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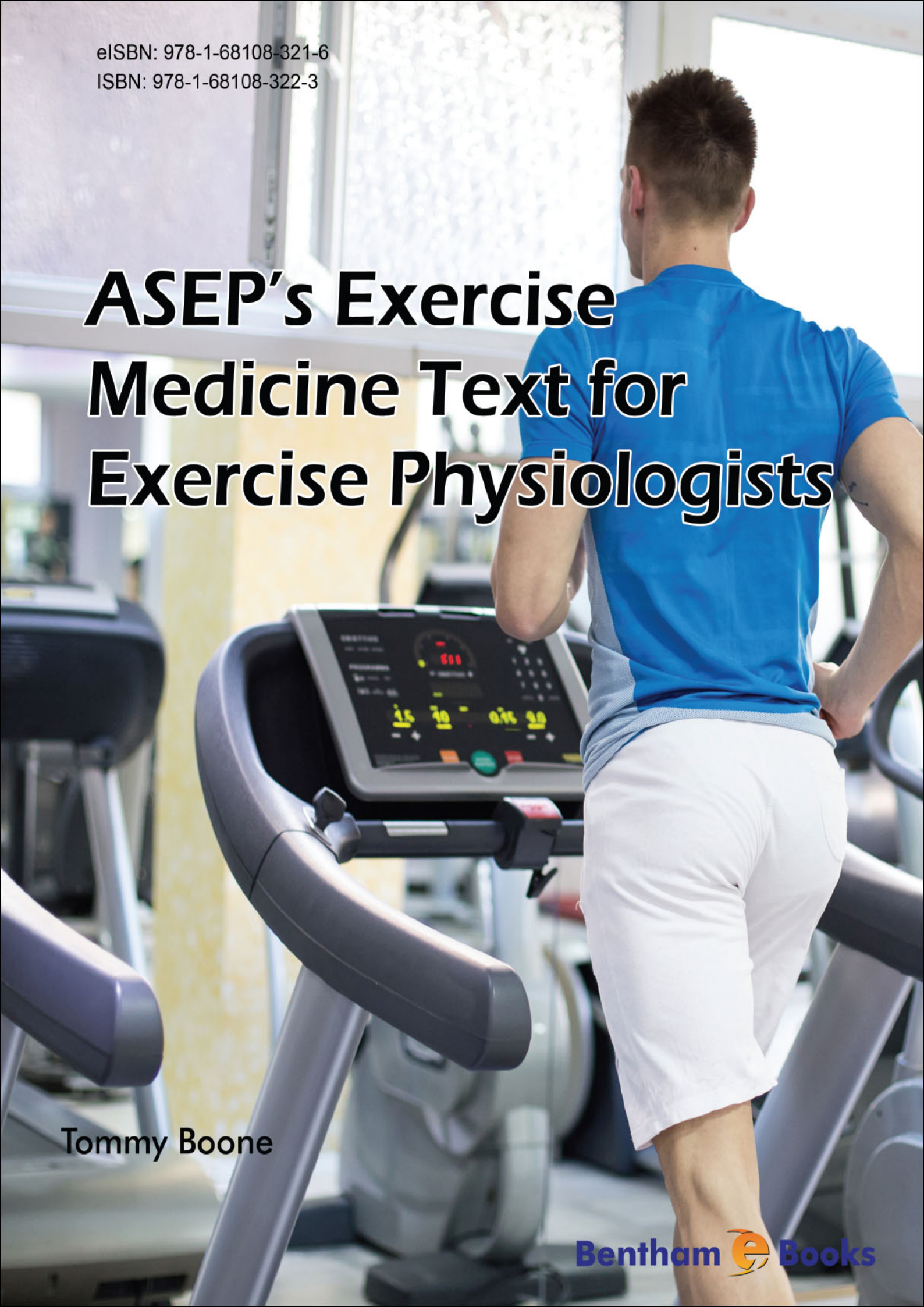
# ASEP's Exercise Medicine Text for Exercise Physiologists



Tommy Boone

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# ASEP's Exercise Medicine
# *Text for Exercise Physiologists*

**Authored By**

**Tommy Boone**
*American Society of Exercise Physiologists*
*USA*

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Author: Tommy Boone

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# FOREWORD

This is a book for all Exercise Physiologists and those who want to adopt this profession. We are at a unique time in history, where our technological advances have led to a sedentary lifestyle. Society has adapted to a lack of physical exertion which is killing thousands of men and women of all ages. Although our science had started by analyzing human performance and ways to enhance it through the exercise stimulus, but Dr. Boone shows us that the stimulus is now a medicine to treat epidemic proportions of preventable and manageable diseases and disabilities.

*ASEP's Exercise Medicine Text for Exercise Physiologists* is a timely resource for our profession. Dr. Tommy Boone's commitment to the professionalization of Exercise Physiology is evident in his contribution to academic and practicing Exercise Physiologists. For the academic, he presents a valuable tool for teachers to help students in seeing the connection between the hands-on laboratory experiences and the physiological assessments of their future clients and patients. The use of regression equations helps in the interpretation and prescription of exercise medicine. This book reinforces the necessary understanding that an accredited education provides both the knowledge and credentials to be a healthcare professional.

Also, for those who have graduated with a degree under the umbrella of exercise sciences, it offers a justification for aligning oneself with the American Society of Exercise Physiologists and pursuing the ASEP Board Certification. This text explains what is expected from a healthcare professional and shows us that ASEP has established itself in that process. Dr. Boone also explains that we have even more work to do. The sooner we come together the sooner our professional opportunities and acceptance will recognized by society. He supports all of this with a wealth of research healthcare statistics that proves a need for a consolidated and accountable Profession of Exercise Physiologists.

Through his work with ASEP, he has given us our professional platform and with this new exercise medicine text, he has given us a treasure for professional practice. This text takes the reader through the meaning of "Professionalism of Exercise Physiology", "Exercise Medicine", and "Entrepreneurship" as each relates to the need for new thinking about chronic diseases, disabilities, and the future of Exercise Physiology as a healthcare profession.

**Shane Paulson**
PhysioLogic Human Performance Systems
USA

# PREFACE

Unfortunately, watching TV, surfing the Internet, and sitting for long hours have replaced more active pursuits. Millions of Americans are simply not moving enough to meet the minimum threshold for good health and longevity. Exercise physiologists have researched and highlighted this fact for decades. That is why they emphasize the importance of regular exercise in the prevention of chronic diseases associated with physical inactivity and a sedentary lifestyle. Heart disease, obesity, type 2 diabetes, high blood pressure, stroke, peripheral arterial disease, depression, several types of cancers, and osteoporosis can be treated or even prevented with properly prescribed exercise.

*ASEP's Exercise Medicine Text for Exercise Physiologists* is designed to educate the reader about the evolution and significance of *professionalism in exercise physiology*, *exercise medicine*, and *entrepreneurship* as each relates to the need for new thinking about chronic diseases, disabilities, and the future of exercise physiology as a healthcare profession. It combines scientific principles and cardiovascular calculations that support its use in the development of safe, well-rounded, and individualized exercise programs to help clients/patients sleep better, reduce stress, maintain a healthy body weight, keep bones strong and joints healthy, decrease the risk for colon cancer, and improve mental function. This work demonstrates the importance of exercise medicine. It should help pave the way for the support and recognition of Exercise Physiologists in healthcare.

## CONFLICT OF INTEREST

The author confirms that author has no conflict of interest to declare for this publication.

## ACKNOWLEDGEMENTS

Declared none.

**Tommy Boone**
American Society of Exercise Physiologists
USA

# Part I- Introduction to the Profession of Exercise Physiology

CHAPTER 1

# Regular Exercise and Disease Prevention

**Abstract:** Physical inactivity is a major public health problem of the 21st century. The spiraling cost of a sedentary lifestyle on morbidity and mortality isn't just dramatic, it is devastating, with an estimated 250,000 premature deaths annually in the U.S. These deaths are directly a function of physical inactivity, which constitutes the 4th leading cause of death globally (with about 3.3. million attributable deaths per year). Exercise medicine serves as a resource for physicians and other healthcare professionals, while providing the unique opportunity for Board Certified Exercise Physiologists to further establish themselves as advocates of the benefits of exercise medicine, physiological assessments, and the exercise prescription. This chapter makes the connection between the benefit of regular exercise on both the primary and secondary prevention of coronary heart disease, obesity, type 2 diabetes, low back pain, hypertension, breast and colon cancer, depression, dementia, and osteoporosis. Without a doubt, exercise is medicine that should be prescribed by Board Certified Exercise Physiologists.

**Keywords:** Exercise medicine, Exercise physiologists, Healthcare professionals, Lifestyle diseases, Oxygen consumption, Physical inactivity, Regular exercise.

## INTRODUCTION

During the past several decades there has been a gradual epidemiologic transition from infectious diseases to chronic diseases as the leading cause of death. This transition is the result of many factors. In particular, there is an increase in older adults in the United States. The aging of the population is correlated with a marked decline in physical exertion. The insufficient activity levels are associated with chronic diseases and poor health conditions (such as an adult obesity rate that has increased in the United States from 15% in 1980 to 34% in 2008).

Exercise is a subcategory of physical activity. Regular exercise is defined as structured and repetitive movements done to improve or maintain physical fitness

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and/or prolong life. Physical activity incorporates all types of physically active movements to improve physical capacity and functional independence. Yet, there is overwhelming evidence that physical inactivity is a worldwide public health problem. In the United States, there is an epidemic emergence of lifestyle related diseases with healthcare costs approaching $1 trillion and millions of premature deaths each year (Booth *et al.* 2000; Booth *et al.* 2008). Physical inactivity is as dangerous as smoking and obesity. Box **1** provides an overview of the physiological and psychosocial benefits of regular exercise (Boone 2014).

**Box 1. Regular exercise can help with the following diseases and conditions.**

| | |
|---|---|
| 1. Ankylosing spondylitis | 14. Heart failure |
| 2. Back pain | 15. Hypertension |
| 3. Breast cancer | 16. Intermittent claudication |
| 4. Cancer | 17. Lung cancer |
| 5. Cholesterol | 18. Multiple sclerosis |
| 6. Chronic fatigue | 19. Obesity |
| 7. Chronic obstructive pulmonary disease | 20. Osteoarthritis |
| 8. Cognitive impairment/dementia | 21. Osteoporosis |
| 9. Colonic cancer | 22. Stroke |
| 10. Coronary artery disease | 23. Parkinson's disease |
| 11. Depression | 24. Rheumatoid arthritis |
| 12. Endometrial cancer | 25. Stroke |
| 13. Fibromyalgia | 26. Type 2 diabetes |

Physical inactivity (sedentary living) is apparent when people fail to engage in 30 min of physical activity each day. Sedentary living is a modifiable risk factor for lifestyle-mediated disorders. Approximately a million lives a year would be saved if physical inactivity rates were to go down by 10% to 20% worldwide. Yet, regardless of the fact that the inactivity pandemic is responsible for 1 in 10 deaths worldwide, regular exercise is undervalued by society. Only 23% to 35% of the men and 17% to 32% of the women engage in regular exercise. As a result of the physical inactivity, these individuals experience a wide range of physical (*e.g.,* musculoskeletal, cardiovascular, and respiratory conditions) and mental problems (such as decreased psychological well-being and quality of life) more often than their active counterparts. Type 2 diabetes mellitus is almost entirely preventable with regular exercise (Blair 2009). That is why sedentary living should be recognized as part of the standard medical diagnosis. Children, teenagers, and adults should exercise at least 30 min·d$^{-1}$ 3 to 5 d·wk$^{-1}$ (Boone 2012a).

The scientific evidence demonstrates a substantial decrease in all-cause mortality when exercise is incorporated into a client's lifestyle. This is especially important because exercise intervention programs, health promotion, and disease prevention are ethically responsible standards of care (Box **2**).

**Box 2. Are you ready to exercise? Look at the benefits of regular exercise.**

Starting an exercise program sounds easy, but it isn't easy at all. Most people start an exercise program several times. There are weeks if not months or years of thinking about it. Then, there is the preparation following by action and staying with it. If they are successful, the benefits are huge (American College of Sports Medicine 2010).

