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Exercise Medicine: A Call to Action for Exercise Physiologists

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> The exercise medicine prescription – 150 minutes of exercise a week!

The research is clear that regular exercise is a powerful medicine for both the treatment and prevention of chronic disease (1). Moreover, it is helpful in dealing with obesity and its negative effects on health and wellness. Individuals who do not exercise on a regular basis are less active and are likely to live a shorter, unhealthy lifestyle. The association between being physically inactive and disease exists in all individuals regardless of age and gender (2).

Unfortunately, the inactive and sedentary lifestyle is so common that many people fail to acknowledge it as a risk factor for early disease and/or death. Why this is the case is a mystery. On one hand, it is simply easier and more direct to deal with an obvious disease by prescribing a drug while, on the other hand, speaking to a client or patient about his or her behaviors that correlate with quality of health isn't always easy to do.

Only a small number of people react in a positive way to talking about the importance of starting an exercise program, stopping smoking, and monitoring one's diet and losing weight. Yet, the question: Why isn't health and fitness a common topic among adults in particular? Also, equally strange with all the talk among certain researchers but not among the majority of the academic types is the little-discussed steps to ensure that the students of exercise physiology are involved in an intensive study of the dangers of inactivity.

Specifically, why aren't the academic programs in the Departments of Exercise Physiology accredited by the **American Society of Exercise Physiologists**? Why aren't the students sitting for the ASEP Board Certification? This does not make sense, given ASEP's emphasis on the "Exercise Physiologist Certification" and exercise medicine? Similarly, why aren't the physicians referring their patients who are either inactive or have recognized chronic disease to the ASEP organization? Considering that ASEP is the first professional organization of exercise physiologists in the United States with an emphasis on accreditation, certification, and exercise medicine, it seems logical to reach out to the leadership to build a bridge between ASEP and the healthcare industry. It is time that ASEP Board Certified Exercise Physiologists are recognized as credible healthcare professionals who have the education and laboratory training to prescribe exercise medicine (3).

So why has the academic community neglected updating exercise science major to the exercise physiology major as "the" recognized major for prescribing exercise medicine? The answer to that question is very complex, but I suspect it is just a matter of time and it is easier to do keep the academic system the way it has been for decades rather than dealing with the accreditation issues and steps. The other issue is the lack of support from the other related academic majors such as kinesiology, sports science, and human performance. They, too, could update their academic curriculum and degree title to exercise physiology. However, it is clear that the change process is very slow. In addition, the deans, department chairs, and faculty seem to be transferring the responsibility for credible career opportunities away from them and onto the students. As long as college professors continue to avoid responsibility for promoting the work of the American Society of Exercise Physiologists on behalf of accreditation and exercise medicine, it is unlikely we will see a big increase in ASEP accredited programs in the next year.

Yet, it makes sense that exercise physiologists should lead the effort in promoting exercise medicine for individuals of all ages and gender. Exercise physiologists have the expertise in helping clients and patients initiate and continue with an exercise medicine prescription. It is also clear that these healthcare professionals can have their greatest influence on the educational points of exercise medicine by explaining the physiology that undergirds the prescription for exercise. In addition, the ASEP leaders should engage as many exercise physiology entrepreneurs in the public sector as an essential part of the getting different communities of individuals involved in at least 150 $min \cdot wk^{-1}$ of regular exercise to stay fit and healthy.

Physiology of the Exercise Physiologist's Practice

"Recently, a friend asked the following question: Will you describe what you mean by educating the students of exercise physiology to the benefits of exercise medicine? I said, Yes, I will be glad to. But, please understand the process of doing so does not happen overnight. I have always believed that it would be a great idea to talk about the benefits of regular exercise while being physically active with my students versus just in the classroom. The more students know why regular exercise increases health and well-being, the more likely they will be able to help their clients stay with an individualized exercise medicine program. That is why I believe it is necessary to go into some detail about the science of exercise. Students need to know about the knowledge and integrity that comes from understanding the physiological responses and the long-term adaptations. This can also be done as part of the exercise medicine prescription that is taught in the students' exercise physiology courses and associated laboratory experiences.

