

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/65240

Abstract

Activity tracking devices are a popular way for health-minded individuals to measure daily movement and estimate energy expenditure. Tracking, in its many forms, has been proven to improve health outcomes. From paper diaries to devices and smartphone applications, these data are becoming more important and have the potential to be used in the physician's office as part of a realistic physical activity plan for improved health outcomes. As a health-care professional, amid a rapidly expanding accelerometer market, it is important to know the application and practicality of these devices, as well as the evidence behind an individual's usage. What we choose to recommend, as health-care professionals, can influence the health and well-being of patients in the wellness arena. This chapter will look at research focused on activity tracking, including metrics such as sleep, nutrition, and physical activity, and health outcomes to further educate health-care professionals in an ever-evolving field.

Keywords: activity tracking, physical activity, health, wellness, behavior modification, accelerometer, disease prevention

1. Introduction

Man has been physically active since our days as primitive nomads [1]. From the Paleolithic Era, where we hunted and gathered to stay alive, to the days of the ancient Greeks and Romans, who placed a high emphasis on exercise and fitness, we have typically necessitated and revered physical activity. Recent research [2] has begun to take a look at the decline in our daily energy expenditure and, since the 1950s, the results have been shocking. In the United States alone, there has been a significant increase in sedentary time, coupled with a decrease in folks employed in careers that have a high level of physical activity [2]. Over the last 50 years, it has been estimated that daily occupation-related energy expenditure has decreased by more than

100 calories, accounting for a significant portion of the increase in mean body weights for women and men in the United States [3]. Many people remain sedentary for a time that equals a normal working shift—close to 7.7 h/day—according to a recent study [4] that looked at 6329 participants and the level of activity they achieved during a 10-h work day. With such a dramatic change in the amount of regular physical activity that our society accrues on a daily basis, it is important to understand the negative implications of the direction we were headed. Regular physical activity provides us with myriad of health benefits [5]. These include, but are not limited to, weight control [6], health condition and disease prevention [7], improvements in mood [8], decreased fatigue [9], and better sleep quality [10].

Even though the benefits from exercise are known, a large population of people does not meet the minimum physical activity guidelines [11], as defined by the American College of Sports Medicine (ACSM). The ACSM physical activity recommendations include "moderate-intensity aerobic (endurance) physical activity for a minimum of 30 minutes on five days each week or vigorous-intensity aerobic physical activity for a minimum of 20 minutes on three days each week" [11]. Accruing 150 min of physical activity at a moderate level (65% $V^{\bullet}O_{2max}$) or 60 min of vigorous activity (80% $V^{\bullet}O_{2max}$), as defined by ACSM [12], does not seem like an arduous task, yet so many people fail to meet these minimum requirements. According to the Centers for Disease Control and Prevention (CDC), only 20% of adults (roughly 50 million men and women as of 2013) meet the overall physical activity recommendations [13]. This lack of overall fitness and physical activity has been shown to contribute directly to an increase in mortality risk [14], among other diseases and conditions. Researchers have even compared it to smoking, with one in 10 deaths being attributed to a sedentary lifestyle [15].

Buried among this doom and gloom of our sedentary society lie the health benefits for those afflicted with acute and chronic diseases, such as diabetes, obesity, cardiovascular disease (CVD), cancer, and other conditions that can be positively affected with regular physical activity. Whether it is a complete elimination of signs and symptoms, or a mitigation of certain chronic disease profiles, physical activity has shown promise in improving quality of life for those with modifiable and nonmodifiable diagnoses [16]. A recent meta-analysis [17] found that individuals who were physically active at levels lower than the minimum amount recommended (150 min of moderate activity per week) also had a significantly lower risk of coronary heart disease (CHD). This is an important finding, as those with sedentary lifestyles and, as a result, low levels of fitness, can reduce their risk for disease with very modest and achievable levels of physical activity. Two Harvard studies showed how little exercise is necessary to reduce the risk of disease. In one paper, walking just ten blocks a day lowered heart disease risk by 33% [18], and in another paper, walking just one hour per week was enough to reduce heart disease risk by 20% [19]. Even in those who are overweight and/or obese, but still exercise regularly, the outcomes are better than individuals who are thin and fail to meet daily exercise recommendations. "What we're learning is that a body that exercises regularly is generally a healthy body, whether that body is fat or thin," says Glenn Gaesser, PhD, a professor of exercise and wellness at Arizona State University [20]. "The message should really be that if you are exercising regularly, you shouldn't necessarily be looking at the scale to determine how healthy or fit you are," Gaesser says [20].

One very popular way to keep track of accumulated physical activity is body-mounted accelerometers. Early versions were simplistic in nature. In 1780, Swiss horologist Abraham-Louis Perrelet created the first pedometer that measured both steps and distance while walking, basing this ingenious invention on a 1770 mechanism that powered a self-winding watch [21]. Since Perrelet's novel development, the field of accelerometry has grown into a projected $5.9 billion industry by 2019 [22]. Brands like Garmin, Jawbone, and Fitbit have captured the activity tracking market, while Samsung and Apple take hold of the smartwatch domain. In between lay thousands of smartphone applications that you can download to turn your phone into a de facto activity tracker, ranging from free to $1.99. According to a recent (2015) publication in BMC Medicine, "consumer wearable devices for activity tracking have shown promise in post-surgery recovery in cardiac patients, pulmonary rehabilitation, and activity counseling in diabetic patients, among others" [23]. An earlier study (2007) suggested that "the use of a pedometer is associated with significant increases in physical activity and significant decreases in body mass index and blood pressure" [24]. Specifically, subjects that tracked their steps, but did not have a step goal, averaged 686 more steps per day. Subjects that were given a 10,000 step/day goal increased their overall step count by 2998 steps. Subjects that were given a step goal, and also gradually increased their steps over the course of the study, got 3175 more steps and an additional 1200 min of "non-seated" time. Overall, pedometer wearers saw a rise in physical activity of 27% [24].

This chapter, appropriately titled "Activity Tracking and Improved Health Outcomes," will go into further detail on the benefits of using devices like pedometers and smartwatches to track physical activity and exercise, while also investigating the improvement of health outcomes as a result. Research in this area is gaining momentum and traction, but the data is not a slam-dunk. Some studies show good correlations between tracking activity and improving overall health [25], while others still believe that more work needs to be done, as it is a challenge to track accurately and use the information advantageously [26]. Regardless, clinicians and researchers have come to one conclusion—the widespread availability to collect patient-centered information on their movement, nutrition, exercise, and sleep can modify risk factors, further concrete healthy behavior change, and look at other outcomes like postsurgical activity or changes in daily lifestyle habits when given new medications or dosages [27]. Our society is slowly, but surely, becoming more and more quantified [28]. There is no better time than now to understand how this quantified self can improve health outcomes with minimal financial and time investment.

2. The health benefits of exercise

Our society has long been aware of the benefits and importance of regular physical activity. For much of our young lives, it was a mandatory part of our regular education [29, 30], and a significant contributor to public health [31, 32]. Sallis noted that "for maximal public health benefit, school physical education programs should prepare children for a lifetime of physical activity" [32]. It makes sense that schools would devote class time to increase the amount of physical activity, given the intended consequences of more health and wellness down the line.