- Decrease the incidence of cardiovascular disease (CVD) and hypertension by ~40%
- Decrease the risk of developing type 2 diabetes by ~60%
- Decrease mortality and the risk of recurrent breast cancer by ~50%
- Decrease the risk of stroke by ~30%
- Decrease the risk of colon cancer by ~60%
- Decrease depression as effectively as Prozac or behavioral therapy
- Increased strength and endurance
- Increased aerobic energy, power, and stamina
- Boost self-esteem and improve sleep
- Increased interest in sex
- Decreased stress, anxiety, and depression
- Improvement in mood and alertness
- Decreased body fat and improved blood lipids

Regardless of the benefits of regular exercise, particularly the improvement in vascular health, it is common knowledge that there are barriers to participating in a preventive exercise program (Box **3**). Hence, starting an exercise program can be difficult and, then, it can even be harder staying with it.

**Box 3. Barriers to regular exercise.**

1. Lack of appreciation or belief in the benefits of physical activity
2. Lack of time, energy, and/or access
3. Poor health and/or illness
4. Decrease mental/emotional state of mind
5. Fear of injury
6. Unpleasant sensations associated with engaging in physical activity
7. Impaired health such that the individual believes he or she should not exercise or engage in physical activity

Why then in face of the common measurements of cholesterol, blood pressure, and body density index is there so little discussion about physical activity? No

**CHAPTER 2**

# Cardiopulmonary Exercise Testing

**Abstract:** Cardiopulmonary exercise testing (CPET) determines the client's functional capacity by measuring pulmonary, cardiovascular, and muscular exercise responses. Generally, two modes of exercise are used in CPET: treadmill and cycle ergometer. The test protocols are either incremental or a constant work rate. There are accepted contraindications to CPET, indications for a CPET, and criteria for terminating the test that involves measuring oxygen consumption ($VO_2$), carbon dioxide output ($VCO_2$), and expired ventilation ($V_E$), blood pressure (BP), and electrocardiography (ECG). These variables and others reflect the maximal ability of the client to take in, transport, and use oxygen. They also allow for the evaluation of client's submaximal exercise responses as well as the client's $VO_2$ max response that represents the maximal level of the body's oxidative metabolism.

**Keywords:** Balke test, Bruce treadmill test, Cardiopulmonary exercise testing, Cardiorespiratory responses, Contraindications and indications for CPET.

## INTRODUCTION

Cardiopulmonary exercise testing (CPET) is used by exercise physiologists to physiologically assess a client's functional capacity and/or impairment. A metabolic gas analyzer is connected to a non-rebreathing valve and mouthpiece to measure ventilation and respiratory gas at rest and during exercise. Expired ventilation ($V_E$) is computed as the product of tidal volume ($T_V$) and frequency of breath (Fb). Respiratory gas parameters ($O_2$ and $CO_2$) and the volume of oxygen consumed ($VO_2$) and the carbon dioxide produced ($VCO_2$) are determined in response to exercise workloads.

The purpose of the exercise test determines the maximal ability to take in and use oxygen ($VO_2$ max). A major part of understanding the procedure that determines $VO_2$ max involves the Fick equation with an increase in heart rate (HR), stroke

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volume (SV), cardiac output (Q), and arteriovenous oxygen difference (a-v$O_2$ diff) in response to a change in work rate (Astrand *et al.* 2003; Boone 2014; Plowman & Smith 2003). The functional capacity protocols can be done with a treadmill or a cycle ergometer. While several popular protocols are used for an incremental test on both the treadmill and the cycle ergometer, the steady-state submaximal test (*i.e.,* the client exercises at a constant work rate for *x* minutes) is carried out on just the cycle ergometer (Mauger & Sculthorpe 2012; Mellerowicz & Smodlaka 1981). Either a computerized breath-by-breath gas exchange system is used to monitor respiratory gases or linear regression equations are used to characterize the physiologic responses.

## CARDIOPULMONARY EXERCISE TESTING

The CPET protocols are used to determine and evaluate exercise capacity from either a physiological basis for research purposes or a clinical perspective to assess the functional capacity and impairment before and after cardiorespiratory endurance training. It is a non-invasive research tool that provides insight into the client's physiological responses during a submaximal exercise test, a peak exercise test, or a symptom-limited exercise test. The primary thread that links each of the tests is the cardiovascular system and its capacity to deliver oxygen to the skeletal muscles, which is used to produce energy for muscle contraction. Hence, repeating the same submaximal exercise test following a 12-wk aerobic exercise program provides specific information about the client's metabolic efficiency and physiological adaptations to the program (Noonan & Dean 2000).

Depending on the client's age, fitness status, and/or chronic disease condition, the Board Certified Exercise Physiologist is likely to identify the CPET as a "peak $VO_2$ exercise test" or a "symptom-limited peak or maximal" exercise test. If the client is an athlete or someone who has a history of regular exercise, the CPET is normally referred to as a maximal $VO_2$ exercise test (*i.e.,* $VO_2$ max). The three tests provide essentially the same information about the client's functional capacity, which is made possible by the: (a) respiratory system (*i.e.,* gas exchange between the alveoli and the pulmonary artery blood); (b) cardiovascular system (*e.g.,* cardiac output, stroke volume, and vascular network); and (c) skeletal muscle metabolism (American College of Sports Medicine 2005; McArdle *et al.*

2007; Robergs & Roberts 2000; Pollock & Wilmore 1990).

The integrated physiologic response is best understood by analysis of the Fick equation: $VO_2$ = Q x a-$vO_2$ diff, where Q is cardiac output and a-$vO_2$ diff is the difference between the arterial oxygen content ($CaO_2$) and the mixed venous oxygen content ($CvO_2$). The equation highlights the transport of oxygen by Q and the use of oxygen at the cellular level (a-$vO_2$ diff). Indirectly, the equation indicates the performance of the pulmonary system *via* $CaO_2$. Otherwise, the client's expired ventilation ($V_E$ = Fb x $T_V$) offers an excellent analysis of the role the lungs play in functional exercise testing.

Maximal oxygen consumption ($VO_2$ max) is the laboratory measure of a client's cardiorespiratory fitness (Astorino *et al.* 2000). Once the value is known and the different physiologic contributors have been analyzed, functional capacity can be scientifically described and understood from an exercise medicine perspective. At a specific point in the progressive exercise protocol that is consistent with the client's capacity to take in, transport, and use oxygen, $VO_2$ will plateau even if the exercise intensity is increased. The plateau is defined as $VO_2$ max, which is the maximal level of oxidative metabolism presently possible given the structure and function of the lungs, heart, and skeletal muscles.

In cardiac rehabilitation, clients are limited in their cardiovascular response to a progressive exercise protocol. The point at which the CPET is stopped is referred to as symptom-limited $VO_2$ max in clients with symptoms or peak $VO_2$ in clients without symptoms but do not meet the criteria for $VO_2$ max (Box **1**). Either is a good indication of the failure of Q to increase due to the failure of HR and/or SV to increase and/or the inability of the skeletal muscles to extract the oxygen needed to continue the work intensity (Boone 2014). As an example, it is common for post-MI clients to take the beta-blocker, atenolol, for high blood pressure. Since atenolol lowers HR at rest and during exercise, the lower than normal exercise Q response means that not enough oxygen will be delivered to the skeletal muscles. Without the required oxygen to generate more high-energy phosphate compounds (*e.g.,* adenosine triphosphate, ATP), there is an increase in anaerobic metabolism that is insufficient to sustain the aerobic exercise test.

# PART II- The Physiology of Exercise Medicine

# CHAPTER 3

# Exercise and Coronary Artery Disease

**Abstract:** Physical activity has a positive influence on mind and body health. ASEP Board Certified Exercise Physiologists are healthcare professionals responsible for developing individualized exercise prescriptions to help manage coronary risk factors (physical inactivity, hypertension, high serum cholesterol, cigarette smoking, obesity, family history, psychological stress, and diabetes mellitus) associated with the sedentary lifestyle and the pathophysiology of coronary artery disease. Regular exercise increases the delivery and utilization of oxygen that produces high-energy compounds, adenosine triphosphate, for efficient and sustainable muscle contraction and relaxation. Chronic adaptations to regular exercise consist of positive structural and functional changes to the lungs, heart, and skeletal muscles. The profession of exercise physiology is witnessing an unprecedented opportunity to prescribe exercise medicine to manage chronic diseases and disabilities. This is good because 45% of the U.S. population has a chronic medical condition.

**Keywords:** Angina pectoris, Coronary artery disease, Diabetes, Exercise Prescription, Hypertension, Obesity, Physiology of exercise, Serum lipids, Stress.

## INTRODUCTION

Clients and patients who engage in regular exercise realize health benefits. But, what is not fully accepted is that exercise is medicine (Berryman 2010). Aside from regular exercise improving functional capacity, it is a healthy means to achieving a chronic positive energy balance in order to protect against obesity, to promote an increase in life span, reduce the risk of stroke, obesity, type 2 diabetes (Boule *et al.* 2001), coronary artery disease (Bowles & Laughlin 2011), hypertension (Fagard 1999), depression (Doyne *et al.* 1983; Hagberg *et al.* 2000), and other conditions resulting in premature morbidity and mortality.

While the medical community has been reluctant to recommend regular exercise

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as a bona fide treatment plan for lifestyle diseases, including coronary artery disease (CAD), the use of an individualized exercise prescription for clients who are at high risk for coronary artery disease is based on solid scientific evidence.

For those who have had a myocardial infarction or coronary by-pass graft, as well as individuals who are physically inactive and sedentary with angina pectoris, exercise is a well-documented therapeutic necessity (Box **1**). Regular exercise improves health and well-being (Dubbert 1992; Fletcher *et al.* 1992; Griest *et al.* 1979; Lane & Lovejoy 2001; Pate *et al.* 1995; Van Rensburg *et al.* 2009).

**Box 1. Beneficial effects of physical activity.**

The DHHS 2008 Physical Activity Guidelines for Americans concluded that … "recently published studies continue to support a strong inverse relation between the amount of habitual physical activity performed and coronary heart disease and cardiovascular disease morbidity or mortality. For both men and women at middle age or older, remaining sedentary is a major independent risk factor, with persons reporting moderate amounts of activity having a 20% lower risk and those reporting activity of higher amounts or intensity having approximately a 30% lower risk than least active persons."

*US Department of Health and Human Services* (2013), Physical Activity Guidelines for Americans, http://www.health.gov/PAGuidelines?

Except for age and sex, regular exercise favorably influences the CAD risk factors (Whelton *et al.* 2002; Wing 2010). Otherwise, the available evidence strongly indicates that physical activity and regular exercise along with other lifestyle changes (diet, psychological stress, blood pressure, and cigarette smoking in particular) consistently decrease the clinical manifestations of CAD. This point is illustrated in the acute and chronic physiological responses to exercise and in the skeletal muscle and myocardial adaptations to exercise training with and without angina pectoris and/or a myocardial infarction (MI) (Levin & Mitchell, 1993).

Developing individualized exercise prescriptions is a major part of the role of the Board Certified Exercise Physiologists in the management of coronary risk factors. They understand the development of atherosclerosis and CAD is blunted by moderate levels of physical activity (Chilton 2004). The quality of the client's exercise conditioning is important for safety and healthcare reasons. There is a high probability of a successful outcome when credible healthcare professionals oversee the risk factor modification process. After all, they are responsible for

helping clients deal with their physical inactivity and the implementation of prevention strategies that help to promote healthy vascular aging (Higgins 2000).

They understand that there is an urgent need to promote moderate levels of physical activity to reduce both morbidity and mortality of CAD. After all, it is the leading cause of death in the United States in both men and women. Every minute of every day, ~3 Americans have an MI. Coronary artery disease is a major contributor to disability, lost productivity, and medical expenses. The underlying cause of CAD is atherosclerosis, which accounts for ~16% of all deaths each year. The cost of physical inactivity in lives, quality of life, and economic loss is increasingly self-evident (Box **2**). The annual cost exceeded $300 billion in 2010. Thus, lifestyle modification, including exercise medicine, is the appropriate healthcare treatment for the cascade of physiologic and metabolic factors that contribute to the development of atherosclerosis and CAD (Wu & Green 2000).

**Box 2. The economic impact of exercise *vs.* percutaneous coronary intervention.**

• **Hambrecht *et al.* "demonstrated that a combined therapy of exercise and diet was superior to percutaneous coronary intervention (PCI) in event free survival in patients with stable CHD."**

Hambrecht, R, Walther, C, Mobius-Winkler, S, Gielen, S, Linke, A, Conradi, K, Erbs, S, Kluge, R, Kendziorra, K, Sabri, O & Schulder, G (2004), Percutaneous coronary angioplasty compared with exercise training in patients with stable coronary artery disease: A randomized trial, *Circulation*, 109,1371-1378.