Understandably, there is much more to this process of educating students. But, for now I hope that my response to the question as well as the following content will help the reader appreciate a few of the basic points important to the science of exercise, which should help to motivate the students to live an active lifestyle. After all, as future exercise physiologists versus being physically inactive and sedentary, they have a major responsibility to their clients as well as their own future financial well-being. Without question, the science of exercise medicine shows that regular exercise is both an attitude and a physical engagement in a new way of thinking and living. Ultimately, however as I have already mentioned, much of society is resistant to being active, decreasing body fat, and acquiring a positive state of mind. Regular exercise and a new outlook on life means a longer life with less disease and disability, but it comes about with dedication, discipline, and a positive state of mind. So, in a nutshell, why wouldn't a college graduate get out of the chair and get with an exercise program? Why wouldn't his or her father, brother, wife, friend, or the young boy across the street want to be healthy, strong, and more in control? Interestingly, that is the question, isn't it? Thus, the point of what I am sharing is that knowing why we need to exercise versus exercise simply for the sake of doing so should help make a difference in a person's commitment to a longer and healthier life (4,5).

To begin with, while reading the following information about the physiologic responses to exercise and adaptations, keep in mind that I am describing these responses as part of the philosophy that undergirds the exercise medicine lifestyle. Also, I understand that the students' future clients aren't likely to understand 5% of what will be presented in the following pages. But, please keep in mind that most everything really important begins with the first few steps and the first words of a different path, that is, a different way to think about exercise and life. Without making such an effort, nothing will change and chronic diseases, frailty and disability, and early death will continue to increase throughout the world in big cities and small towns throughout the United States. This isn't good. We must individually and collectively accept the responsibility for not giving in to society's status quo. We must change how we live, and the change process begins with educating individuals of all ages and genders and race about the significance of exercise medicine in healing the mind and body and to sustain and empower life (4,5).

To open the door of exercise physiology as exercise medicine professionals is to speak to what is critical, such as the air we breathe. While it is common knowledge that the body needs oxygen (O_2) to produce energy for muscle contraction to be more physically productive, often times we fail to appreciate that with each breath the body needs to get rid of carbon dioxide (CO_2) to maintain an acid-base balance. Both are done through the response of the respiratory and cardiovascular systems. At rest, a client who weighs 70 kg (154 lb) will consume an average volume of oxygen (VO_2) equal to approximately 250 $mL \cdot min^{-1}$. The transition from rest to walking will cause the lungs to work harder. This is done by breathing more frequently and deeper per breath per minute. The first is referred to as frequency of breaths (Fb) and the second is called tidal volume (T_V), which is the volume of air breathed in with each breath. Hence, an increase in Fb from 12 to 20 $breaths \cdot min^{-1}$ and Tv from 500 mL to 1000 mL per breath increases the volume of oxygen inhaled and CO_2 exhaled, which is known as expired ventilation (V_E, $L \cdot min^{-1}$) (4,5).

The VO_2 response is a function of how much O_2 is needed at the cellular level to produce energy in the form of ATP (i.e., adenosine triphosphate) that is used by the muscles to contract and bring about movement (such as walking). With the increase in response of the lungs to exercise, the work of the myocardium (i.e., heart) is increased to make sure there is an increase in O_2 at the peripheral tissues throughout the body. This is done by increasing heart rate (HR) and stroke volume (SV, which is the volume of blood ejected from the ventricles with each ventricular contraction or heart beat). At rest, the SV is on average 70 mL per beat from each of the ventricles. Thus, 70 mL of blood carrying O_2 is ejected from the left ventricle with each ventricular contraction. The blood enters the aorta to find its way via a multitude of large to smaller arteries in the peripheral tissues (i.e., muscles in particular), while 70 mL of blood from the right ventricle is loaded with a higher carbon dioxide (CO_2) content that is pumped to the lungs (4,5).