As school children, we were exposed to hours of recess and physical activity, and summers spent playing outdoors with friends and family. For some of us, as we progressed to middle and high school, play turned to sport. Physical activity was now a component of achieving success on the court or playing field. For those who did not compete in a sport, physical education class might have been our only option for an increase in caloric expenditure during the school day. It is at this point when we begin contemplating purposeful exercise—something is more commonly known as "working out." According to Dr. David Bassett, Jr., a professor in the Department of Exercise, Sport, and Leisure Studies at the University of Tennessee, Knoxville, exercise is a specific form of physical activity that is planned, purposeful, and performed with the intention of acquiring fitness or other health benefits. Examples include working out at a health club or recreation center, swimming, cycling, running, and recreational sports [33].

As Dr. Bassett mentioned, purposeful exercise has an inherent intention to acquire fitness, along with other health benefits. These benefits, long researched, in the form of recommendations [34] and position stances [35–39] published regularly to increase the awareness of regular physical activity and the importance of such. The most recent position stance on exercise, courtesy of the ACSM, recommends "a comprehensive program of exercise including cardiorespiratory, resistance, flexibility, and neuromotor exercise of sufficient volume and quality…for apparently healthy adults of all ages" [39]. This stance, focused primarily on healthy adults, delves into specific benefits of regular exercise that include a lower risk of all-cause mortality and cardiovascular disease with increased levels of cardiorespiratory fitness [39–43], a risk reduction in developing coronary heart disease (CHD), stroke, type 2 diabetes (T2D), and some forms of cancer (e.g., colon and breast cancers) [44]. Additionally, regular exercise and physical activity lower blood pressure, have been shown to improve lipoprotein profile, C-reactive protein, and other CHD biomarkers, enhance insulin sensitivity, and play an important role in weight management [44].

Clearly, evidence supports the health benefits of exercise in adults, especially when performed on a regular basis. While exercise remains a somewhat ambiguous term or phrase, it is clear that a well-rounded program, consisting of cardiovascular and resistance training, as well as regular flexibility and neuromotor (read—functional fitness) exercise gives an individual an excellent, and beneficial, chance to improve their overall health profile. More specifically, the literature supports the following recommendations:

"The ACSM recommends that most adults engage in moderate-intensity cardiorespiratory exercise training for ≥30 min d^{-1} on ≥5 d wk^{-1} for a total of ≥150 min wk^{-1}, vigorous-intensity cardiorespiratory exercise training for ≥20 min d^{-1} on ≥3 d wk^{-1} (≥75 min wk^{-1}), or a combination of moderate- and vigorous-intensity exercise to achieve a total energy expenditure of ≥500–1000 MET min wk^{-1}. On 2–3 d wk^{-1}, adults should also perform resistance exercises for each of the major muscle groups, and neuromotor exercise involving balance, agility, and coordination. Crucial to maintaining joint range of movement, completing a series of flexibility exercises for each of the major muscle-tendon groups (a total of 60 s per exercise) on ≥2 d wk^{-1} is recommended [39].

http://dx.doi.org/10.5772/65240

While it would be easy to give blanket physical activity recommendations for children and elderly adults, the above-mentioned recommendations cannot be directly translated to the youth and the older population. Still—both groups benefit greatly from regular exercise with comparable, and just as important, improvements in overall health and wellness. Children do not consider purposeful exercise. Rather, they look at opportunities to play games and sports with friends and family, both at school and at home, as ways to have fun and socialize. When children engage in regular physical activity, they are less likely to become obese [45], will have stronger muscles [46] and bones [47], lower their risk of developing type 2 diabetes [48], and have a better outlook on life [49]. They will also sleep better [50] and learn to handle physical and emotional challenges better [51]—skills that will undoubtedly translate when they reach their teenage and adult years. The Centers for Disease Control and Prevention (CDC) recommend children and adolescents accumulate 60 or more minutes of activity each day. Most of those 60 min should be moderate (walking) to vigorous (running) aerobic activity, in addition to 3 days of strength and resistance exercises (gymnastics or push-ups) per week, and 3 days a week of bone-strengthening activities (jumping rope or running) [52]. The World Health Organization (WHO) recommends children and youth (5–17 years old) accumulate at least 60 min of moderate- to vigorous-intensity physical activity daily, with amounts of physical activity greater than 60 min providing additional health benefits [53]. WHO and CDC concur on the bulk of a child's daily activity being aerobic, incorporating vigorous-intensity activities should, including those that strengthen muscle and bone at a minimum of three times per week [52, 53].

As we age, we become progressively more sedentary. The reasons behind this are multifactorial—elderly have self-reported barriers to exercise including inertia, fear of falling/safety, time, negative affect, physical ailments, social, discomfort, weather, age, inconvenience, perceived capability, and verbal persuasion [54]. With a rapid increase in the population of men and women over the age of 65, it is important to know about how to overcome the barriers to exercise that the elderly deal with on a regular basis. Specific recommendations include identifying realistic goals, such as making it easier for an older adult to play with loved ones, improving performance in activities of daily living, and improving the overall quality of life. These strategies might improve exercise adherence and eliminate the above-mentioned perceived barriers [54]. It can be difficult to persuade the elderly to become physically active. As self-reported above, the elderly often believe themselves to be too old or frail for physical activity.

When compared to prescriptions for better health, exercise is rarely viewed as a surrogate to medication. Older adults also encounter more barriers to physical activity and exercise participation [55]. Even so, exercise recommendations for the elderly exist. To promote and maintain health, recommendations include moderate-intensity aerobic exercise 5 days a week for a minimum of 30 min, or vigorous intensity aerobic activity 3 days a week for a minimum of 20 min [56]. Strength and resistance training is also recommended for older adults. Recommendations include performing activities that maintain or increase muscular strength and endurance for a minimum of 2 days each week [56]. Examples include push-ups, squats, biceps curls, triceps extensions, and any core or abdominal exercises. Ideally, one should perform 8–

10 exercises, using major muscle groups, on two or more nonconsecutive days per week. Flexibility and balance are also excellent additions to a well-rounded exercise program for the elderly. Older adults should regularly perform activities with a goal of maintaining or increasing flexibility at least twice a week for a minimum of 10 min each day. Additionally, older adults that are independent and live without assistance should perform exercises that maintain or improve balance to decrease the substantial risk of falls [56, 57]. Since more than 1.3 million adults in the U.S. visit the emergency department for fall-related injuries each year, exercise can have a drastic impact on fall prevention [58]. It is important for folks in their sixth decade and beyond to exercise, as it can reduce the risk of falls and injuries from falls [59], prevent functional limitations [60–63], and can serve as effective therapy for many chronic diseases, many of which will be covered in the next section.

3. Disease prevention and mitigation with exercise

As covered in the previous section, there is a clear relationship [64, 65] between improved health and wellness and the inclusion of regular physical activity. While it would be an ideal scenario for everyone to accumulate the recommended bouts of exercise week after week, research has shown that we are less active on a regular basis, especially in the last 50 years [3]. With an increase in sedentary time comes an increase in diseases [66] that could, conceivably, be prevented with more movement throughout the day. Over the next few pages, ways to prevent, mitigate, or eliminate chronic or modifiable diseases, like diabetes and hypertension (HTN), will be discussed. The focal point will be on specific exercise recommendations and outcomes that revolve around incorporating physical activity with the sole goal of disease prevention and elimination.

When one thinks of diseases that are related to inactivity and a sedentary lifestyle, many come to mind. According to the WHO, "sedentary lifestyles increase all causes of mortality, double the risk of cardiovascular diseases, diabetes, and obesity, and increase the risks of colon cancer, high blood pressure, osteoporosis, lipid disorders, depression and anxiety" [67]. There is another conformation of diseases that result from a lack of daily caloric expenditure called metabolic syndrome. It is defined as having three of the following five conditions—abdominal obesity, high triglycerides, low high density lipoprotein (HDL) cholesterol, high blood pressure, and high fasting blood sugar [68]. Regardless of what disease or diseases one has, it has been proven that exercise can help prevent, reduce, or eliminate the signs and symptoms of one or more acute or chronic conditions.