•

**"In 2006, the American Heart Association reported that more than 1.3 million percutaneous coronary intervention (PCI) were performed in the United States, thus optimizing exercise as an alternative therapy to PCI for stable CHD (~60% of all CHD patients) could save over $2.6 billion annually in healthcare costs."**

American Heart Association (2009), Heart Disease and Stroke Statistics – 2009 Update, *American Heart Association,* Dallas, Texas.

Physical inactivity is the most obvious of the modifiable risk factors (smoking, dietary habits, physical inactivity, and obesity), with ~70% of Americans engaged in little or no regular exercise (Snell & Mitchell 1999). The sedentary lifestyle and the high intake of calories have resulted in excess visceral adiposity, which is a major factor involved in the development of cardiovascular disease, type 2 diabetes mellitus (AADE Position Statement 2012; Agurs-Collins *et al.* 1997;

CHAPTER 4

# Exercise and Obesity

**Abstract:** Obese people in the United States will increase from 99 million in 2008 to 164 million by 2030, and the cost to treat obesity will increase to 66 billion per year by 2030. These figures and the knowledge of real life events with family and friends clearly indicate that the U.S. and its population are in the midst of an epidemic of health and economic consequences. It is pastime that the scope and ramifications of obesity and the effects of a sedentary lifestyle should be taken much more seriously by the American population. Board Certified Exercise Physiologists are prepared to educate, evaluate, and supervise exercise prescriptions that can be incorporated in the client or patient's lifestyle to help prevent weight gain, premature death, and overall metabolic risk for diabetes, heart disease, hypertension, and stroke.

**Keywords:** Aerobic exercise, Exercise medicine, Exercise recommendations, Hemodynamic factors, Lifestyle intervention, Physical activity, Resistance training.

## INTRODUCTION

The obesity problem is a major healthcare epidemic in the United States and the world. The health consequences are apparent in many forms. By 2030, 51% of the U.S. population will be obese. The obesity rate is anticipated to increase to ~50% in men and ~52% in women (Wang *et al.* 2011). Obese individuals are expected to increase to 164 million by 2020, which is driven by the fact that 66% of the population is presently overweight or obese. Greater than 70% of Americans are physically inactive with a decrease in predicted life span.

## EPIDEMIOLOGY OF OBESITY

Compared to the non-obese adults, a body mass index (BMI) of 30 or higher (obese) is statistically linked to a 200 to 300% increase in mortality. In just 4

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years, (from 1986 and 2000) the number of Americans ~100 lbs overweight (BMI of 40 or higher) quadrupled from ~1 in 200 adults to 1 in 50 (Sturm 2003). By 2030, the economic burden will be $66 billion per year to treat obesity-related diseases such as cardiovascular disease, stroke, and adult-onset diabetes.

A major health condition related to obesity is hypertension (Landsberg 2013). It is the most common consequence of obesity. Normal-weight persons are more than twice as likely to not have high blood pressure as obese persons. It is hard to imagine that society has turned a blind eye to the role of inactivity and a sedentary lifestyle, yet that is exactly what has happened. Obesity-related workplace healthcare costs continue to increase in the billions of dollars each year (Finkelstein *et al.* 2012). The expenditures for sick leave, life insurance, disability insurance, and treating the effects of obesity-related musculoskeletal impairments, complications, and diseases (particularly type 2 diabetes) continue to increase for millions of Americans (Box **1**).

**Box 1. Obesity-related musculoskeletal impairments.**

• In 2012, ~43 million Americans had osteoarthritis and >20 million Americans had arthritis. Both musculoskeletal joint diseases and/or impairments are linked to obesity. The risk of developing osteoarthritis in the knees is greater in obese women (~4 times) and obese men (~5 times) compared to women and men who are not obese.

Anderson, J & Felson, D (1988), Factors associated with osteoarthritis of the knee in the First National Health and Nutrition Examination, *American Journal of Epidemiology,* 128,179-189.
The Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity. Available at http://www.surgeongeneral.gov/topics/obesity/calltoaction/fact_adolescents.htm

While genetic studies indicate that there can be a genetic predisposition to obesity (such as the deficiency in the hormone leptin that is normally produced in the fat cells) (Pejovic *et al.* 2010), the two most common causes for obesity are caloric intake (overeating) and energy expenditure (inactivity/sedentary lifestyle). The overeating of foods high in fat or sugar (*e.g.,* sweets, fried food, and fast food) that are high in calories leads to weight gain and obesity (Flegal *et al.* 1998).

Also, it is believed that the higher than normal insulin release that occurs after consuming simple carbohydrates (desserts, soft drinks, beer, and wine) *versus* complex carbohydrates (*e.g.,* brown rice, vegetables, raw fruits, and pasta)

contributes to weight gain and obesity. The answer to the obesity health concerns and financial problems is to decrease caloric intake or to increase energy expenditure by way of physical activity or both. Indeed, many research studies indicate that the answer to the prevention of weight gain and the obesity problem is an obvious matter of lifestyle. Sedentary clients who also consume a large number of calories while using fewer calories throughout the day and evening store more calories than the physically active clients who consume a normal caloric diet and engage in regular exercise (Box **2**).

**Box 2. Lifestyle intervention in overweight men and women.**

• Compared to diet alone or physical activity alone versus the combination of a dietary intervention plus regular physical activity, there is a significant improvement in weight loss with diet and physical activity.

Wing, RR, Venditti, E, Jakicic, JM, Polley, BA & Lang, W (1998), Lifestyle intervention in overweight individuals with a family history of diabetes, *Diabetes Care,* 21,350-359.

## EXERCISE SPECIFICS AND BENEFITS

The addition of aerobic physical activity of ~150 min·wk$^{-1}$ (*i.e.,* 30 min·d$^{-1}$ for 5 d·wk$^{-1}$) is not only necessary to lower the risk of chronic diseases, it promotes weight loss and keeps it off as long as the diet is modified as well (Hagan *et al.* 1986). Also, when combined with strength training exercises, lean muscle mass and strength are increased while fat mass is decreased. These changes plus the decrease in low-density lipoprotein cholesterol and the increase in insulin sensitivity represent a positive treatment for the obesity epidemic (Roth *et al.* 2000).

There are two major epidemics in the United States: (a) physical inactivity; and (b) obesity. Both can be supervised and managed by Board Certified Exercise Physiologists. They understand the importance of maintaining a healthy weight through a combination of diet, exercise, and behavior modifications to avoid the health issues associated with obesity and chronic health problems. The American Society of Exercise Physiologists is in agreement with the forecast of future obesity and severe obesity prevalence over the next 20 or more years. They, too, anticipate that by 2030, ~51% of the adults in the United States will be obese.

CHAPTER 5

# Exercise and Type 2 Diabetes Mellitus

**Abstract:** Type 2 diabetes mellitus (T2DM) is the most common form of diabetes in which the body does not use insulin properly (*i.e.*, insulin resistance). At first, the pancreas makes extra insulin to make up for it. But, over time it does not keep up and cannot make enough insulin to keep blood glucose at normal levels. In adults, T2DM accounts for ~90% of all diagnosed cases of diabetes. Type 2 DM is a significant cause of premature mortality and morbidity related primarily to cardiovascular disease, kidney and nerve disease, blindness, and amputation that cost the U.S. ~$245 billion in 2012. Extra body fat is highly correlated with developing T2DM. Regular exercise helps to decrease body fat and improve insulin action. The ASEP Board Certified Exercise Physiologists can help T2DM clients become physically active.

**Keywords:** Exercise, Hyperglycemic, Metabolism, Obesity, Physical activity, Peripheral neuropathy, Pre-exercise evaluation, Retinopathy, Type 2 diabetes.

## INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder that is on the rise in the U.S. and worldwide. The International Diabetes Federation 2013 report indicates that more than 382 million people are living with diabetes (Hirst 2013). Type 2 DM is also increasing in children due to the increase in overweight youth (Daniels *et al.* 2005). While the majority of the T2DM clients are inactive, it is clear that the most cost-effective prevention and management methods include regular exercise, increased physical activity, and a healthy diet.

## EPIDEMIOLOGY OF T2DM

In clients 20 yrs of age and older, more than 1 in 10 people have diabetes, and in seniors 65 and older it increases to more than 1 in 4. While men are at slightly higher risk of developing diabetes than women, physical inactivity, age, excess

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weight around the waist, family history, and poor diet are also important risk factors. It is more prevalent among Native Americans, African Americans, Hispanics, and Asian Americans than among Caucasians in the United States (Santos-Longhurst 2014). Approximately 85% of the complications and morbidities among clients with T2DM can be prevented, delayed or treated, and minimized with regular exercise supervised by a Board Certified Exercise Physiologist (Boone 2014). It is also important that the client or patient takes appropriate medications and eats a healthy diet (Box **1**).

**Box 1. The findings of the diabetes prevention program.**

"Weight loss and increased physical activity reduced the development of type 2 diabetes by 58% during a 3-yr study period. Amongst older subjects (those age 60 yrs or older), the reduction was 71%. Overweight individuals who lose 5 to 7% of their body weight through exercising and healthy eating may effectively prevent or delay the onset of type 2 diabetes indefinitely. Regular checks of blood cholesterol levels, blood pressure, and blood sugar levels to monitor risk factors and work to achieve and maintain healthy levels of each. Having healthy levels of these three indicators significantly reduces the risk of diabetes. The drug Metformin was found to reduce the risk of diabetes onset by 31%, particularly in younger (ages 25 to 44 yrs) and heavier adults (with a body mass index >35) who were considered pre-diabetic".

Santos-Longhurst, A (2014), Type 2 diabetes statistics and facts. *Healthline*, Accessed 1/23/15, http://www.healthline.com/health/type-2-diabetes/statistics#1

The problems and complications associated with T2DM are common and severe. Heart diseases and stroke kill 50% of the people with diabetes. "More than 71% of adults with diabetes have hypertension. In 2010, 7,686 cases of diabetic retinopathy lived in the United States. Diabetes is the leading cause of newly diagnosed adult (20-74 yrs of age) blindness, and it was the primary cause of kidney failure in 44% of all new cases in 2011. During the same year, it was reported that 228,924 people (all age groups) were treated for kidney failure due to diabetes. There is also a mild loss of sensation in extremities in as many as 70% of diabetic adults" (American Diabetes Association 2014). Combined with decreased blood flow, nerve damage (neuropathy) in the feet increases the likelihood of foot ulcers and infection. When this happens, amputations of lower limbs may be necessary. In fact, more than 60% of all non-traumatic amputations of lower limbs (~73,000) were performed in diabetic adults age 20 and older. The list of complications also includes depression and sexual dysfunction (Roglic *et al.* 2005).

Uncontrolled diabetes during pregnancy can be especially troubling, given that it increases the likelihood of birth defects, large babies, and other complications that

can be dangerous to the baby and the mother. Individuals with diabetes are twice as likely to suffer from depression as non-diabetics. "In 2010, diabetes was listed as the 7th leading cause of death in the United States, and the contribution of diabetes to death is likely to be dramatically underreported on death certificates. Diabetics have twice the risk of death of any cause compared to individuals of the same age without diabetes" (American Diabetes Association 2014).

## Diagnosis and Treatment

The symptoms of T2DM are at times difficult for the general public to link to diabetes. Hence, many people have T2DM for a long period of time before being diagnosed with the disease. The symptoms are: (a) being very thirsty; (b) frequent urination; (c) feeling very hungry or tired; (d) losing weight without trying; (e) sudden loss of lean muscle mass; (f) sores that heal slowly; and (g) blurry eyesight (American Diabetes Association 2014). Diagnosis of T2DM can be made by testing fasting plasma glucose. If it is $\geq$126 $mg \cdot dL^{-1}$ (or 7.0 $mmol \cdot L^{-1}$), then T2DM is the diagnosis (Sigal *et al.* 2004).

"Treatment of diabetes involves lowering blood glucose (BG) and the levels of other known risk factors that damage blood vessels. Tobacco use cessation is important to avoid related complications. People with type 1 diabetes require insulin while people with T2DM can be treated with oral medication. Occasionally, T2DM clients may also require insulin, blood pressure control, and foot care" (Sigal *et al.* 2006). Other concerns and reason for treatment include retinopathy (which can cause blindness), blood lipid control (to regulate blood cholesterol levels), and screening for early signs of diabetes-related kidney disease. These treatment measures should also include a healthy diet, maintain a normal body weight, and engage in regular exercise program, and avoid tobacco use. If these healthcare measures are not taken seriously by the general public, T2DM will increase dramatically. According to the Centers for Disease Control and Prevention (2010), if the current trends continue, 1 in 3 Americans could have T2DM by 2050. Currently, 1 in 10 Americans has T2DM. Extra body fat is highly correlated with developing T2DM, which is why overweight people are at a much greater risk of developing T2DM than normal weight individuals. In fact, almost 90% of people with T2DM are overweight. That is why an active lifestyle that

CHAPTER 6

# Exercise and Hypertension

**Abstract:** Hypertension is a major risk factor and contributor to premature death and disability from stroke, acute myocardial infarction, cardiac insufficiency, and sudden death. A person with a systolic blood pressure of 140 mmHg has twice the risk of cardiovascular death as a person with a systolic blood pressure of 120 mmHg. Aside from drugs, regular exercise and lifestyle changes are significant treatments in correcting hypertension. It is important to help clients and patients achieving a certain minimum exercise level along with appropriate lifestyle behavioral changes. It is especially important to prescribe low to moderate 30 min of continuous exercise with a frequency of 3 to 5 $d \cdot wk^{-1}$ along with a certain amount of resistance training to maintain lean muscle mass.