Hence, given an average resting HR of 70 $beats \cdot min^{-1}$ and an average SV of 70 mL, the volume of blood ejected from the heart is ~5000 $mL \cdot min^{-1}$ or 5 $L \cdot min^{-1}$, which is consistent with the average VO_2 at rest of .25 $L \cdot min^{-1}$. The O_2 in the lungs diffuses into the blood to be carried by hemoglobin (Hb) to form oxyhemoglobin (HbO_2) that goes to the heart. From the heart (specifically, the left ventricle), the O_2 in the blood is pumped to the muscle tissues throughout the body. The 1-min ejection of blood from the left ventricle to the muscles is referred to as cardiac output (Q), which is equal to the product of HR and SV. At rest, the volume of O_2 pumped by the left ventricle to the muscles by the 5 $L \cdot min^{-1}$ Q is increased with the transition from rest to exercise because the muscles need more O_2 to contract more frequently per minute of exercise. The increase in Q occurs by way of an automatic increase in HR due to the role of the sympathetic nervous system (SNS), which is a division of the autonomic nervous system (ANS). The SNS also increases ventricular contractility that results in a larger SV. The latter response is important because it helps to eject more blood from the ventricles during each contraction. If HR is increased to 130 $beats \cdot min^{-1}$ and SV increased to 95 $mL \cdot bt^{-1}$ from rest to moderate intensity exercise, Q would be 12,350 $mL \cdot min^{-1}$ or 12.35 $L \cdot min^{-1}$ (4,5).

The increase in Q provides more O_2 to the muscles by way of what is known as arteriovenous oxygen difference (a-vO_2 diff), which is the difference between the oxygen content of the arterial blood to the muscles and the venous blood leaving the muscles to return to the heart and then to the lungs. The a-vO_2 diff is an indication of how much oxygen is removed from the arterial blood in the capillaries as the blood circulates throughout the body. At rest, the left ventricle generally pumps 20 mL of O_2 per 100 mL of blood or 20 $mL \cdot dL^{-1}$ with a venous O_2 difference of 15 mL of O_2 per 100 mL of blood (15 $mL \cdot dL^{-1}$). Thus, at rest it becomes apparent that the muscles consume 5 $mL \cdot dL^{-1}$ of blood. This difference at rest indicates that 25% of the O_2 is removed from each 100 mL of blood as it passes through the tissues. The oxygen is used in the electron transport system within the mitochondria of the muscle cells to provide energy in the form of ATP for muscle contraction and other cellular needs (4,5).

During exercise the muscles need more energy, which is accomplished by increasing the dissociation of O_2 from the Hb in the blood at the cell level. Hence, the a-vO_2 diff is expected to increase from the 5 $mL \cdot dL^{-1}$ of blood to 10 or 15 $mL \cdot dL^{-1}$ (depending on the intensity of the exercise). The increase is necessary to supply the O_2 that is needed to produce more ATP to allow for a greater increase in muscle contraction. Again, this means there is less O_2 in the venous blood leaving the muscles that returns to the heart and ultimately to the lungs. At the lungs, the CO_2 in the venous blood goes into the lungs to be exhaled. At the same time, the increase in HR and SV produce a larger Q that continues to deliver a full volume of O_2 per 100 mL to the tissues. As a result, the resting VO_2 increases to match the muscular workload, which may be (for example) a submaximal exercise VO_2 of 1500 $mL \cdot min^{-1}$ (or 1.5 $L \cdot min^{-1}$) at 600 $kpm \cdot min^{-1}$ on a bicycle ergometer. This means the myocardium must get the first supply of rich oxygenated blood ejected from the left ventricle via the coronary arteries. The continuous blood flow to the different muscular structures of the heart is the means to which the heart continues to work in supplying blood to all the cells of the body (4,5).

At this point, it is beginning to make sense to the client that the integrity of the lungs and the heart are critical to supplying the body (especially the muscles during exercise) with the O_2 from the air we breathe to the peripheral tissues. As the blood from the right ventricle to the lungs interfaces with the pulmonary capillaries, the higher pressure of O_2 in the lungs and the pulmonary capillaries versus the venous blood drives the O_2 from the lungs into the blood. The blood leaving the lungs is saturated with O_2 to be dispersed throughout the body.