3.1. Exercise and mortality risk

When we think of exercise, one thing that comes to mind is how it can positively effect and improve our quality of life. We rarely think of how it can prevent us from dying early, yet data supports this "fact of life." Fortunately, it does not take much to move the needle. Those who did a little movement (less than the amount outlined in the 2008 Physical Activity Guidelines for Americans) still had a 20% lower mortality risk when compared with indi-

http://dx.doi.org/10.5772/65240

viduals who did no exercise at all. Those who exercised for the minimum recommended physical-activity target had a 31% lower risk of dying compared with their sedentary counterparts. Those who did a lot more, including those who exceeded the weekly recommendations, had an even larger reduction in mortality risk. On the extreme ends of the exercise spectrum, individuals who performed 3–5 times the recommended minimum for physical activity had nearly a 40% mortality risk reduction when compared to sedentary individuals [69]. It is clear that an exercise dose-response exists and, as this data shows, it seems to be a minimal dose with a maximal response when looking at mortality risk. Studies have taken a deeper look into specific exercise modalities—one being a very popular and widespread form of aerobic exercise: jogging. In its Outdoor Participation Report, the Outdoor Foundation noted that 31.6 million adults over the age of 25 went running or jogging in 2016 [70]. Such a widespread physical activity can have beneficial effects on health and wellness, even in small doses. One research study that compared joggers to nonjoggers, completing as little as 1–2.4 h/week of jogging, had lower mortality rates. Based on these results, the authors recommend modest jogging recommendations of 2–3 times per week for a total cumulative duration of 2.5 h [71]. While it seems counterintuitive, it does not take much physical activity to improve our chances at survival and longevity. If nothing else, some light cardiovascular activity can improve the time we spend alive, with friends and family. Since the exercise recommendations are modest, it is important to spread the word to those who need help getting started on a regular activity program.

3.2. Exercise and cardiovascular disease risk

Cardiovascular disease (CVD) is prevalent across both genders and all backgrounds and nationalities. According to a recent report from the American Heart Association [72], one of every three deaths in the U.S. in 2013 was from heart disease, stroke, and other CVDs. Additionally, heart disease and stroke were the top two killers worldwide. In the United States, CVDs claimed 801,000 lives, and heart disease killed more than 370,000 people. 795,000 people suffered strokes, 129,000 of which did not survive. 116,000 of the 750,000 people in the U.S. who had a heart attack died [72]. Even cost is an issue with those afflicted with CVD—costs for each U.S. state can be up to $26 billion, and the cost of lost work days can be up to $1.3 billion [73]. Damning evidence, but what can we do about it? Is exercise the answer to combat the risk of CVD? As we learned above, it can help improve our quality of life and decrease the risk of mortality. As CVD claims nearly a million lives in the United States each year, it would be presumptive that exercise could work in a similar fashion.

It has been repeatedly shown that an inverse relationship exists between physical activity and the occurrence of CVDs. This means that with an increase in physical activity, the relative risk of developing CVD is decreased [74]. Regular physical activity using large muscle groups (quadriceps, hamstrings, as well as the muscles of the chest, back, and upper arms), like walking, running, or swimming, produces cardiovascular adaptations that increase exercise capacity, endurance, and skeletal muscle strength. Routine physical activity also prevents the development of coronary artery disease (CAD) and reduces symptoms in patients with established cardiovascular disease [75]. Thus, it has been proven that we can reduce the likelihood of CVD with regular exercise. How much mitigation or prevention remains to be seen, but we know through numerous studies that there is a positive relationship that exists.

3.3. Exercise and diabetes prevention/mitigation

Since 1980, the number of people with diabetes has risen from 108 million to 422 million in 2014, and the global prevalence of diabetes among adults over the age of 18 has risen from 4.7% to 8.5% in 2014 [76]. In areas of middle and low-income, diabetes prevalence is trending upwards, and contributes to blindness, kidney failure, heart attacks, stroke, and lower limb amputation [76]. 1.5 million deaths were caused by diabetes and another 2.2 million deaths were attributed to high blood glucose in 2012 [76], with half of those deaths attributable to high blood glucose occurring before 70 years of age [76]. The World Health Organization projects that diabetes will be the 7th leading cause of death by 2030 [77], a staggering thought considering the relative stranglehold that cancer and heart disease have on mortality.

A great deal of evidence has been collected that supports physical activity, among other therapies, may be useful in preventing or delaying the onset of type 2 diabetes (T2D). There are now three published trials documenting that, with lifestyle modification (weight loss and regular moderate physical activity), diabetes can be delayed or prevented [78–81]. Additionally, other research has proven that long-term interventions, using both diet and exercise, leads to substantial metabolic improvement that may contribute to prevent or postpone manifest diabetes [82]. In the case of T2D, exercise is truly medicine. Increasing physical activity can reduce the incidence of T2D by almost 60% in people at risk [83].

3.4. Exercise and obesity

While increased caloric intake is often blamed for rising rates of obesity, no association between these two variables was found in a recent study, which looked at data from the National Health and Nutrition Examination Survey (NHANES) from 1988 to 2010. More importantly, and in the interest of this particular chapter, an association was found between the trends over time for lack of physical activity and high BMI numbers [84]. Society is less active than we once were, especially at work, where we expend roughly 100–150 calories/day less than what we used to in the 1960s. Researchers from this study noted that such a dramatic reduction in daily calorie burn from our jobs alone, extrapolated over the course of a year, could explain the steady rise in weight gain [3]. This weight gain is not limited to adults alone. A recent study found that roughly a third of obese preschool children were obese as adults, and about half of obese school-age children were obese as adults. Across all conditions, the risk of adult obesity was at least twice as high for obese children as for non-obese children. The risk of adult obesity was greater for children who were at higher levels of obesity and for children who were obese at older ages [85]. Children or adults alike, when individuals increase physical activity, there is a positive relationship with reductions in total adiposity [86]. It has also been shown that physical activity is associated with reduction in abdominal and visceral fat, both of which can contribute to other diseases within the body, particularly the cardiovascular system [87, 88]. More specifically, the more exercise and activity one gets, the less fat an individual has. We need to be physically active to burn more calories and, in turn, see reductions in body composition.

3.5. Exercise and cancer prevention

Cancer and exercise have a tricky relationship. Often, those diagnosed and undergoing treatment for cancer do not have the energy for physical activity, yet it can be beneficial for one's overall health and well-being, especially in the throes of such a debilitating disease. Women undergoing chemotherapy or radiation therapy for breast cancer that maintained a regular exercise routine (at least 90 min in duration per week for 3 or more days) felt less fatigued and emotionally distressed, and had higher functional ability and quality of life when compared to their less active counterparts [9]. A recent meta-analysis found an inverse association between physical activity and colon cancer. Individuals can likely reduce their risk of colon cancer with the addition of physical activity [89]. Breast cancer seems to be just as responsive, as there is reasonably clear evidence that physically active women have about nearly a third of the risk when compared to inactive women. Even more, just 30–60 min of moderate to vigorous activity per week has been shown to reduce the risk of breast cancer [89]. Like the previously mentioned mortality rates, it does not take much to reduce the likelihood of such a terrible disease like cancer. In addition to risk reduction, there is also the benefit of exercise and cancer survivorship. Participants with higher levels of physical activity following a cancer diagnosis were less likely to have a cancer recurrence and had increased survival [90]. Over 20 studies have examined the impact of physical activity on the risk of lung cancer. Overall, this wealth of data suggests an inverse association between physical activity and lung cancer risk. In fact, the most physically active individuals experienced about a 20% reduction in risk. A theme is recurring—exercise is medicine [91].