**Keywords:** Afterload, Cardiovascular system, Myocardial infarction, Myocardial oxygen consumption, Systemic vascular resistance, Systolic blood pressure.

## INTRODUCTION

According to the American Heart Association 2013 Statistical Fact Sheet, in the United States, ~80 million (*i.e.,* 1 out of 3 adults) of the total resident population of ~319 million have high blood pressure (Go *et al.* 2013). Although it is present in all ages, the prevalence of hypertension, as the silent killer, continues to increase among the middle-aged and elderly. The cost of health care services, medications to treat high blood pressure, and missed days of work is $47.5 billion each year (Heidenreich *et al.* 2011).

## EPIDEMIOLOGY OF HYPERTENSION

When systolic blood pressure (SBP) at rest is less than 120 mmHg (specifically, between 90 and 119 mmHg), it is considered normal. Diastolic blood pressure (DBP) is normal when it is between 60 and 79 mmHg (*i.e.,* essentially, 80 mmHg)

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at rest. When BP is chronically elevated (SBP ≥140 mmHg or DBP ≥90 mmHg, Box **1**), the cardiac consequences are increased left ventricular hypertrophy and coronary artery disease (CAD).

For middle-age and older clients (40 to 70 yrs of age), each increase of 20 mmHg in SBP and 10 mmHg in DBP doubles the risk of CAD, heart attack (*i.e.,* myocardial infarction, MI), and stroke) (Lewington *et al.* 2002).

**Box 1. National guidelines for hypertension.**

| Classification | SBP (mmHg) | DBP (mmHg) |
|---|---|---|
| Normal | <120 | <80 |
| Prehypertension | 120 – 139 | 80 – 89 |
| State 1 | 140 – 159 | 90 – 99 |
| Stage 2 | 160 – 179 | 100 – 109 |
| Stage 3 | >180 | >110 |

Aside from hypertension occurring secondarily from endocrine disorders, renal disease, and other physiological conditions, the etiology for high blood pressure is unknown in 90 to 95% of the patients. Moreover, among hypertensive patients, only ~53% appear to have it under control while ~47% do not have it under control at all. To further complicate the consequences of high blood pressure, there is the negative influence of ethnicity, obesity, stress, anxiety, alcohol (*e.g.,* more than 1 drink per day for women and more than 2 drinks per day for men), consuming too much salt, diabetes, and smoking. Whatever the reason may be, it is important to normalize BP (Bauchner *et al.* 2014; CDC, 2012) (Box **2**).

**Box 2. Hypertension and deaths.**

North American studies have shown that hypertension is a major contributor to 500,000 strokes (250,000 deaths) and 1,000,000 myocardial infarctions (500,000 deaths) per year.

Foex, P & Sear, JW (2004), Hypertension: Pathophysiology and treatment, Continuing Education in Anaesthesia, *Critical Care & Pain*, 4,71-75.

The 1995 NHANES survey reported the age-specific prevalence was 3.3% in white men 18 to 29 yrs of age, which increased to 13.2% in the 30 to 39 yrs of

age. The prevalence further increased to 22% in the white men aged 40 to 49, to 37.5% in the 50 to 59 age group, and to 51% in the 60 to 74 age group. Women are about as likely as men to develop hypertension during their lifetimes. However, for people younger than 45 yrs old, the condition affects more men than women. For people 65 yrs old or older, hypertension affects more women than men with significant health implications Fang *et al.* 2005) (Box **3**).

**Box 3. Relationship of hypertension to sex, age, and cardiovascular problems.**

| Age | Men (%) | Women (%) |
|---|---|---|
| **20-34** | 11.1 | 6.8 |
| **35-44** | 25.1 | 19.0 |
| **45-54** | 37.1 | 35.2 |
| **55-64** | 54.0 | 53.3 |
| **65-74** | 64.0 | 69.3 |
| **≥75** | 66.7 | 78.5 |
| **All** | 34.1 | 32.7 |
| About 69% of people who have a first heart attack, 77% who have a first stroke, and 74% who have congestive heart failure have blood pressure higher than 140/90 mmHg. | | |
| Go AS, Mozaffarian D, Roger VL *et al.* (2013), On behalf of the American Heart Association Statistics Committee and Stroke Statistics Subcommittee, Heart disease and stroke statistics - 2013 update: A report from the *American Heart Association, Circulation*, 127,e6-e245. | | |

ASEP Board Certified Exercise Physiologists can help clients lower elevated arterial pressure by initiating positive lifestyle interventions that may include dietary sodium restriction, potassium supplementation, reduction in body weight, moderation in alcohol consumption, and increased physical activity. As to the latter consideration, it is well documented that physical training of clients with hypertension results in a clinically relevant decrease in resting and daytime ambulatory blood pressure (Naka *et al.* 2003; Pescatello *et al.* 2004) (Box **4**).

**Box 4. Age-specific relevance of decreasing SBP.**

| |
|---|
| A decrease in SBP of 2 mmHg reduced death by stroke by 10% and death from ischemic heart disease by 7% among middle-aged persons.<br><br>Lewington, S, Clarke, R, Qizilbash, N *et al.* (2002), Age-specific relevance of usual blood pressure to vascular mortality, *Lancet,* 360,1903-1913. |

CHAPTER 7

# Exercise and Stroke

**Abstract:** An estimated 7 million Americans are living with a stroke, which is a leading cause of long-term disability. The major contributor to the anticipated increase of 4 million strokes by 2030 is hypertension, which is close to a ~25% increase in prevalence from 2010. Survivors are more sedentary than the average person, thus increasing the likelihood of falls and other chronic diseases. To increase their cardiovascular health, regular exercise is recommended. Also, regular exercise can help decrease the ~800,000 annual strokes in the United States. This is important in that strokes are the 3rd leading cause of death with huge medical cost. Fortunately, it is now medically recognized that exercise medicine improves aerobic capacity, physical functioning, and quality of life.

**Keywords:** Comorbid conditions, Exercise medicine, Exercise testing, Hemodynamic response, Resistance training, Stroke survivors, Stroke-related medical costs.

## INTRODUCTION

A stroke occurs when blood flow to the brain is interrupted preventing oxygen and nutrients from reaching brain cells. Without oxygen, brain cells die and specific body functions are diminished or completely lost (American College of Sports Medicine 2010). There are two types of strokes: (a) ischemic stroke, which accounts for ~83% of all cases due to a clot that blocks an artery supplying blood to the brain; and (b) hemorrhagic stroke accounts for ~17% of stroke cases, resulting from leaking or breaking of an artery to the brain (Adams *et al.* 2003). If a client is older than 55 yrs of age, male or has a family or personal medical history of stroke, there is the risk of a stroke. Aside from taking high blood pressure medicine, regular exercise and losing excess weight can help prevent it.

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## EPIDEMIOLOGY OF STROKE

Approximately 800,000 Americans have a new or recurrent stroke each year of which ~600,000 of these are first attacks, and ~185,000 are recurrent attacks. This means that an American suffers a stroke about every 45 sec and dies of a stroke about every 4 min (Gordon *et al.* 2004). Of these deaths, ~40% are men and ~60% are women at an annual stroke-related medical costs and disability of about $73.7 billion in 2010. As the 3rd leading cause of death in America, stroke kills ~130,000 each year or 1 out of every 20 deaths (CDC, NCHS 2015). The risk of having a stroke varies with race and ethnicity. African-Americans are nearly twice at risk of having a stroke than are whites, and they are more likely to die after a stroke than whites. Even though strokes can occur at any age, ~75% of all strokes occur in adults 65 yrs of age or older (West 2010).

The risk of ischemic stroke in current smokers is ~2 times that of nonsmokers (Shah & Cole, 2010). In ischemic stroke survivors >65 yrs of age, ~35% have symptoms of depression, ~30% cannot walk without assistance, ~26% live in a nursing home, and ~19% have difficulty speaking and/or understanding language. Three in 10 over 65 yrs of age cannot walk on their own 6 months after their stroke, and 1 out of 4 are not able to live independently. Stroke is a leading cause of long-term disability due to clots that occur in the arteries supplying the brain. The clots are usually the result of a buildup of cholesterol and fatty deposits (*e.g.,* atherosclerosis).

If more adults embrace regular exercise, it would likely translate into a reduced risk for mortality from stroke by decreasing atherosclerotic lesions throughout the vascular system. Modification of multiple risk factors is important in the prevention of stroke (Sacco *et al.* 1997) (Box **1**). Approximately 80% of the strokes in the United States are preventable by decreasing the clients' risk factors (particularly, the hemorrhagic stroke that is the result of a break in an artery to the brain due to uncontrolled hypertension or an aneurysm).

**Box 1. Risk factors for stroke.**

| | |
|---|---|
| • Atria fibrillation | • Diabetes mellitus |
| • Hypertension | • Obesutt |
| • Abnormal blood lipids and lipoproteins | • Sleep apnea |
| • Cigarette smoking | • Birth-control pills |
| • Physical inactivity | • Family history of stroke |
| • Congestive heart failure | • Gender |
| • Previous heart attack | • Race |

A large number of stroke survivors live in the United States, which is likely to continue to increase. This is especially the case since so many people do not exercise regularly, consume too many calories, and turn a blind eye to monitoring their blood pressure. In addition, they smoke, drink alcohol to the excess, and fail to implement control measures to deal effectively with stress. Ultimately, when all factors are considered, they are subject to an increased risk of hypertension and stroke. Even when physicians prescribe medication for high blood pressure, people often fail to take the medication properly (whether it is for hypertension or high low-density lipoprotein cholesterol) (Brown & Bussell 2011).

Part of the healthcare role of the Board Certified Exercise Physiologist is to help clients understand the risk factors for stroke (Boone 2014). Another part is to help clients who are statistically predisposed to a stroke such as: (a) numbness or weakness of your face, arm, or leg (usually on one side of the body); (b) mental confusion and/or difficulty speaking or understanding; (c) blurred, double, or decreased vision; (d) dizziness and/or loss of balance; and (e) severe and/or unusual headache with no known cause (American Association of Neurological Surgeons 2015). They also need to understand that the symptoms may progress or fluctuate for 1 or 2 days.

A stroke can happen to anyone regardless of age, gender, or race. The good news is that stroke is preventable if risk factors are treated early by living a healthy lifestyle (Box **2**). Given the coexisting medical disorders among stroke survivors, it is imperative the client's medical status (especially, concomitant heart disease) is closely monitored. Complications impact the client's capacity to exercise. But, if they are successfully treated, they are not contraindications to the client's participation in an exercise medicine program (Hillman & Kravitz 2007).

CHAPTER 8

# Exercise and Peripheral Arterial Disease

**Abstract:** Peripheral artery disease (PAD) is a disease of the lower extremities that is a component of the chronic, progressive atherosclerotic process. In the United States, there are 8 million adults with PAD. Aside from the increased risk of cardiovascular morbidity and mortality, it leads to altered skeletal muscle energetics linked to mitochondrial dysfunction that hastens physical decline and disability. Fortunately, exercise medicine benefits clients with PAD by increasing walking time, walking distance, and functional capacity that reduces the risk of cardiovascular events while improving quality of life. The benefits of exercise medicine in PAD are linked to the enhanced distal blood flow and $O_2$ supply due to vascular adaptations.

**Keywords:** Atherosclerosis, Atrophy, Cardiovascular events, Diabetes, Exercise medicine, Mitochondrial dysfunction, Muscle energetic, Peripheral artery disease.