Ultimately, the functional integrity of the lungs and the heart is matched by the metabolic needs of the peripheral tissues. Gradually, the client will come to understand that VO_2 is the product of Q (HR x SV) and a-vO_2 diff (i.e., the O_2 that is delivered by the heart and the O_2 that is used by the peripheral cells) (4,5).

While clients do not need to be treated as students in an exercise physiology course, it is reasonable to think they would be more motivated to exercise if they knew some of the information just presented. Just think, after age 25 or so, VO_2 decreases 9 to 15% per year. Why, because age (or rather lack of regular exercise) is associated with the decrease in Q and a-vO_2 diff. Aging is in a sense the opposite of regular exercise. Without exercise, the body ages and with aging there is the decrease in structure and function of the body parts. Also, please appreciate that this brief assessment of the client's physiology is just #1 out of at least 50 bits of information (1) that could be the key to helping a person to stay with the exercise medicine prescription (4,5).

Myocardial oxygen uptake (MVO_2) is determined by the Board Certified Exercise Physiologist through the use of a regression formula, such as [$MVO_2 = .14 (HR \times SBP \times .01) - 6.3$]. The product of HR and systolic blood pressure (SBP) is called double product (DP). It is a linear relation between MVO_2 and coronary blood flow. During exercise, HR increases linearly with workload and VO_2. Systolic blood pressure rises with increased work as a result of the increase in Q while diastolic blood pressure usually remains the same or decreases somewhat. Failure of SBP to rise with exercise can be the result of aortic outflow obstruction, left ventricular dysfunction, or myocardial ischemia. Changes in blood pressure may also reflect peripheral vascular resistance, given that systemic vascular resistance (SVR) equals mean arterial pressure (MAP) divided by Q. Since Q is expected to increase with progressive increments in exercise work and MAP usually changes very little, then, SVR is expected to decrease with exercise (1)."

Measurement and Examination

Exercise physiology "measurement and examination" includes: (a) giving a health history questionnaire, a disease-specific or disorder-specific laboratory evaluation as well as the assessment of the client's musculoskeletal system and/or cardiorespiratory system using standard laboratory equipment, exercise tests protocols, exercise programs, and risk factor modification and/or measurements to assist in evaluating the client's overt and/or objective responses, signs, and/or symptoms for cardiorespiratory fitness of individuals who are apparently healthy or who have disease including, but are not limited to, tests that measure body composition, range of motion (flexibility), muscle strength, endurance, work, and power; (b) tests that assist in the overall analysis of the central and/or peripheral components of oxygen consumption and energy expenditure; (c) tests of pulmonary function, and exercise prescription for cardiorespiratory fitness of individuals with metabolic disorders including, but not limited to, deficiencies of the cardiovascular system, diabetes, lipid disorders, hypertension, cancer, cystic fibrosis, chronic obstructive and restrictive pulmonary diseases, arthritis, organ transplant, peripheral vascular disease, and obesity; and (d) treadmill or other ergometer test protocols in conjunction with exercise electrocardiography (ECG) to identify the HR and ECG responses at rest and during submaximal and maximal (graded) exercise programs in addition to specific contraindications for continuing exercise (7).

Instruction

Exercise physiology "instruction" includes providing educational, consultative, or other advisory services for the purpose of helping the public with issues and concerns regarding fundamental and scientific information about mind-body health and fitness. Instruction pertains to matters that are believed to develop and/or maintain health, fitness, rehabilitation, and/or athletics is also included. Instruction includes, but may not be limited to, the: (a) acute physiological responses to exercise; (b) chronic physiological adaptations to training; (c) designing resistance training programs; (d) measuring energy expenditure at rest and during exercise; (e) hormonal regulation and/or metabolic adaptations to training; (f) cardiorespiratory regulation and adaptation during exercise; (g) thermal regulation during exercise; (h) exercising at altitude, underwater, and in space; (i) optimizing sports training through the use of ergogenic aids and better nutrition; (j) appropriate body composition and optimal body weight and the role each plays in diabetes and physical activity; (k) growth and development of young athletes, aging and gender issues; (l) preventing cardiovascular disease through exercise, the prescription of exercise for health and performance; (m) biomechanical aspects of posture and sports and the physiological assessment of human movement; (n) stress testing protocols for athletics and special populations; (o) resting and exercise electrocardiography changes; (p) biobehavioral techniques for reducing stress and/or increasing running economy; and (q) biochemistry of nutrition and exercise.