3.6. Exercise and hypertension

Exercise is advocated for the prevention, treatment, and control of high blood pressure or hypertension (HTN) [92]. When left uncontrolled, high blood pressure can lead to stroke by damaging and weakening blood vessels in the brain, causing them to narrow, rupture, or leak. High blood pressure can also cause blood clots to form in the arteries leading to the brain, blocking blood flow, and potentially causing a stroke. It can also cause arterial and kidney complications, in addition to the eyes, bones, and sleep [93]. Exercise intervention studies have shown that regular aerobic exercise significantly lowers blood pressure in hypertensive individuals. Regular physical activity—somewhere in the ballpark of 30 min on most days of the week—can lower the blood pressure by 4–9 mm of mercury [94]. As exercise intensity moves from moderate to vigorous, it may be even more effective in lowering blood pressure. Since exercise-induced reductions in resting blood pressure and prevention of abnormal increases in blood pressure during physical exertion can lead to fewer cardiovascular events, it makes sense that the same benefits for exercise and CVD are correlated to HTN. Most importantly, they can allow folks with HTN to come off medications, see fewer medication-related side-effects, and, as has been repeated, improve quality of life [95]. High blood pressure is not a terminal diagnosis, but it can lead to further complications that can be quite deleterious if left uncontrolled. It is important to begin stressing exercise as a modifier in order to eliminate the stress that HTN places on the cardiovascular system.

3.7. Exercise and osteoporosis

Often thought of as a disease that only impacts older women, osteoporosis is characterized by low bone mineral density (BMD), coupled with deterioration of bone tissue. These two factors contribute to an increase in bone fragility, leaving those afflicted with this systemic skeletal disease more susceptible to fracture. While fractures might not seem like a big deal, as we age, it becomes more and more important to avoid them at all costs. Nationally, an estimated 13–18% of women and 1–4% of men age 50 and older have osteoporosis; an additional 37–50% of women and 28–47% of men age 50 and older have low bone mass [96]. A recent meta-analysis revealed that women sustaining a hip fracture were five times as likely and men nearly eight times as likely to die within the first 3 months as compared with age- and sex-matched controls [97]. Given the fragility of the skeletal system for those with osteoporosis, it is important to know how to prevent fractures and preserve bone strength.

Osteoporosis is a silent disease that does not cause pain or outward signs of an underlying cause or condition. It has become the most common bone disease worldwide, thus making it a major health problem. One of the contributing factors to maintaining bone health is regular weight-bearing exercise throughout the life span. Moderate exercise protects against osteoporosis, but too little or extremely prolonged bouts of exercise may cause osteoporosis [98]. Unfortunately, as we age, we progressively become sedentary [99]. This is largely attributed to a lack of energy, muscle mass, adequate caloric intake, and fear of injuring oneself and becoming less independent. Disuse and inactivity can cause bone loss, whereas weight-bearing exercises may maintain or improve bone mineral density. There is a significant correlation between muscle strength and bone mineral density, as well as enough evidence to support strengthening exercises leading to an increase in BMD. A well-rounded exercise program, incorporating cardiovascular and resistance training, as well as balance exercises, may prove to be effective for retarding age-related bone loss [100]. At the very least, with more weight-bearing movement (e.g., jogging, running, hopping, or skipping), the likelihood of physical inactivity-related damage to the skeletal system is reduced.

3.8. Exercise and lipid disorders

Physical activity, which involves working major muscle groups like the quadriceps and hamstrings, is vital when controlling lipid metabolism and preventing lipid disorders. Increased physical activity induces a number of positive changes in the metabolism of lipoproteins—serum triglycerides are lowered and the high density lipoprotein (HDL) production is increased [101]. Intervention programs that revolve around daily physical activity can have a positive effect on the concentrations of plasma lipids and lipoproteins, thus reducing the risk of coronary artery disease (CAD) [102]. Specifically, programs that expend roughly 1200–2200 kilocalories of energy per week (kcal/week), the equivalent of 15–20 miles/week of brisk walking or jogging, is associated with significant triglyceride reduction and HDL increases. It can be posited that, for most individuals, the benefits of regular physical activity are present at low training volumes, so long as total caloric expenditure is between 1200 and 2200 and accrue kcals/week. Weekly caloric expenditures through purposeful exercise that meet or exceed the higher end of this range are more likely to produce the desired lipid changes. As far as lipid control is concerned, it is clear that more exercise is better. So much is already known about the benefits of exercise and the concomitant lipid and lipoprotein modifications, as well as the physiological mechanisms for such changes. Exercise professionals and those working in preventative medicine can strive to develop more comprehensive exercise programming to optimize specific caloric expenditure to take advantage of such personalized data and knowledge [103].

3.9. Exercise and depression

Depression is a mood disorder that causes a persistent feeling of sadness and loss of interest. It can affect how you feel, think, and behave and can lead to a variety of emotional and physical problems, including issues with activities of daily living, or even feeling as if life is not worth living [104]. Fortunately, exercise has been shown to benefit those who suffer from depression. A study that looked at individuals with major depression found that those who participated in 4 months of aerobic exercise saw a significant reduction in their depression symptoms. Even more powerful was that if they kept exercising, there was a significant therapeutic benefit over time, with regards to a relapse in symptoms [105]. In short, if they kept up with an exercise program, the antidepressant benefits continued. A review of the literature suggests that exercise is more effective in treating depression than no treatment, and is as effective as psychotherapy and antidepressant medication [106, 107]. Unfortunately, the majority of studies has significant methodological shortcomings. These conclusions are consistent with three recent meta-analyses [108]. In the most recent meta-analysis, Lawlor and Hopker [108] found that exercise was associated with a greater reduction in depressive symptoms when compared with no treatment, and was as effective as cognitive therapy. However, because of the poor quality of evidence reviewed, the effectiveness of exercise in reducing symptoms of depression could not be determined. Therefore, exercise professionals and preventative medicine specialists should proceed with caution when looking for alternative means to help patients afflicted with a depression diagnosis.

3.10. Exercise and anxiety

Anxiety is a somewhat ubiquitous term. The most common form of anxiety, general anxiety disorder (GAD), has a wide range of symptoms that frequently vary. They include, but are not limited to persistent worrying or obsession, inability to set aside or let go, inability to relax, difficulty concentrating, worrying, and distress about decision making [109]. The relationship between exercise and anxiety has been extensively examined over the last 15 years [110], and the results are somewhat similar to its common counterpart, depression, reviewed above. According to the Anxiety and Depression Association of America, it is not uncommon for someone with an anxiety disorder to also suffer from depression or vice versa. Nearly one-half of those diagnosed with depression are also diagnosed with an anxiety disorder [111]. Individuals taking part in exercising conditions significantly reduced anxiety, and additional analyses indicated that subjects experienced an acute increase in anxiety during exercise that subsided upon completion of the exercise bout [112]. More specifically, men who ran on a treadmill at 75% of their VO_{2max} for 30 min saw significant reductions in anxiety following exercise at 10-min intervals up to 30 min [113]. In a different study, subjects exercised at a lesser intensity (70% of VO_{2max}) saw a similar reduction in anxiety, when compared to meditation and quiet rest [114]. Other research has found that aerobic exercise of at least 21 min seems necessary to achieve reductions in anxiety, thus offering therapeutic benefits for reducing anxiety without the dangers or costs of drug therapy or psychotherapy [110]. Perhaps it might be time to pursue nonpharmacological options when treating patients with GAD. The data seems to strongly support such a notion.