## INTRODUCTION

Today, there are 8 to 12 million Americans who are affected by peripheral arterial disease (PAD). By 2050, PAD is expected to reach ~19 million. Atherosclerosis is the most common cause for PAD, which leaves clients at high risk for myocardial infarction, stroke, and death (Rosamond *et al.* 2007). Hence, as with heart disease, the risk factors are hypertension, hypercholesterolemia, diabetes mellitus, and tobacco use. Approximately 50% of the people with PAD do not have any symptoms (of which the most common symptom is intermittent claudication) (McDermott *et al.* 1999). Clients with claudication experience pain, aching, and cramping in their calf muscles when walking or engaged in daily physical activities. But, if they do engage in regular exercise, it is possible to preserve and/or improve functional capacity (Milani & Lavie 2007).

**Tommy Boone**

## EPIDEMIOLOGY OF PAD

The hallmark symptom of PAD is intermittent claudication. This has always been true until PAD was recognized in patients without claudication. Whether there is claudication or not with PAD, the disease limits functional capacity due to the impairment by narrowing or blockage of the arteries in the arms and legs. In addition to the physical limitation, the client's quality of life is decreased to the point of self-imposed restriction in physical activities and quality of life. In addition to pharmacotherapy (cilostazol) and revascularization, the primary treatment is exercise medicine. The major risk factors for PAD include cigarette smoking, hypertension, hyperlipidemia, and diabetes. Lowering cholesterol can prevent worsening of PAD, and it can help reduce the symptoms of claudication. A blood LDL-cholesterol level <100 $mg \cdot dL^{-1}$ (2.6 $mmol \cdot L^{-1}$) is recommended. Antiplatelet agents (aspirin and clopidogrel) are recommended for clients with PAD to help decrease the need for surgery. They also help to decrease the risk of myocardial infarction, stroke, or death from PAD (Milani & Lavie 2007).

The pain and discomfort associated with intermittent claudication varies. Some clients will have severe, debilitating discomfort while others will have minimal symptoms. The severity of symptoms depends on the number of arteries affected, how narrow the arteries are, and the number of collateral vessels that provides blood and oxygen. A client may have pain in the buttock, thigh, calf, or foot, either alone or in combination. Calf claudication is the most frequent location of pain due to disease in the popliteal artery on the posterior side of the knee.

## IMPROVING THE FUNCTIONAL STATUS OF PAD CLIENTS

Most clients with claudication are treated medically, which includes reducing risk factors, exercise training, and using medications that may improve walking distance. Exercise programs help to reduce the symptoms of claudication, but the benefits of exercise decrease when exercise training stops. The Board Certified Exercise Physiologist's exercise medicine strategy is to increase the client's functional capacity by improving walking ability. Exercise training also helps to decrease limb symptoms and disability (American Association of Cardiovascular and Pulmonary Rehabilitation 2004). Supervised exercise medicine increases

physical function while decreasing cardiovascular risk (Askew *et al.* 2013; Bendermacher *et al.* 2006; Bronas *et al.* 2009; Clyne *et al.* 1985).

While treadmill exercise training has been associated with an improvement in endothelial health and function, additional research is needed to clarify the role of strength training. Exercise training helps to offset the mitochondrial dysfunction and impaired metabolism that impedes energy production. Long-term, supervised exercise training (*vs.* unsupervised training) appears to suppress the inflammatory markers associated with intermittent claudication, thus allowing for improvement in functional outcomes (Gardner & Poehlman 1995; Hamburg & Balady 2011).

**The Physiological Assessment**

The ASEP Board Certified Exercise Physiologists are in an excellent position to determine the client's ability to walk using a low exercise work rate with low increments on a treadmill or a cycle ergometer. This is done to determine the client's walking capacity and exercise limitations. Interestingly enough, they understand that the exercise test may be limited as much by myocardial ischemia and/or arrhythmias as by PAD. Conversely, there is the possibility that the PAD may limit the assessment of the cardiorespiratory system (Mohler 2003).

The purpose of the treadmill test is to evaluate the client's cardiorespiratory system and walking ability. The test should be stopped when the leg pain makes it difficult to continue to walk. Also, when there are objective signs of ischemia *via* the ECG recordings, the test should be stopped with recordings of the client's walking distance and time to experiencing symptoms of claudication.

Because of the limitations imposed by the reduced blood supply to the muscles of the legs, the lack of regular exercise results in significant functional impairment. Not only are there structural and functional changes to the cardiorespiratory system (such as the decrease in SV, Q, and $VO_2$ max) that reduce the availability of $O_2$ at the cellular level, the musculoskeletal system undergoes a significant decrease in muscle mass, strength, and endurance (Parmenter *et al.* 2015).

**THE EXERCISE PRESCRIPTION**

The treadmill is used more often than the cycle ergometer for PAD clients with

# CHAPTER 9

# Exercise and Chronic Obstructive Pulmonary Disease

**Abstract:** Approximately 17 million adults in the United States are diagnosed with chronic obstructive pulmonary disease (COPD), which is the third leading cause of death in America with more females dying from COPD than males. Yet, despite the death rate due to COPD and the awareness of smoking as the primary risk factor, 80 to 90% of the patients with COPD smoked cigarettes. Because the shortness of breath increases the likelihood of a sedentary lifestyle with decreases in functional capacity, skeletal muscle mass, and quality of life, COPD patients should be encouraged to participate in an exercise medicine program that is safe and effective.

**Keywords:** Acute bronchitis, Aerobic training, COPD, Dyspnea, Emphysema, Exercise medicine, Exercise precautions, Hypoxemic clients, Pulmonary rehab.

## INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a term that refers to chronic obstructive bronchitis and emphysema. Difficulty in emptying the lungs is a major health problem since the lungs are critical to the respiratory process that is responsible for supplying $O_2$ to the body. Thus, an obstruction of the lungs contributes to disability and a sedentary lifestyle. This means that COPD patients are limited in their capacity to engage in household and/or recreational activities. The intolerance to exercise leads to a progressive deconditioning of the skeletal muscles, cognitive function, and aerobic power (Allaire *et al.* 2004). More often than not, patients become homebound and isolated from their family and friends, which leads to depression and anxiety (Bosken *et al.* 1992; Centers for Disease Control and Prevention 2002; Hnizdo *et al.* 2002).

**Tommy Boone**

## EPIDEMIOLOGY OF COPD

Chronic obstructive pulmonary disease (COPD) refers to different lung diseases characterized by the obstruction of air flow that interferes with normal respiration. While ~17 million adults in the United States have been diagnosed with COPD, the actual number is closer to 25 million. The umbrella term, COPD, is used for three different diseases (emphysema, chronic obstructive bronchitis, and chronic asthmatic bronchitis) (Box **1**). What the diseases have in common with each other is the obstructed air flow through the lungs (Boone 2014).

**Box 1. COPD = Three diseases!**

• Emphysema involves the gradual destruction of the alveoli (air sacs) located at the tip of the bronchioles (the smallest air passages). The walls of the alveoli are destroyed and gas exchange is decreased, leading to dyspnea, fatigue, and early death.
• Chronic bronchitis is characterized by chronic inflammation of the lining of the bronchial tubes that transport $O_2$ in and $CO_2$ out of the lungs. Symptoms include shortness of breath (dyspnea), thickening, and narrowing of the airway lining, constant coughing to remove phlegm, wheezing, and fatigue.
• Chronic asthmatic bronchitis is often a complication of frequent asthma and/or bronchitis. The asthmatic problem has become so persistent that chronic airflow obstruction is present despite anti-asthmatic therapy.

According to the American Lung Association, Epidemiology and Statistics Unit, Research and Health Education Division (2013), the national projected annual cost for COPD in 2010 was $49.9 billion. This includes $29.5 billion in direct health care expenditures, $8 billion in indirect morbidity costs (accounts for lost productivity due to illness), and $12.4 billion in indirect mortality costs (*i.e.,* productivity lost to early death).

Since 1993, the hospital discharge rate for COPD is higher in women than in men. Also, since 1999, the number of women who have died from COPD exceeds the number in men. Women are twice as likely to be diagnosed with chronic bronchitis as men, and women are more likely than men to receive a diagnosis of emphysema. This means that more women than men are limited in the abilities to perform daily work activities. The resultant physical inactivity and ventilatory limitation further increases the likelihood of becoming isolated and depressed.

Oxygen delivery and oxygen consumption by the muscles of the lower extremities are impaired during physical exertion and exercise. The impairment results in the

avoidance of physical activities due to dyspnea, leg discomfort, lower extremity fatigue, diminished functional capacity and strength, depression, and anxiety. However, it has been known since the 1960s that if COPD clients are motivated by credible healthcare professionals to engage in exercise training (even with the irreversible structural alterations in lung architecture), exercise tolerance and respiratory limitations can be improved (Casaburi *et al.* 1997; Cooper 2001).

## BENEFITS OF EXERCISE IN COPD

COPD patients benefit psychologically and physiologically from participation in exercise medicine programs that involve lower and upper body aerobic training and resistance training. The leg exercises vary from treadmill walking, track walking, or using a stationary bike. The benefits include an increase in physical capacity and a decrease in leg fatigue. Overall, the client is less anxious about breathlessness (despite the impaired lung function and the shortness of breath). The improvement in fitness and confidence raises the client's hope and expectation of an improved quality of life. With less shortness of breath, more energy, and there is an increased sense of control, especially exercise medicine helps to reduce hospitalization (Debigare & Maltais 2008; Rochester 2003). As the client's exercise program progresses from low-intensity to a slightly higher percentage of peak work capacity, the sensation of breathlessness should decrease somewhat. This expectation is no different from non-COPD clients who benefit more from mixing moderate-intensity exercise for a variable period of time with low-intensity training *versus* a sustained low-intensity exercise throughout the exercise period (Dressendorfer *et al.* 2014; Garcia-Aymerich *et al.* 2006).

Clients also benefit from information about diaphragmatic and pursed-lip breathing. Client education and counseling (regarding medications, the use of supplemental oxygen, and bronchodilators before and during exercise) are a critical part of the exercise medicine program. Naturally, the client should stop exercising if there is pain or pressure in the jaw, neck, chest, or arm. This is true for headaches, lightheadedness, and nausea during exercise as well. The exercise should be stopped. If the symptoms of inadequate blood flow to the heart and/or head continue, the client should consult with a medical doctor.

CHAPTER 10

# Exercise and Osteoporosis

**Abstract:** Osteoporosis is increasingly a global disease in which the remodeling process (*i.e.*, replacement of new bone for the old) results in an excessive loss in bone mass to the point that they fracture easily. Although weak bones are more common in older men and women, it can begin in childhood. The risk of developing osteoporosis and the risk of falling and susceptibility to fractures can be reduced by eating a healthy diet and engaging in regular exercise. In fact, regular exercise is believed to be the most important factor to increase or maintain bone mass density (BMD). The mechanical forces placed on the skeletal system during exercise stimulate bone size, shape, and strength by increasing BMD at weight bearing sites to promote bone mass.

**Keywords:** Aerobic training, Bone mineral density, Kyphosis, Osteoarthritis, Osteopenia, Osteoporosis, Resistance training, Weight bearing exercises.

## INTRODUCTION

Osteoporosis is a disease and a healthcare problem marked by a decrease in bone mass density (BMD) that leads to an increase in fractures, mortality, and musculoskeletal impairment. The decrease in BMD takes place when there is a large amount of bone loss during resorption and/or an insufficient bone formation. Lifestyle factors (*e.g.,* diet, smoking, alcohol, and exercise) and gender influence bone formation throughout life. Regular exercise is an important modifiable factor with the potential to increase or maintain BMD (Nordstrom *et al.* 2011).

## EPIDEMIOLOGY OF OSTEOPOROSIS

Currently, ~2 million men and ~8 million women have decreased BMD that is consistent with osteoporosis in the United States (MacLean *et al.* 2008. The women are 4 times more likely to meet the diagnostic criteria for osteoporosis.

**Tommy Boone**

Also, since age is highly correlated with osteoporosis, the percent of older, postmenopausal women goes up dramatically with age, which is also true with fractures (given that for every 10% decrease in bone mass, there is ~2 times the risk of a fracture). Worldwide, ~200 million people suffer from osteoporosis.

The decrease in BMD reduces the strength of skeletal system, thus setting the stage for increased osteoporotic fractures and disability. In fact, 1 out of 2 women and 1 out of 4 men over 50 yrs of age experience bone weakness related fractures. The disease is responsible for more than 1.5 million fractures annually, including:

- ~300,000 hip fractures
- ~700,000 vertebral fractures
- ~250,000 wrist fractures, and
- ~300,000 fractures at other sites

Although environmental and lifestyle factors (*e.g.,* milk consumption in youth and as young adults) can modify ~30% of peak bone mass, osteoporosis is determined primarily by genetic factors. Alcohol intake, smoking, physical inactivity, medications (steroids), and chronic diseases (such as lung disease, rheumatoid arthritis, hyperthyroidism, and neurologic disorders) affect bone remodeling to the point of increasing the risk of osteoporosis (Lanyon 1966; Waugh *et al.* 2009).