Analysis and Treatment

Exercise physiology "analysis and treatment" includes performing laboratory tests, with specific expectations for 'treatment' measures and activities. This may include, but not limited to: (a) range of motion (flexibility) exercises; (b) muscle strength and muscle endurance exercises; (c) lean muscle tissue-fat analysis; (d) musculoskeletal and/or postural exercises; (e) sports nutrition programs; (f) sports biomechanics instructions for the enhancement of sports or occupational related skills; (g) stress management exercises; (h) sports training and the development programs; (i) cardiac and pulmonary rehabilitation (including, but not limited to, development of such programs, supervising testing, development of exercise prescription, and other functions such as the education and counseling of patients); and (j) exercise physiology instruction that pertains to all forms of sports training and athletics (7).

CONCLUSIONS

Physical activity can be designed as physical exercise, which can be prescribed as exercise medicine by an ASEP Board Certified Exercise Physiologist to decrease risk factors linked to chronic diseases and disabilities. Why then aren't more adults exercising and seeking out the guidance of an exercise physiologist? The short answer is that it requires a state of mind that is different from the present day way of thinking. Most people simply do not have the discipline to exercise even though they may understand it is necessary. It is easier to play on the computer or watch a football game on TV and consume calories from redundant eating. When it does click that their blood pressure is elevated or that they have gained another 10 lbs a second year in a role, perhaps then, they will begin to think about exercising. Of the adults who actually start walking, only a few will stay with it (6).

This is where the Board Certified Exercise Physiologist can help motivate individuals to stay with the exercise program, particularly from the point of view that exercise is medicine. Like most medicines, it should be taken with caution. Exercise physiologists are educated to help their clients and patients understand the physiologic responses to exercise, but they need the help of the medical community (8). This point is important, given that it provides meaning purpose to prescribing exercise medicine and to the repetitious physical acts of walking around the block or lifting weights. The exercise physiologist can help keep the exercise response centered within one's own being, without which there is often the lack of desire to continue exercising. Because of this thinking, clients and patients need to be educated to the physiologic responses that are specific to exercise medicine (6).

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REFERENCES

1. Boone T. ***ASEP's Exercise Medicine Text for Exercise Physiologists.*** Sharjah, United Arab Emirates: Bentham Science Publishers. ISBN (eBook): 978-1-68108-321-6, ISBN (Print): 978-1-68108-322-3, Pages: 361, Year: 2016.

2. Booth FW, Roberts CK, Laye MJ. Lack of Exercise is a Major Cause of Chronic Diseases. ***Compr Physiol.*** 2012;2(3):1143-1211.

3. ***American Society of Exercise Physiologists (ASEP).*** Home Page. (Online). https://www.asep.org

4. Boone T. ***Introduction to Exercise Physiology.*** Burlington, MA: Jones & Bartlett Publishing, 2013.

5. Boone T. Diligence, Exercise Medicine, the Exercise Pill, and Career Success as an Exercise Physiologist: A Personal Perspective. ***JEMonline.*** 2018;3(2):15-26.

6. Boone T. The Role of the Board Certified Exercise Physiologist is to Explain the Physiologic Responses of Exercise Medicine. ***JEMonline*** 2017;2(1):1-6.

7. ***American Society of Exercise Physiologists.*** Standards of Practice. (Online). https://www.asep.org/index.php/organization/practice/

8. Boone T. Nothing Will Change Unless Physicians and Exercise Physiologists Start to Think Differently. ***JEMonline*** 2016;1(4):1-9.