3.11. Disease mitigation and prevention conclusion

With all the evidence so strongly supporting physical activity as a way to modify certain lifestyle and health issues, it seems as though more practitioners would prescribe exercise and employ the help of trained exercise science professionals. Unfortunately, health care does not cover the vast majority of services that can be performed by health and wellness specialists, who have an extensive background in disease prevention through exercise, as well as exercise prescription and modification for special populations. Nevertheless, books such as this will serve as the vanguard for providers looking to add more than just a new prescription to their patient's medicine cabinet. It is much easier to engage in physical activity, in the form of walking, cycling, or resistance training exercises when you know the cumulative benefits and how they can alter the potential risks of a sedentary lifestyle. It is not a short-term fix—it is a lifestyle change that has been shown to benefit individuals in need of a change to their quality of life.

4. Tracking and disease prevention/mitigation

As simple as it seems, many of the diseases and conditions mentioned in the previous section have been shown to either resolve or reduce in severity when those afflicted undergo an exercise program with regular physical activity. The research documenting the health benefits of exercise is convincing, but finding ways to encourage sedentary patients to become more active remains a challenge [115]. One concept that is relatively new is keeping track of total exercise minutes from week to week, in an attempt to accumulate the recommended minutes of exercise to see the specific benefits related to the disease(s). Unfortunately, human beings are not as good as remembering exercise times, or many other things, as we might think. Thus, the importance of tracking health data and information is at a premium in our multitasking society. According to Pew Research [116], 70% of the US adults track at least one health metric daily, but the array of how they track varied. 43% were "head trackers," meaning they kept track in their heads—essentially memorizing what they did; 41% used more traditional methods of writing it down on paper; and 23% used technology to track health data and statistics [116]. Given the prevalence of commercially available activity tracking devices, like Fitbit, we can overcome our forgetful nature as human beings and rely on technology to count our steps and activity. No matter what method individuals used to keep track of their data, 40% stated that tracking has changed their health approach [116]. We all keep lists, whether they are for groceries, errands, or job-related tasks that need to be accomplished by the end of the day, week, or even month. It is important to think of exercise as another important item or task to put on the "to do" list.

Walking is one of the most common forms of physical activity, one that can be done by the vast majority of our society, barring any major physical limitations. Daily walking has previously been linked to important cardiovascular risk variables [117], which were also strongly associated with increased body fat percentage. As mentioned above, individuals can track their daily walking with something as simple as a pedometer. The first electronic pedometer, called "manpo-kei," meaning "10,000 steps meter," was developed by the Japanese" [118]. The well-known walking goal of 10,000 steps per day has been shown to be a reasonable goal of daily activity for healthy adults, and studies have documented the health benefits of attaining similar levels [119, 120]. Those who meet the daily 10,000-step recommendation are more likely to meet physical activity guidelines from the CDC, the ACSM, and the US Surgeon General [121–123]. A recent study found that individuals who accumulate more than 9000 steps per day were more frequently classified as normal weight for height, whereas those accumulating less than 5000 steps per day were more frequently classified as obese [124]. For those who need physical activity the most, the most effective way to eliminate a sedentary lifestyle has been to incorporate pedometers into their activities of daily living [125, 126].

The benefits of using a pedometer revolve around an increase in physical activity. When looking at specific diseases, especially those mentioned in previous sections, there is evidence that they benefit from pedometer use. A meta-analysis of studies that used pedometers to monitor physical activity for weight loss found that using a device increased daily step counts by 2000–4000 steps per day, in addition to weight loss of about 1 lb every 10 weeks [127]. While that might seem modest, over the course of a year, with continued behaviors, it amounts to 5 lbs per year, effectively offsetting the amount of weight gained yearly at now-sedentary careers [3]. Individuals who are looking to lose weight would benefit from incorporating pedometers and activity tracking devices in order to accomplish a goal in a realistic and efficacious manner. Activity tracking has also been useful in people with T2D, as they became more aware of their exercise habits and, as a result, increased their daily activity and exercise capacity [128]. The more exercise minutes a person with T2D accumulates on a regular basis, the more likely they are to eliminate a disease that is often a byproduct of sedentary behavior and obesity. Cancer patients have also found benefit in a pedometer-based walking program, noting a decrease in cancer-related fatigue, improved physical function, and enhanced well-being [129]. Even in the throes of chemotherapy, people with advanced cancer diagnoses felt better performing a little bit more activity than usual for 8 weeks. Results of a study looking at CVD variables and increased activity (tracked by a pedometer) found that there was an increase in steps per day (1500), as well as changes in CVD variables, including HDL, TC, insulin, and a reduction in SBP [130]. The long-term implications of uncontrolled CVD are numerous, and include some very staggering and deleterious results. Given the rather simplistic nature of the necessary exercise to improve CVD values, it makes sense to "prescribe" a way to track activity in order to modify certain risk factors. At this point, it would seem feasible to assume that pedometers can be a useful intervention and motivational device in people with osteoporosis, as sedentary behavior and a lack of weight-bearing activity contribute to the disease. In fact, much has been written about remaining active throughout the lifespan in order to prevent skeletal demineralization from occurring by placing regular stress on one's bones and joints [131]. Therefore, interested parties could extrapolate the results of activity tracking to this population, as well as any other disease or condition that benefits from physical activity that was not specifically focused on to this point. This is not to say there are more or less important afflictions; rather, the ten that were highlighted comprised a large body of research when looking at physical activity and positive outcomes when there was an increase in exercise and/or caloric expenditure. Exercise, in general, promotes a greater sense of physical well-being [132], a by-product even the healthiest person can benefit from.

5. Conclusion

Much of our population lives a sedentary lifestyle. The byproducts of increasing levels of inactivity are quite morose, including fragile bones, poor heart health, and increased body weight. Fortunately, one way to off-set a sedentary lifestyle is to increase daily physical activity. Modest amounts of walking or other forms of cardiovascular exercise (cycling, swimming, hiking) can play a major role in preventing or reversing certain conditions like hypertension, obesity, mortality risk, and T2D. Research has shown that similar conditions can benefit from tracking activity, using pedometers and other commercially available devices that motivate and encourage people to move more and increase their daily levels of activity. Therefore, health-care providers who have the power to recommend such devices and exercise programs should feel empowered to do so. Health and wellness professionals should feel the same sense of empowerment when working with patients and clients who are looking to improve body composition and reduce chronic diseases with increased activity outside of the traditional gym-based workout.

Acknowledgements

The authors would like to thank the Mayo Clinic Healthy Living program for allowing them to diligently work on such an important contribution to academia. Without their support and guidance, they would not be able to put such a thoughtful chapter together. They hope that many will benefit from this information and encourage more people to move.

http://dx.doi.org/10.5772/65240

Author details

Daniel V. Gaz*, Thomas M. Rieck and Nolan W. Peterson

*Address all correspondence to: gaz.daniel@mayo.edu

Mayo Clinic, Rochester, MN, United States

References

[1] Eaton, S.B., An evolutionary perspective on human physical activity: implications for health. Comparative Biochemistry and Physiology. Part A, Molecular & Integrative Physiology, 2003. 136(1): p. 153–9.