Peak bone mass of young adults is 5% to 10% greater in the black population, and 5% to 10% higher in young men than young women. Women tend to lose bone mass more quickly than men, but that can be modified by applying loads to the skeletal system. Regular exercise and increased participation in sports programs increase in bone density in both sexes. This is especially true for gymnastics and rope jumping; both physical activities result in greater bone density than running.

Bone growth and bone mass is largely driven by both the removal of old bone and the replacement of new bone (a process called remodeling) to maintain skeletal strength. The process is regulated by hormones and growth factors that become evident in premenopausal women (when more bone is removed than replaced) due possibly to the decline in the activity of the ovaries (Morris *et al.* 1997). Adequate intake of calcium and vitamin D helps to prevent osteoporosis by retarding bone loss in postmenopausal women, thus decreasing the risk of falls (Avenell *et al.*

2009).

Vitamin D is needed to absorb calcium from the intestines and into the blood. About ~35% of the adults with hip fractures are vitamin D deficient, which is critical to absorbing calcium. Vitamin D is synthesized in the skin when exposed to sunlight, and it is also in fortified milk and cereals. However, many people do not produce enough vitamin D or get enough from food, and vitamin D deficiency can be a problem for older adults who are homebound or bed-ridden (Box **1**). After all, osteoporosis is a silent disease until it is complicated by fractures.

**Box 1. The power of exercise and sunshine.**

"Walking outside in the sunshine not only gives bones the strengthening benefits that come with the weight bearing exercise of walking, but the skin exposure to sunshine also helps with the absorption of Vitamin D."


Since bone mass peaks by 20 yrs of age, it is important that exercise is part of the lifestyle of young adults as they age. The role of exercise medicine is well-known, especially in promoting calcium intake, maintaining bone mass, and strengthening the functionality of bone (Halioua & Anderson 1989; Looker *et al.* 1997). All three help to avoid a decrease in bone mass and the deterioration of bone tissue. By way of its load-bearing effect on the skeletal system, regular exercise is the single most important influence on bone density, architecture, and maintaining healthy bones (Kemmis 2010; Rackoff *et al.* 2009; Robinson *et al.* 1995; Welten *et al.* 1995) (Box **2**).

**Box 2. The load-bearing effect on the skeleton.**

"Bone cells respond to mechanical loading by improving the balance between bone formation and bone resorption, which in turn builds greater bone mass. The higher the load, the greater the bone mass; conversely, when the skeleton is unloaded (as with inactivity), bone mass declines."

Lanyon, LE (1987), Functional strain in bone tissue as an objective, and controlling stimulus for adaptive bone remodeling, *Journal of Biomechanics*, 20,1083-1093.

Lanyon, LE (1993), Osteocytes, strain detection, bone modeling and remodeling, *Calcified Tissue International,* 53,1,S102-S107.

CHAPTER 11

# Exercise and Cancer

**Abstract:** Nearly 14.5 million children and adults with a history of cancer were alive in 2014 in the United States. A total of ~1.7 million new cancer cases and 589,430 cancer deaths are projected to occur in the United States in 2015. While it was common for physicians to advise cancer patients to avoid physical activity, the recommendation today is low- to moderate-intensity exercise of 150 min·wk$^{-1}$ (*i.e.*, 50 min·d$^{-1}$, 3 times·wk$^{-1}$). Board Certified Exercise Physiologists pay close attention to cancer survivors' responses to exercise training to ensure their safety. Exercise medicine improves aerobic fitness and muscle strength, and increases the cancer survivor's quality of life. Regular exercise is safe, and it does not interfere with the client's medical condition. In fact, it helps to offset the increased risk for chronic diseases (such as T2DM and CHD).

**Keywords:** Aerobic capacity, Anemia, Atrophy, Chemotherapy, Chronic diseases, Dyspnea, Invasive breast cancer, Osteoporosis, Radiation therapy, Strength training.

## INTRODUCTION

From the time of diagnosis through the rest of their lives, anyone who has been diagnosed with cancer is a cancer survivor. The number is increasing every year, especially since more people are getting older and seeking early detection and treatment. In the United States, the number of cancer survivors is more than 14 million and is expected to increase (American Cancer Society 2010; Jemal *et al.* 2008). Soon, the estimate of 1 in 25 Americans with cancer will be even higher. Many cancer survivors are highly motivated to find healthcare professionals with scientific training in prescribing exercise medicine and other therapies to improve their recovery process (Meyerhardt *et al.* 2006; Rock *et al.* 2012).

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## EPIDEMIOLOGY OF CANCER

Cancer is a major public health problem in the United States. Aging contributes to the problem since there is an age-related increased susceptibility to neoplasia. In fact, the majority of the cancer survivors are 65 yrs of age and older. It is the second most common cause of death following heart disease that also appears to be related to aging. New guidelines from the American Cancer Society (ACS) offer scientific-based advice for eating better and staying physically active. The fact is people with cancer live longer if they engage in regular exercise. It is not only safe and feasible during and after cancer treatment, it helps to fight fatigue, enhance functional capacity, and improve quality of life (Abrahamson *et al.* 2006). Also, since physical inactivity is associated with the risk of colon, breast, and possibly other cancers, regular exercise is one of several modifiable risk factors for cancer (Kenfield *et al.* 2011; Kushi *et al.* 2012) (Box **1**).

**Box 1. Modifiable risk factors for cancer.**

- Diet and obesity (associated with increased risk of colon, breast, and other cancers)
- Tobacco smoking (associated with lung cancer, mouth, and throat cancer)
- Drinking alcohol (associated with a small increase in oral, esophageal, breast, liver, and other cancers)
- Sexual transmission of human papillomavirus (that causes cervical cancer and some forms of anal cancer)
- Ultraviolet rays from the sun and radon gas in the home

This means that the abovementioned risk factors in Box **1** can be treated or controlled. In most cases, there is good evidence that treatment leads to a significant reduction in the occurrence of cancer. There are also other lifestyle and environmental factors known to influence cancer risk (Schmitz *et al.* 2010). Hormone replacement therapy increases the risk of breast cancer, and exposure to ionizing radiation and ultraviolet radiation, and certain occupational and chemical exposures warrant concern for an increase in the risk of cancer. Workers increase their risk of pleural and peritoneal mesothelioma from exposure to asbestos fibers or leukemia from exposure to benzene at work (Danaei *et al.* 2005).

Cancer is a combination of related diseases. It is not a single disease. Different genetic factors (*e.g.,* family history) are involved as well as a person's lifestyle. While there are numerous environmental factors that may increase or decrease the risk of getting cancer, it is clear that exercise medicine: (a) decreases the risk of

different cancers; (b) extends survival for breast and colon cancer survivors; and (c) promotes psychosocial well-being of cancer survivors (Doyle *et al.* 2006).

After completing treatment for cancer, the recovery process begins. For the most part, it is complete within several weeks. But, cancer survivors should not be surprised that there will be a few side effects after treatment. Moreover, some late-occurring effects or complications (Box **2**) may not show up for months or even years later after treatment (American College of Sports Medicine 2011).

**Box 2. Late and long-term complications after cancer treatment.**

| | |
|---|---|
| • Fatigue | • Pain |
| • Nervous system problems | • Lymphedema |
| • Difficulty chewing and swallowing | • Osteoporosis |
| • Difficulty building lean muscle mass | • Vision problems |
| • Altered sense of taste | • Menopausal symptoms |
| • Diarrhea | • Changes in weight |
| • Constipation | • Bladder problems |
| • Fertility problems | • Decreased thyroid function |
| • Heart problems | • Lung problems |

The late effects appear months or years after treatment while the long-term effects represent complications that begin during or very shortly after cancer treatment. Board Certified Exercise Physiologists are aware of the effects of treatment and the role each may play in a cancer survivor's exercise prescription, tolerance, and training.

## EXERCISE GUIDELINES FOR CANCER SURVIVORS

The presence of a Board Certified Exercise Physiologist who understands the importance of individualized exercise prescriptions will help to ensure the client's training is safe and appropriate. This means that the exercise protocol will be defined in accordance to the client's pretreatment physical exercise capacity, existing comorbidities, mental and physical responses to treatment, and the late and long-term effects of treatment (Dusek & Benson 2009). Understandably, there are contraindications to starting an exercise training program and indications for stopping the program. The ASEP position on which cancer survivor should and should not exercise is the responsibility of the attending physician. It is not the

CHAPTER 12

# Exercise and Aging

**Abstract:** The aging population is presently healthier and better educated about lifestyle risk factors than ever before. This fact as well as the improvements in healthcare represent why ~60% of the older adults are healthy at age 65 and expect to live another 15 to 20 yrs. But, this does not mean that everything is great. The high percent of heart disease, hypertension, stroke, respiratory disease, peripheral vascular disease, arthritis, and falls in adults 65 yrs of age and older requires specialized attention from Board Certified Exercise Physiologists to prescribe exercise medicine to lower the risks of living with or dying prematurely from chronic diseases.

**Keywords:** Advancing age, Aerobic capacity, Aging, Cognitive impairment, Elderly, Exercise prescription, Functionality, Hypertrophy, Lean muscle mass.

## INTRODUCTION

Most physiological systems in the body undergo structural and functional changes with aging. If the deterioration is bad enough, the changes influence the quality of daily living. From the exercise physiologist's perspective, aging is associated with large decreases in maximal oxygen consumption ($VO_2$ max) and lean muscle mass and strength. As a result, the aging effect on $VO_2$ means that a higher percent is required to do what was easier when younger. Also, it is clear that (Spirduso *et al.* 2005) the profound decrease in lean muscle mass and bone mass density with aging adds even a greater workload to the already elevated heart rate (HR) and systolic blood pressure (SBP) responses during life's daily activities.

## EPIDEMIOLOGY OF AGING

Not only is the population of the United States aging, adults worldwide are aging. While 4% of the U.S. population in 1900 was aged 65 yrs or older, at the end of

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the 20th century it increased to 13%. By year 2030, the percent of older adults aged 65 yrs and older is expected to increase to 20% of the population. The reality of living longer is not without concerns and challenges. In particular, the aging population needs a better understanding of underlying risk factors that diminish health and well-being (Hillman *et al.* 2008). There is also the need for more qualified healthcare professionals such as the ASEP Board Certified Exercise Physiologist to improve the client's quality of life, maintain optimal health and function, and decrease healthcare needs and costs.

It is recognized that aging is a primary risk factor for the development and progression of chronic degenerative diseases and musculoskeletal conditions (Box **1**). In addition to the epidemiologic complexity of these interactions, there are lifestyle behaviors, interventions (including exercise), and genetic factors that impact the aging process and disease mechanisms (Miller *et al.* 2014). The significance of the changes with aging requires a better understanding of the effects on the muscular response, cardiovascular function, pulmonary capacity, physical functionality, body composition, and metabolism (Koopman *et al.* 2014).

**Box 1. The 15 most prevalent conditions among persons aged 65 yrs or more in the U.S.**

| Condition | Annual Prevalence (per 1,000)* | |
|---|---|---|
| Arthritis | 473 | 47.3% |
| Hypertension | 415 | 41.5% |
| Heart disease | 305 | 30.5% |
| Hearing loss | 294 | 29.4% |
| Influenza | 214 | 21.4% |
| Injuries | 176 | 17.6% |
| Orthopedic impairment | 171 | 17.1% |
| Cataracts | 164 | 16.4% |
| Chronic sinusitisc | 155 | 15.5% |
| Depression | 147 | 14.7% |
| Malignant neoplasms | 145 | 14.5% |
| Diabetes mellitus | 104 | 10.4% |
| Visual impairment | 97 | 9.7% |
| Urinary incontinence | 88 | 8.8% |

*(Box 1) contd.....*

| Condition | Annual Prevalence (per 1,000)* | |
|---|---|---|
| Varicose veins | 76 | 7.6% |

*Source: National Center for Health Statistics (Moss, AJ & Parsons, VL, Current estimates from the National Health Interview Survey, United States, 1985, Hyattsville, MD: *National Center for Health Statistics*, 1986, *Vital and Health Statistics*, series 10, no. 160, DHHS publication no., PHS, 86-1588, and Harris, T, Aging in the eighties: prevalence and impact of urinary problems in individuals age 65 years and over, Preliminary data from the Supplement on Aging to the National Health Interview Survey, United States, January-June, 1984. Hyattsville, MD: *National Center for Health Statistics*, 1986).

## PHYSIOLOGICAL CHANGES WITH AGING

### Decrease in Lean Muscle Mass and Strength

Adults ~40 yrs of age and inactive lose as much as 3% to 5% of their skeletal muscle mass per decade after age 30, which means that aging reduces muscle strength and mobility. This age-related decrease in the ability to lift a heavy object (*i.e.,* concentric contraction orthe shortening of muscles as they contract), to lower the object in a safe manner (eccentric contraction or lengthening of muscles as they contract), and to hold an object in one position for 30 sec without movement (isometric contraction) is harder to carry out due to the decline in muscle mass and strength (sarcopenia, which is characterized by a preferential decrease in type II fast-twitch fibers) (Bogdanis 2012; Booth & Thomason 1991).

After ~65 yrs of age, sarcopenia accelerates with noticeable changes in the control and performance of muscle strength and endurance as well as the power and quality of body movements. The changes are especially evident with the lower extremity muscles more so than the upper extremity muscles. By ~75 yrs of age, there are sensory, motor, and cognitive changes that alter and impair balance and simple acts of human movement, particularly with regards to poor flexibility that results from decreases in muscle and tendon elasticity (Podosky & Schoenberg 1983). The fear of falling and physically suffering from a fracture places undo constraints on lifestyle with adverse affects on daily activities (Shephard 1998).

The effect of age-related changes in body weight and body mass index (BMI) is misleading in that weight in pounds often stays the same. The problem is that the decrease in lean muscle mass is commonly replaced by essentially an equal

CHAPTER 13

# Exercise and Depression

**Abstract:** Depression is a widespread mental disorder that presents with depressed mood, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, low energy, and poor cognitive function. While the use of drugs is a common practice, exercise is an effective therapy in the treatment of mild to moderate depression. Exercise is also an excellent complementary therapy to the treatments of antidepressant medications and psychotherapy for severe depression. Also, there is strong evidence that regular exercise is effective in the treatment of depression related incidence of co-morbid somatic illnesses (*e.g.*, coronary heart disease, type 2 diabetes, and osteoporosis). Board Certified Exercise Physiologists are in an excellent position to motivate physically inactive and depressed clients to become physically active and to optimize the mind-body effects of exercise medicine.

**Keywords:** Antidepressant, Chronic fatigue syndrome, Depression, Endorphins, Exercise prescription, Psychotherapy, Regular exercise, Relaxation, Stressors.

## INTRODUCTION

Depression is a mental disorder with a high incidence of coronary heart disease (CHD), type 2 diabetes mellitus (T2DM), and cognitive decline (Blumenthal 2008). Patients are often sedentary with poor cardiorespiratory fitness. The common practice is to treat depression with antidepressants and psychotherapy. It is less common to treat with exercise medicine (Babyak *et al.* 2000).

## EPIDEMIOLOGY OF DEPRESSION

Depression is a widespread mental disorder with high rates of relapse. In fact, according to the World Health Organization (2004), 22% to 50% of the recovered patients will suffer recurrent episodes within 6 months after recovery. Women are twice as likely as men to be depressed, which is defined by the American

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Psychiatric Association (1994) as a mental disorder that presents with: (a) depressed mood; (b) loss of interest or pleasure; (c) feelings of guilt or low self-worth; (d) disturbed sleep or appetite; (e) low energy; and (f) poor concentration.

In addition to 5 or more of the following symptoms being present during the same 2-wk period that also represents a change from the client's previous functioning, at least one of the symptoms is either "depressed mood" or "loss of interest and/or pleasure".

1. Depressed mood nearly every day during most of the day
2. Marked diminished interest and/or pleasure in almost all activities
3. Significant weight loss (when not dieting), weight gain, or a change in appetite
4. Insomnia or hypersomnia (excess sleep)
5. Psychomotor agitation and/or psychomotor retardation
6. Fatigue and/or loss of energy
7. Feelings of worthlessness and/or inappropriate guilt
8. Impaired ability to concentrate and/or indecisiveness
9. Recurrent thoughts of death and/or suicidal ideation

Lifetime prevalence varies widely from 3% in Japan to 17% in the United States (Andrade & Caraveo-A 2003). In most countries, the number of people who suffer from depression falls within an 8 to 12% range. In North America, the probability of having a major depressive episode within a period of 1 yr is 3 to 5% for males and 8 to 10% for females (Kessler *et al.* 2003). The first depressive episode is most likely to take place between 50 to 60 yrs of age. When the depressive symptoms coexist with CHD (*e.g.,* myocardial infarction), it increases the risk of death ~2.5-fold. Depression is also linked to developing T2DM, and it is a risk factor for osteoporosis (Ilias *et al.* 2006).

The Centers for Disease Control and Prevention (CDC) (2012) indicate that 8% of persons aged ≥12 yrs (6% of males and 10% of females) reported current depression. Females have higher rates of depression than males in every age group. Males aged 40 to 59 yrs have higher rates of depression (7%) than males aged ≥60 yrs (5%). Females aged 40 to 59 yrs have higher rates of depression (12%) than females aged 12 to 17 yrs (8%) and females aged ≥60 yrs (7%).

Among the states surveyed by the CDC, those with the highest levels of depression are Alabama, Mississippi, and West Virginia and those with the lowest rates of depression are North Dakota, Minnesota, Alaska, and Iowa. The range of depression is ~5% in North Dakota to ~15% in Mississippi. Depression is involved in more than two-thirds of the 30,000 suicides that occur in the United States every year, especially among white men 85 yrs of age or older.

## EXERCISE MEDICINE

Regular exercise (*e.g.,* 3 to 5 times·wk$^{-1}$ for 40 to 60 min·d$^{-1}$ with a weekly energy expenditure of at least 17.5 kcal·kg$^{-1}$·wk$^{-1}$) is associated with a decrease in the prevalence of mild to moderate depressive symptoms (Barbour *et al.* 2007). Part of the reason stems from the improvement in self-esteem (Fox 2000; Sonstroem & Morgan 1989). Exercise releases endorphins that interact with receptors in the brain that improve mood (Fremont & Craighead 1987). The effect is similar to that of morphine and other painkillers (without the addiction) with a reduction in the perception of pain. Also, exercise increases the positive feelings of self control, social interaction, and cognitive function (Knapen *et al.* 2009; Somers *et al.* 2006) (Box **1**).

**Box 1. Aerobic exercise and the brain structure and function.**

• **"There is an increasing recognition that habitual aerobic exercise enhances cognitive function and attenuates age-related deterioration of brain structure."**

Tarumi, T & Zhang, R (2014), Cerebral hemodynamics of the aging brain: Risk of Alzheimer disease and benefit of aerobic exercise, *Frontiers in Physiology*, 5,16.

• **"Regular aerobic exercise preserves the microstructural integrity of white matter that is responsible for visuospatial function, motor control, and coordination."**

Tseng, BY, Gundapuneedi, T, Khan, MA, Diaz-Arrastia, R, Levine, BD, Lu, H *et al.* (2013), White matter integrity in physically fit older adults, *Neuroimage*, 82,510-516.

• **>"Aerobic exercise increases the peripheral levels of growth factors, which cross the blood-brain barrier and stimulate neurogenesis and angiogenesis. Consistent with this, exercise-related enlargement of hippocampus was accompanied by increases in cerebral blood volume and capillary densities. Enhanced cerebral perfusion may not only facilitate the delivery of energy substrates, but also lower the risk of vascular-related brain damage."**

Pereira, AC, Huddleston, DE, Brickman, AM, Sosunov, AA, Hen, R, McKhann, GM *et al.* (2007), An *in vivo* correlate of exercise-induced neurogenesis in the adult dentate gyrus, *Proceedings of the National Academy of Sciences,* 104,5638-5643.

# PART III- The Business of Exercise Physiology

CHAPTER 14

# Exercise Physiology: A New Healthcare Profession

**Abstract:** The epidemic of sedentary behavior is a serious public health issue that requires the attention of exercise physiologists. The American Society of Exercise Physiologists (ASEP) is playing a key role in providing a profession-specific infrastructure for exercise physiologists as healthcare professionals. After all, exercise medicine is a credible treatment and should be prescribed by Board Certified Exercise Physiologists. Exercise medicine is the new treatment for heart disease, hypertension, hyperlipidemia, osteoarthritis, stroke, type 2 diabetes, cancer, obesity, osteoporosis, sarcopenia, aging, sleep apnea, and depression. Aside from Board Certified Exercise Physiologists practicing exercise medicine guided by their own Code of Ethics and Standards of Practice in their own healthcare clinics, it is inevitable that they will become members of the medical team. Exercise physiologists should join the ASEP organization, support it, and speak up to help with the professionalization of exercise physiology.

**Keywords:** Accountability, Board certification, Code of ethics, Credentialing, Exercise medicine, Exercise physiology, Healthcare profession, Professional.

## INTRODUCTION

Over the past four decades academic exercise physiologists have defined exercise physiology as a research discipline. The objective has always been to pursue and develop the scientific knowledge of the acute and chronic physiologic adaptations underlying sports training. While a better understanding of sports training, athletic competition, and human movement is always important, it is also important that it does not take precedent over the improvement of health and fitness, and the prevention and treatment of chronic diseases and disabilities (Boone 2012a).

The ASEP exercise physiologists have dedicated their efforts to the prevention and management of chronic lifestyle diseases. They have the scientific and hands-

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on knowledge and laboratory training to help prevent mental and physical health problems resulting from a sedentary lifestyle (Boone 2014). The ASEP leaders believe it is pastime to get beyond the user-dependency on the medical system.

The key is not the availability of self-monitoring technology to track information about an activity at a personal level. Rather, it is the professional interaction, discussion, clarification, and vision of responsible health habits between the healthcare professional and the client. Changing behavior requires supervision of the client's exercise activities and personalized instruction and counseling that is communicated in an understandable and personally relevant format.

The power of the technology used by Board Certified Exercise Physiologists allows them to monitor clients and track changes that associate with prescriptive exercise medicine programs. The growing use of direct physiologic access to real-time data and/or regression equations to generate discussion and purposeful analysis of the client's physiology should generate increased interest in new thinking for management of health and target interventions. The interaction and collaboration between the ASEP exercise physiologists and clients and patients will help change both from a passive view of personal healthcare to one of an active participant in the prevention and management of chronic lifestyle-related diseases (Boone 2012b).

## EXERCISE MEDICINE AND THE HEALTHCARE IMAGE

The expression "Change your image. Change your life" is true for many different reasons. The future of exercise physiology as a new healthcare profession is in the exercise physiologists' hands (Box **1**). But, first, they must appreciate the importance of professionalism and learn why it is important to promote the professionalization of exercise physiology (Boone 2008a). To accomplish both, exercise physiologists must learn what they think is either helping or hurting them. After all, their thoughts literally make them what they will be. No doubt that is why Emerson said: "A man is what he thinks about all day long."

The first impression of an academic degree is most often what a person walks away thinking. If you are an exercise physiologist teaching at the college level, do you want your students leave your classroom or department thinking that you are

interested only in teaching athletes to jump higher, run faster, or build bigger muscles? If not, then, you may wish to do something about what the exercise physiology contemporary image portrays (Boone 2015).

**Box 1. Becoming what we think.**

"We become what we think, what we talk about, and what we do. If we think that our work is for the right reasons, if we think that our actions will produce positive results, and if we start living as professionals, we will become our vision."

-- William Thomas Boone, PhD, MPH, MAM, MBA
Board Certified Exercise Physiologist

The leadership within the American Society of Exercise Physiologists (2015c) is interested in developing and re-enforcing the image of exercise physiology as a healthcare profession. It is part of the ASEP vision to help students think outside the box. After all, since exercise is medicine, it is only logical that it is prescribed by qualified healthcare professionals? Similarly, ask yourself this question: "Why is a college degree important with respect to one's career, particularly in the healthcare industry?" The answer can be found in a parallel thought by Plato who said that "The greatest mistake physicians make is that they attempt to cure the body without attempting to cure the mind; yet the mind and body are one and should not be treated separately!"

The greatest mistake academic exercise physiologists are making is that they go about teaching their classes and doing research without thinking of their work as a healthcare profession. Yet, exercise and medicine are one and should not be treated separately (Box **2**). Ask yourself, "Why did the ASEP leaders develop early on as an integral part of the founding of the Society of exercise physiologists specific academic accreditation guidelines?" The answer is simple and to the point. After getting the facts about "what is" professionalism, after analyzing the facts (particularly in regards to the established healthcare professions), they arrived at the decision that exercise physiology accreditation was required and, then, they acted on that decision (American Society of Exercise Physiologists 2015a).