[2] Brownson, R.C., T.K. Boehmer, and D.A. Luke, Declining rates of physical activity in the United States: what are the contributors? Annual Review of Public Health, 2005. 26: p. 421–43.

[3] Church, T.S., et al., Trends over 5 decades in U.S. occupation-related physical activity and their associations with obesity. PLoS One, 2011. 6(5): p. e19657.

[4] Matthews, C.E., et al., Amount of time spent in sedentary behaviors in the United States, 2003–2004. American Journal of Epidemiol, 2008. 167(7): p. 875–81.

[5] Exercise: 7 Benefits of Regular Physical Activity. Mayo Clinic, 05 Feb. 2014. Web. 26 Aug. 2016.

[6] Jeffery, R.W., et al., Physical activity and weight loss: does prescribing higher physical activity goals improve outcome? American Journal of Clinical Nutrition, 2003. 78(4): p. 684–9.

[7] Kruk, J., Physical activity in the prevention of the most frequent chronic diseases: an analysis of the recent evidence. Asian Pacific Journal of Cancer Prevention, 2007. 8(3): p. 325–38.

[8] Fox, K.R., The influence of physical activity on mental well-being. Public Health Nutrition, 1999. 2(3A): p. 411–8.

[9] Mock, V., et al., Fatigue and quality of life outcomes of exercise during cancer treatment. Cancer Practice, 2001. 9(3): p. 119–27.

[10] King, A.C., et al., Moderate-intensity exercise and self-rated quality of sleep in older adults. A randomized controlled trial. JAMA, 1997. 277(1): p. 32–7.

[11] Haskell, W.L., et al., Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation, 2007. 116(9): p. 1081–93.

[12] Garber, C.E., et al., 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 and Science in Sports and Exercise, 2011. 43(7): p. 1334–59.

[13] One in five adults meet overall physical activity guidelines, in CDC Newsroom. 2013, Centers for Disease Control and Prevention, Atlanta, GA.

[14] Lee, D.C., et al., Mortality trends in the general population: the importance of cardiorespiratory fitness. Journal of Psychopharmacology, 2010. 24(4 Suppl): p. 27–35.

[15] Lee, I.M., et al., Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet, 2012. 380(9838): p. 219–29.

[16] Durstine, J.L., et al., Chronic disease and the link to physical activity. Journal of Sport and Health Science, 2013. 2(1): p. 3–11.

[17] Sattelmair, J., et al., Dose response between physical activity and risk of coronary heart disease: a meta-analysis. Circulation, 2011. 124(7): p. 789–95.

[18] Sesso, H.D., et al., Physical activity and cardiovascular disease risk in middle-aged and older women. American Journal of Epidemiol, 1999. 150(4): p. 408–16.

[19] Sesso, H.D., R.S. Paffenbarger, Jr., and I.M. Lee, Physical activity and coronary heart disease in men: the Harvard Alumni Health Study. Circulation, 2000. 102(9): p. 975–80.

[20] Rosen, P. "Can You Be Fat But Fit?" Fitness Magazine 1 June 2013: n. pag. Web. 26 Aug. 2016.

[21] MacManus, R. Trackers: How Technology Is Helping Us Monitor & Improve Our Health. Auckland: Bateman, 2014. 55. Print.

[22] Lamkin, P. Fitness tracker market to top $5bn by 2019. Wareable, 2015.

[23] Chiauzzi, E., C. Rodarte, and P. DasMahapatra, Patient-centered activity monitoring in the self-management of chronic health conditions. BMC Medicine, 2015. 13: p. 77.

[24] Bravata, D.M., et al., Using pedometers to increase physical activity and improve health: a systematic review. JAMA, 2007. 298(19): p. 2296–2304.

[25] Pourzanjani, A., T. Quisel, and L. Foschini, Adherent use of digital health trackers is associated with weight loss. PLoS One, 2016. 11(4): p. e0152504.

[26] Cox, J.L., The challenge with tracking health outcomes. Canadian Journal of Clinical Pharmacology, 2001. 8 (Suppl A): p. 10A–16A.

[27] Dobkin, B.H. and A. Dorsch, The promise of mHealth: daily activity monitoring and outcome assessments by wearable sensors. Neurorehabilitation & Neural Repair, 2011. 25(9): p. 788–98.

[28] Hoy, M.B., Personal activity trackers and the quantified self. Medical Reference Services Quarterly, 2016. 35(1): p. 94–100.

[29] Shaw, J.H. and M.R. Rogers, The status of required physical education in colleges and universities of the United States. Research Quarterly, 1946. 17: p. 2–9.

[30] Saunders, R.J., et al., Physical fitness of high school students and participation in physical education classes. Research Quarterly, 1969. 40(3): p. 552–60.

[31] Sallis, J.F., et al., Physical education's role in public health: steps forward and backward over 20 years and HOPE for the future. Research Quarterly for Exercise and Sport, 2012. 83(2): p. 125–35.

[32] Sallis, J.F. and T.L. McKenzie, Physical education's role in public health. Research Quarterly for Exercise and Sport, 1991. 62(2): p. 124–37.

[33] Robb, B. "Exercise and Physical Activity: What's the Difference?" Everyday Health.com. Everyday Health, n.d. Web. 26 Aug. 2016.

[34] "Physical Activity Basics." Centers for Disease Control and Prevention. Centers for Disease Control and Prevention, 04 June 2015. Web. 26 Aug. 2016.

[35] American College of Sports Medicine position stand . The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness in healthy adults. Medicine and Science in Sports and Exercise, 1990. 22(2): p. 265–74.

[36] The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness in healthy adults. Position stand of the American College of Sports Medicine . Schweizerische Zeitschrift fur Sportmedizin, 1993. 41(3): p. 127–37.

[37] American College of Sports Medicine Position Stand and American Heart Association . Recommendations for cardiovascular screening, staffing, and emergency policies at health/fitness facilities. Medicine and Science in Sports and Exercise, 1998. 30(6): p. 1009–18.

[38] American College of Sports Medicine Position Stand . The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Medicine and Science in Sports and Exercise, 1998. 30(6): p. 975–91.

[39] Garber, C.E., et al., 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 and Science in Sports and Exercise, 2011. 43(7): p. 1334–59.

[40] Blair, S.N., et al., Changes in physical fitness and all-cause mortality. A prospective study of healthy and unhealthy men. JAMA, 1995. 273(14): p. 1093–8.

[41] Lee, D.C., et al., Comparisons of leisure-time physical activity and cardiorespiratory fitness as predictors of all-cause mortality in men and women. British Journal of Sports Medicine, 2011. 45(6): p. 504–10.

[42] Sui, X., M.J. LaMonte, and S.N. Blair, Cardiorespiratory fitness as a predictor of nonfatal cardiovascular events in asymptomatic women and men. American Journal of Epidemiology, 2007. 165(12): p. 1413–23.

[43] Sui, X., et al., Cardiorespiratory fitness and adiposity as mortality predictors in older adults. JAMA, 2007. 298(21): p. 2507–16.

[44] Physical Activity Guidelines Advisory Committee report, 2008. To the Secretary of Health and Human Services. Part A: executive summary. Nutrition Reviews, 2009. 67(2): p. 114–20.

[45] Epstein, L.H., K.J. Coleman, and M.D. Myers, Exercise in treating obesity in children and adolescents. Medicine and Science in Sports and Exercise, 1996. 28(4): p. 428–35.