While the path to attaining a professional healthcare image has its challenges, it is

CHAPTER 15

# Exercise Medicine

**Abstract:** Physicians need to prescribe exercise. Will they do so? Not likely in the foreseeable future. Yet, exercise can prevent chronic disease and premature death. Then, who will share the message that physical inactivity is the biggest health problem of the 21st century? Who is ready to do something about the ~50% of all adults in the U.S. will be obese by 2030? There will also be "7.8 million extra cases of diabetes, 6.8 million extra cases of coronary heart disease and stroke, and 539,000 extra cancer cases" (Wang *et al.* 2011). Board Certified Exercise Physiologists are scientifically educated to take on obesity, diabetes, and cardiovascular disease as well as depression and hypertension by prescribing exercise medicine. They understand the science of designing personalized exercise medicine programs to fight illness and poor health by promoting healthy lifestyle behaviors.

**Keywords:** Active daily living, Benefits of exercise, Chronic diseases, Evidence-based healthcare, Human and economic cost, Professionalism, Quality of life.

## INTRODUCTION

Chronic diseases are here to stay. No one in the U.S. or elsewhere is going to escape death, whether it is from an unhealthy lifestyle or not. The world is redundant with heart disease, chronic obstructive pulmonary disease, cancer, stroke, osteoporosis, type 2 diabetes, cystic fibrosis, meningitis, rheumatoid arthritis, and much more. Many people of all ages and gender suffer from several of these diseases! Life is a challenge that is driven by a mix of known factors that contribute ~40% of the total healthcare costs and associated morbidity and premature mortality. The ASEP leaders encourage all Board Certified Exercise Physiologists to share the message that exercise medicine is the equivalent of a powerful drug to treat chronic diseases and disabilities (Boone 2009b).

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## PHARMACOLOGICAL BENEFITS OF EXERCISE

There is irrefutable evidence that exercise prevents and treats osteoporosis, which affects more than 200 million people worldwide. Research findings show that lifting weights and aerobic training help to increase bone strength *via* the increase in mineral density (BMD). Aside from regular exercise strengthening muscles, optimizing the cardiovascular system, reducing blood pressure, raising the number of red blood cells, improving the quality of sleep, improving mental health, controlling body weight, and avoiding disability in the elderly, there is good scientific evidence of the medical benefits of exercise medicine improving the muscles' ability to use fats (thus preserving intramuscular glycogen during exercise), alleviating low-back pain, decreasing the onset of cataracts and age-related macular degeneration, and reducing the risk of colon cancer (Boone 2006).

An increasing amount of evidence indicates that exercise may very well be the best medicine for much of what is problematic in society, both mentally and physically (Berryman 2010). There is also evidence that the benefits of individualized exercise often help in reducing the side effects of medications. But, although some clinical practice guidelines are now recommending exercise as a therapy, the medical profession does not presently hire exercise physiologists as part of the healthcare team to prescribe exercise medicine (Box **1**). While the reasons are complex, it is worth a brief analysis.

**Box 1. Primary care physicians should hire EPCs to prescribe exercise medicine.**

When it comes to preventing and treating acute and chronic diseases associated with physical inactivity, the physician could simply hire a Board Certified Exercise Physiologist to design and oversee an exercise medicine plan. The physician can continue to address the medical issues and concerns of his/her patients while referring the exercise medicine prescription to the ASEP exercise physiologist to cut the risk of future health problems. By incorporating the profession of exercise physiology into the physician's routine medical practice, physically inactive middle-aged men and women could reduce their risk of cardiovascular and cancer related mortality and disability from joint diseases and depression.

### Exercise Physiology: An Evidence-Based Healthcare Profession

It is likely that physicians will agree that exercise has preventive and therapeutic health benefits. Yet, why would members of the medical profession hire someone

who says he or she is an exercise physiologist when the resume indicates a degree in exercise science or health and sports science? Medical doctors understand that a degree in medicine is necessary to practice medicine. Lawyers cannot practice law without a law degree. The same is true for physical therapists, occupational therapists, nurses, and dozens of other professions. Can you imagine calling yourself an athletic trainer without a degree in athletic training? No!

The importance of an academic degree giving rise to specific professional duties and responsibilities is not new. The connection between the two has been part of the credibility statement and identification of specific professions for decades. It is tragically ironic that during the past 50 yrs department chairs and exercise physiology faculty have done very little to promote exercise physiology as an accredited academic degree (Boone 2014).

But, if the medical community understood that the ASEP leadership supports their thinking by having developed very specific steps to earn the professional title –

Board Certified Exercise Physiologist – isn't it reasonable that doctors would reach out to the ASEP exercise physiologists as credible healthcare employees? From the ASEP perspective, Board Certified Exercise Physiologists are "the" healthcare professional to safely prescribe exercise medicine. That is why the ASEP exercise physiologists should be hired to prescribe exercise when physicians are treating chronic diseases just as physical therapists, physician assistants, and nurses are hired to work with physicians to help patients improve their health in accordance with their profession-specific practice standards.

ASEP Board Certified Exercise Physiologists are held accountable to a code of ethics and standards of professional practice (Boone 2009a). They are responsible for evaluating the "physiology" of exercise-related diseases and disabilities. With proper counseling and individually prescribed exercise programs, improvements in fitness can produce mental and physical health benefits. The lowering of blood pressure and the improvement in lipoprotein profile along with the enhanced bone mass and decreased risk of falling are so important that exercise should be prescribed by qualified healthcare professionals (Boone 2012; Boone 2009c).

Regular exercise has a positive influence on the mind and body. In fact, this idea

CHAPTER 16

# Entrepreneurship and Exercise Physiology

**Abstract:** ASEP Board Certified Exercise Physiologists' education and laboratory skills are decades ahead of fitness instructors or personal trainers. This is why they are recognized as a healthcare professional and entrepreneur. While the idea of starting a healthcare business driven by the scientific knowledge that is identified with exercise physiology is relatively new in academia, it is becoming increasingly popular. Given the health issues from chronic diseases, it is an opportune time to start a business that evaluates and prescribes individualized exercise medicine to patients and clients of all ages. This means that students should take several business courses while in college. Starting a healthcare business requires a lot of work, persistence, and passion along with consulting with an attorney as well as an accountant. But, like life itself, the declaration of intent and personal permission to "just do it" are a sufficient beginning to setting the course to be successful. It all begins in the mind of the believer. Belief is power!

**Keywords:** Business plan, Entrepreneur, Equipment, Fixed lease, Insurance, Lessee, Occupancy costs, Operating expenses, Sole proprietorship, Tenant.

## INTRODUCTION

There is something special about college graduates who have taken the time to plan for their future after college. More often than not, they have been influenced by their parents or a college teacher from a different department who encouraged them to think and act as an entrepreneur. In other words, the students learned that it was important to decide their professional mindset. They did not want to settle for working in "Bob's Gym". Instead, they wanted to start their own healthcare business (Boone 2012a; Boone 2012b).

They learned that their future as an entrepreneur depends on their determination as exercise physiologists to adapt, change, and grow to be successful in marketing

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their own business. But, while the emerging paradigm (*i.e.,* the role of exercise medicine in the promotion and maintenance of health and well-being) does not require a doctorate degree in exercise physiology, there are questions that need answers. How soon should students become familiar with business transactions to help evaluate their business options? Will academic exercise physiologists rise to the occasion of teaching students about small business fundamentals, products and/or services, and what healthcare markets will be serviced? What are the rules and regulations of operating a small healthcare business? What kinds of licenses and permits are required to specialize in entrepreneurship? Who are the clients? When will the business get underway? How will relationships with healthcare professionals in the community be built? Will it be obvious when necessary to change directions, strategies, and will there be the drive to stay the course?

Answers to these questions will come with new thinking. As James Allen said, "Our thoughts determine our destiny." Imagine, students just graduating from college sitting for the ASEP Exercise Physiologist Certified (EPC) exam to earn the professional title, Board Certified Exercise Physiologist (American Society of Exercise Physiologist 2015a). Now, imagine that they are interested in starting their own healthcare business. Will it be a challenge? You bet. But, starting their own business is obviously better than being a fitness instructor without health benefits or a part-time exercise specialist job in cardiac rehab.

Increasingly, more Board Certified Exercise Physiologists want to learn more about the entrepreneurial spirit. They have the desire to understand it, and they believe they can do it by developing a step-by-step plan as to how the business is expected to operate, make money, and help clients. They have studied the dynamics of marketing and advertising, and they have taken to heart advice from family members and friends, and others (*e.g.,* lawyers, accountants, and bankers) to help avoid making critical mistakes (Berson 2011; Boone 2008; Boone 1998).

## THINKING AS ENTREPRENEURS

Academic exercise physiologists must step up to the plate. They are uniquely responsible for changing the thinking of exercise physiology as a discipline to that of a healthcare profession. Avoiding and/or postponing support of ASEP cannot

help the students become successful. No matter how busy they may be doing research or for whatever reason they may want to stay disengaged from ASEP, academic exercise physiologists must see the value in teaching basic business management skills to help their students become self-employed business owners (Boone 2015a; Boone 2015b; Boone 2014; Boone 2011).

"This means there must be special moments at work or elsewhere to share with their academic colleagues the importance of ASEP and its work towards ethical thinking, accreditation, board certification, and standards of practice. Even though they may know little about each, by virtue of their identity with exercise physiology, they are responsible for extending themselves to help market exercise physiology, and to help change the work of exercise physiologists from the fitness gym mentality to that of a healthcare entrepreneur and innovator" (Boone 2009).

The most important caveat is that if exercise physiologists believe change is possible and they are willing to make it happen, then, it will happen but only in proportion to their support and that of their colleagues. This means sharing with colleagues the importance of supporting the American Society of Exercise Physiologists (2015c). It means communicating with local physicians that Board Certified Exercise Physiologists have the professional scientific education to safely prescribe and supervise exercise medicine for their patients? The physicians need to know and trust that the exercise physiologists' judgments are not compromised by financial ties to metabolic devices and sports supplement companies.

Academic exercise physiologists need to understand "that the students' education should reflect the real-world environment, including how to write a business plan, anticipate new market development, expansion strategies, and financing a business" (Boone 2012). Also, while doubts and mistakes are part of "the big picture", students need an understanding of why and how to buy adequate comprehensive insurance and plan for liability issues (Boone 2000).

While fitness professionals and physical therapists may think they are experts at prescribing exercise medicine, the fact is they do not have the exercise physiology education that Board Certified Exercise Physiologists have. Exercise physiology

# SUBJECT INDEX

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## W

## Tommy Boone, PhD, MPH, MAM, MBA

From 1973 to 1981, Dr. Tommy Boone taught exercise physiology courses at Wake Forest University in Winston-Salem, where he also developed an Anatomy Laboratory with cadavers for the graduate students. He was also the Exercise Coordinator of the WFU Cardiac Rehabilitation Program. In 1981-82, Dr. Boone moved to the University of Southern Mississippi to assume the Graduate Coordinator position in the School of Human Performance and Recreation. Aside from the responsibility of updating the graduate programs, he taught exercise physiology courses and developed an Anatomy Laboratory with cadaver for doctoral students. Prior to leaving USM, Dr. Boone completed Master of Public Health (MPH) degree to further integrate exercise physiology with health and disease prevention strategies. In 1993, Dr. Boone was appointed Chair of the Department of Exercise Science at The College of St. Scholastica in Duluth, MN. In 1994, he changed the name of the department to Exercise Physiology. In 1995, he developed a master's level graduate exercise physiology program along with an Anatomy Laboratory for graduate students to dissect cadavers. In 1997, he founded the American Society of Exercise Physiologists (ASEP) to promote the professionalization of exercise physiology as a healthcare profession. While at St. Scholastica, he completed Master of Arts in Management (MAM) in 1999 and Master of Business Administration (MBA) in 2010 to help ASEP organizational development and promote exercise physiology entrepreneurial healthcare activities. He developed the Journal of Exercise Physiology online (JEPonline) in 1998, and shortly thereafter the Professionalization of Exercise Physiology online (PEPonline), and the Professional Journal of Exercise Physiology (JPEP). In 2013-2014, Jones & Bartlett Learning published his college textbook, Introduction to Exercise Physiology, which is used for the ASEP Board Certification Exam. In 2016, he developed and published the Journal of Exercise Medicine online as credible content for Board Certified Exercise Physiologists. Dr. Boone has taught ~6,000 students in more than 250 college courses while publishing books, research articles, and presenting at national meetings throughout the U.S.