[46] Faigenbaum, A.D., et al., Effects of different resistance training protocols on upper-body strength and endurance development in children. Journal of Strength and Conditioning Research/National Strength & Conditioning Association, 2001. 15(4): p. 459–65.

[47] Vicente-Rodriguez, G., How does exercise affect bone development during growth? Sports Medicine, 2006. 36(7): p. 561–9.

[48] Type 2 diabetes in children and adolescents. American Diabetes Association . Pediatrics, 2000. 105(3 Pt 1): p. 671–80.

[49] Strauss, R.S., et al., Psychosocial correlates of physical activity in healthy children. Archives of Pediatrics & Adolescent Medicine, 2001. 155(8): p. 897–902.

[50] Galland, B.C. and E.A. Mitchell, Helping children sleep. Archives of Disease in Childhood, 2010. 95(10): p. 850–3.

[51] Biddle, S. and N. Armstrong, Children's physical activity: an exploratory study of psychological correlates. Social Science & Medicine, 1992. 34(3): p. 325–31.

[52] "How Much Physical Activity Do Children Need?" Centers for Disease Control and Prevention. Centers for Disease Control and Prevention, 04 June 2015. Web. 26 Aug. 2016.

[53] Physical activity and young people. Global Strategy on Diet, Physical Activity and Health, 2011.

[54] Lees, F.D., et al., Barriers to exercise behavior among older adults: a focus-group study. Journal of Aging and Physical Activity, 2005. 13(1): p. 23–33.

[55] Schutzer, K.A. and B.S. Graves, Barriers and motivations to exercise in older adults. Preventive Medicine, 2004. 39(5): p. 1056–61.

[56] Nelson, M.E., et al., Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. Circulation, 2007. 116(9): p. 1094–105.

[57] Shumway-Cook, A., et al., The effect of multidimensional exercises on balance, mobility, and fall risk in community-dwelling older adults. Physical Therapy, 1997. 77(1): p. 46–57.

[58] Falls and Older Age. [cited 2016 July 20]; Available from: http://nihseniorhealth.gov/falls/aboutfalls/01.html.

[59] Guideline for the prevention of falls in older persons. American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention . Journal of the American Geriatrics Society, 2001. 49(5): p. 664–72.

[60] Kesaniemi, Y.K., et al., Dose-response issues concerning physical activity and health: an evidence-based symposium. Medicine and Science in Sports and Exercise, 2001. 33(6 Suppl): p. S351–8.

[61] Keysor, J.J., Does late-life physical activity or exercise prevent or minimize disablement? A critical review of the scientific evidence. American Journal of Preventive Medicine, 2003. 25(3): p. 129–136.

[62] Pahor, M., et al., Effects of a physical activity intervention on measures of physical performance: results of the lifestyle interventions and independence for Elders Pilot (LIFE-P) study. The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 2006. 61(11): p. 1157–65.

[63] Nelson, M.E., et al., The effects of multidimensional home-based exercise on functional performance in elderly people. The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 2004. 59(2): p. 154–60.

[64] Oja, P., Dose response between total volume of physical activity and health and fitness. Medicine and Science in Sports and Exercise, 2001. 33(6 Suppl): p. S428–37; discussion S452–3.

[65] Shephard, R.J., Absolute versus relative intensity of physical activity in a dose-response context. Medicine and Science in Sports and Exercise, 2001. 33(6 Suppl): p. S400–18; discussion S419–20.

[66] Warburton, D.E., C.W. Nicol, and S.S. Bredin, Health benefits of physical activity: the evidence. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne, 2006. 174(6): p. 801–9.

[67] Prakash, R. “Physical Inactivity a Leading Cause of Disease and Disability, Warns WHO.” WHO. World Health Organization, 04 Apr. 2002. Web. 26 Aug. 2016.

[68] “What Is Metabolic Syndrome?” Health Information for the Public. National Institutes of Health, 26 June 2016. Web. 26 Aug. 2016.

[69] Arem, H., et al., Leisure time physical activity and mortality: a detailed pooled analysis of the dose-response relationship. JAMA Internal Medicine, 2015. 175(6): p. 959–67.

[70] Outdoor Recreation Participation Topline Report, 2016, Outdoor Foundation. p. 10.

[71] Schnohr, P., et al., Dose of jogging and long-term mortality: the Copenhagen City Heart Study. Journal of the American College of Cardiology, 2015. 65(5): p. 411–9.

[72] Mozaffarian, D., et al., Heart disease and stroke statistics-2016 update: a report from the American Heart Association. Circulation, 2016. 133(4): p. e38–60.

[73] Miller, SG. "How Much Do Chronic Diseases Cost in the US?" Live Science. TechMedia Network, 03 Sept. 2015. Web. 26 Aug. 2016.

[74] Buttar, H.S., T. Li, and N. Ravi, Prevention of cardiovascular diseases: role of exercise, dietary interventions, obesity and smoking cessation. Experimental and Clinical Cardiology, 2005. 10(4): p. 229–49.

[75] Thompson, P.D., et al., Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease: a statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Rehabilitation, and Prevention) and the Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity). Circulation, 2003. 107(24): p. 3109–16.

[76] Global Report on Diabetes, 2016, World Health Organizatoin: Geneva.

[77] Mathers, C.D. and D. Loncar, Projections of global mortality and burden of disease from 2002 to 2030. PLoS Medicine, 2006. 3(11): p. e442.

[78] Zinman, B., et al., Physical activity/exercise and diabetes mellitus. Diabetes Care, 2003. 26 Suppl 1: p. S73–7.

[79] Tuomilehto, J., et al., Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. New England Journal of Medicine, 2001. 344(18): p. 1343–1350.

[80] Pan, X.R., et al., Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance. The Da Qing IGT and Diabetes Study. Diabetes Care, 1997. 20(4): p. 537–44.

[81] Group, D.P.P.R., Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. The New England Journal of Medicine, 2002. 2002(346): p. 393–403.

[82] Eriksson, K.F. and F. Lindgarde, Prevention of type 2 (non-insulin-dependent) diabetes mellitus by diet and physical exercise. The 6-year Malmo feasibility study. Diabetologia, 1991. 34(12): p. 891–8.

[83] Knowler, W.C., et al., Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. The New England Journal of Medicine, 2002. 346(6): p. 393–403.

[84] Ladabaum, U., et al., Obesity, abdominal obesity, physical activity, and caloric intake in US adults: 1988 to 2010. The American Journal of Medicine, 2014. 127(8): p. 717–727 e12.

[85] Serdula, M.K., et al., Do obese children become obese adults? A review of the literature. Preventive Medicine, 1993. 22(2): p. 167–177.

[86] Ross, R. and I. Janssen, Physical activity, total and regional obesity: dose-response considerations. Medicine and Science in Sports and Exercise, 2001. 33(6 Suppl): p. S521–7; discussion S528–9.

[87] Mahabadi, A.A., et al., Association of pericardial fat, intrathoracic fat, and visceral abdominal fat with cardiovascular disease burden: the Framingham Heart Study. European Heart Journal, 2009. 30(7): p. 850–6.

[88] Sahakyan, K.R., et al., Normal-weight central obesity: implications for total and cardiovascular mortality. Annals of Internal Medicine, 2015. 163(11): p. 827–35.

[89] Lee, I.M., Physical activity and cancer prevention—data from epidemiologic studies. Medicine and Science in Sports and Exercise, 2003. 35(11): p. 1823–7.

[90] Meyerhardt, J.A., et al., Physical activity and survival after colorectal cancer diagnosis. Journal of Clinical Oncology: Official Journal of the American Society of Clinical Oncology, 2006. 24(22): p. 3527–34.

[91] Sallis, R.E., Exercise is medicine and physicians need to prescribe it! British Journal of Sports Medicine, 2009. 43(1): p. 3–4.

[92] Baster, T. and C. Baster-Brooks, Exercise and hypertension. Australian Family Physician, 2005. 34(6): p. 419–24.

[93] "High Blood Pressure Dangers: Hypertension's Effects on Your Body." Diseases and Conditions. Mayo Clinic, 18 Feb. 2014. Web. 26 Aug. 2016.

[94] 10 ways to control high blood pressure without medication. Patient Care & Health Info, 2015.

[95] Kokkinos, P.F. and V. Papademetriou, Exercise and hypertension. Coronary Artery Disease, 2000. 11(2): p. 99–102.

[96] Ray, N.F., et al., Medical expenditures for the treatment of osteoporotic fractures in the United States in 1995: report from the National Osteoporosis Foundation. Journal of Bone and Mineral Research: The Official Journal of the American Society for Bone and Mineral Research, 1997. 12(1): p. 24–35.

[97] Phy, M.P., et al., Effects of a hospitalist model on elderly patients with hip fracture. Archives of Internal Medicine, 2005. 165(7): p. 796–801.

[98] O'Brien, M., Exercise and osteoporosis. Irish Journal of Medical Science, 2001. 170(1): p. 58–62.

[99] Charansonney, O.L., Physical activity and aging: a life-long story. Discovery Medicine, 2011. 12(64): p. 177–85.

[100] Sinaki, M., Exercise and osteoporosis. Archives of Physical Medicine and Rehabilitation, 1989. 70(3): p. 220–9.

[101] Berg, A., et al., Physical activity and lipoprotein lipid disorders. Sports Medicine, 1994. 17(1): p. 6–21.

[102] Durstine, J.L. and P.D. Thompson, Exercise in the treatment of lipid disorders. Cardiology Clinics, 2001. 19(3): p. 471–88.

[103] Durstine, J.L., et al., Lipids, lipoproteins, and exercise. Journal of Cardiopulmonary Rehabilitation, 2002. 22(6): p. 385–98.

[104] Depression (major depressive disorder). Patient Care & Health Info, 2016.

[105] Nabkasorn, C., et al., Effects of physical exercise on depression, neuroendocrine stress hormones and physiological fitness in adolescent females with depressive symptoms. European Journal of Public Health, 2006. 16(2): p. 179–84.

[106] Brosse, A.L., et al., Exercise and the treatment of clinical depression in adults: recent findings and future directions. Sports Medicine, 2002. 32(12): p. 741–60.

[107] North, T.C., P. McCullagh, and Z.V. Tran, Effect of exercise on depression. Exercise and Sport Sciences Reviews, 1990. 18: p. 379–415.

[108] Lawlor, D.A. and S.W. Hopker, The effectiveness of exercise as an intervention in the management of depression: systematic review and meta-regression analysis of randomised controlled trials. BMJ, 2001. 322(7289): p. 763.

[109] Generalized anxiety disorder. Patient Care & Health Info: Diseases and Conditions, 2014.

[110] Petruzzello, S.J., et al., A meta-analysis on the anxiety-reducing effects of acute and chronic exercise. Sports Medicine, 1991. 11(3): p. 143–182.

[111] Facts & Statistics: Did You Know. About ADAA 2014 September 2014 [cited 2016 July 19, 2016]; Available from: http://www.adaa.org/about-adaa/press-room/facts-statistics.

[112] McAuley, E., S.L. Mihalko, and S.M. Bane, Acute exercise and anxiety reduction: does the environment matter? Journal of Sport and Exercise Psychology, 1996. 18: p. 408–419.

[113] Petruzzello, S.J., and D.M. Landers. "State Anxiety Reduction and Exercise." Medicine and Science in Sports and Exercise 26.8 (1994): 1028–035.

[114] Bahrke, M.S. and W.P. Morgan, Anxiety reduction following exercise and meditation. Cognitive Therapy and Research, 1978. 2(4): p. 323–333.

[115] Thompson, D.L., et al., Pedometer-measured walking and risk factors for disease. Southern Medical Journal, 2006. 99(1): p. 100–1.

[116] Fox, S., Health topics. Pew Research Center's Internet & American Life Project, 2011, Retirado de http://www. pewinternet.org/2011/02/01/health-topics-2.

[117] Oja, P., I. Vuori, and O. Paronen, Daily walking and cycling to work: their utility as health-enhancing physical activity. Patient Education and Counseling, 1998. 33: p. S87–S94.

[118] Hatano, Y., Use of the pedometer for promoting daily walking exercise. International Council for Health, Physical Education, and Recreation, 1993. 29(4): p. 4–8.

[119] Tudor-Locke, C., et al., Controlled outcome evaluation of the First Step Program: a daily physical activity intervention for individuals with type II diabetes. International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity, 2004. 28(1): p. 113–9.

[120] Tudor-Locke, C., et al., Revisiting ``how many steps are enough?''. Medicine and Science in Sports and Exercise, 2008. 40(7): p. S537.

[121] Le Masurier, G.C., C.L. Sidman, and C.B. Corbin, Accumulating 10,000 steps: does this meet current physical activity guidelines? Research Quarterly for Exercise and Sport, 2003. 74(4): p. 389–94.

[122] Pate, R.R., et al., Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA, 1995. 273(5): p. 402–7.

[123] Shalala, D.E. "Physical Activity and Health: A Report of the Surgeon General." Centers for Disease Control and Prevention. Centers for Disease Control and Prevention, 17 Nov. 1999. Web. 26 Aug. 2016.

[124] Tudor-Locke, C., et al., The relationship between pedometer-determined ambulatory activity and body composition variables. International Journal of Obesity & Related Metabolic Disorders, 2001. 25(11): 1571–1578.

[125] Hultquist, C.N., C. Albright, and D.L. Thompson, Comparison of walking recommendations in previously inactive women. Medicine and Science in Sports and Exercise, 2005. 37(4): p. 676–83.

[126] Stovitz, S.D., et al., Pedometers and brief physician counseling: increasing physical activity for patients seen at a family practice clinic. Medicine & Science in Sports & Exercise, 2004. 36(5): p. S241.

[127] Richardson, C.R., et al., A meta-analysis of pedometer-based walking interventions and weight loss. Annals of Family Medicine, 2008. 6(1): p. 69–77.

[128] Korkiakangas, E. et al. "Pedometer Use Among Adults at High Risk of Type 2 Diabetes, Finland, 2007–2008." Preventing Chronic Disease 7.2 (2010): A37. Print.

[129] Mayo, N.E., et al., Pedometer-facilitated walking intervention shows promising effectiveness for reducing cancer fatigue: a pilot randomized trial. Clinical rehabilitation, 2014. 28(12): p. 1198–209.

[130] Miyazaki, R., et al., Effects of a year-long pedometer-based walking program on cardiovascular disease risk factors in active older people. Asia-Pacific Journal of public health/Asia-Pacific Academic Consortium for Public Health, 2015. 27(2): p. 155–63.

[131] Drinkwater, B.L., Exercise in the prevention of osteoporosis. Osteoporosis International : A Journal Established as Result of Cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA, 1993. 3 Suppl 1: p. 169–71.

[132] Hassmen, P., N. Koivula, and A. Uutela, Physical exercise and psychological well-being: a population study in Finland. Preventive Medicine, 2000. 30(1): p. 17–25.