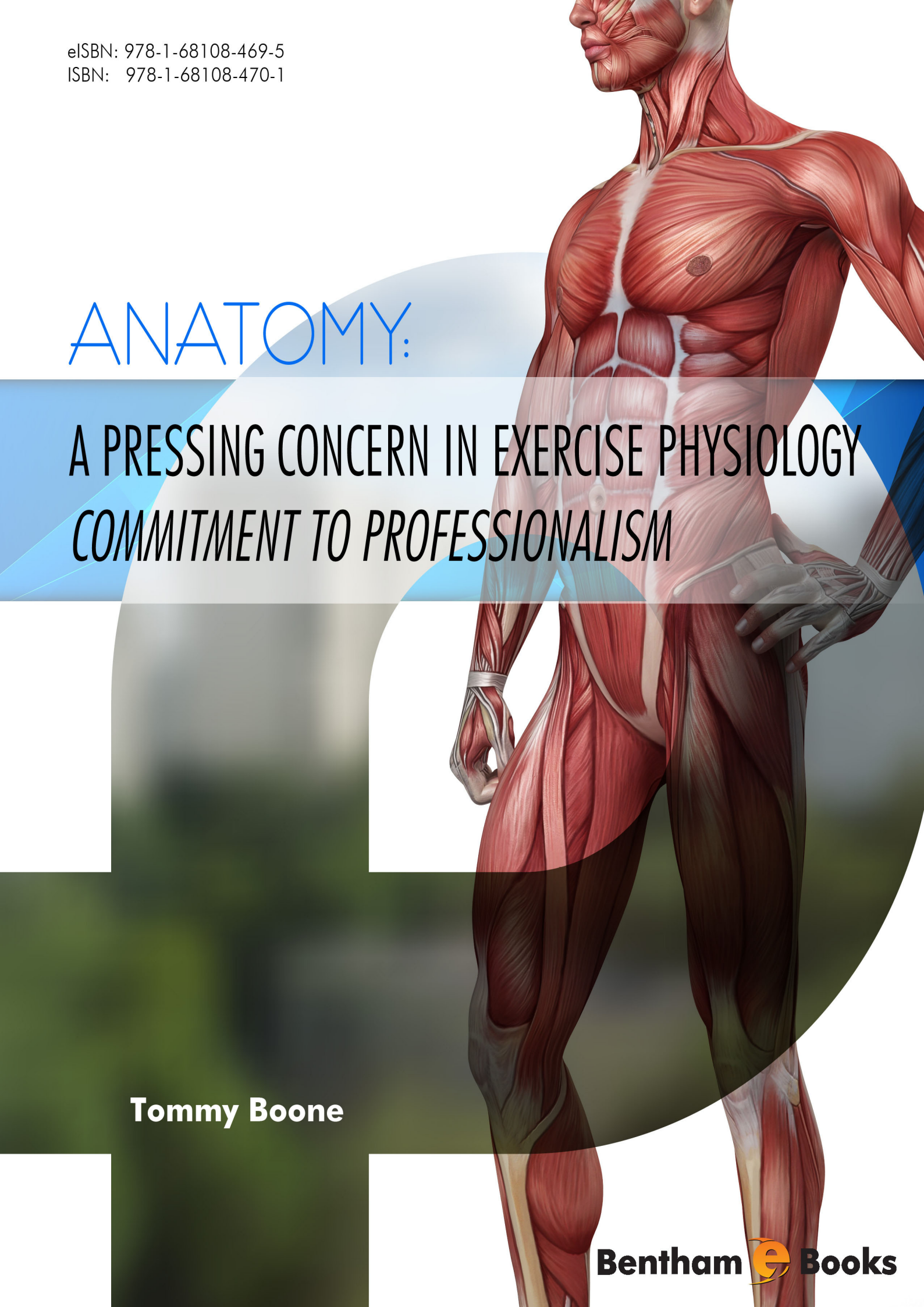
eISBN: 978-1-68108-469-5
ISBN: 978-1-68108-470-1



ANATOMY:

A PRESSING CONCERN IN EXERCISE PHYSIOLOGY

COMMITMENT TO PROFESSIONALISM

Tommy Boone

Bentham Books

Anatomy: A Pressing Concern in Exercise Physiology

(Commitment to Professionalism)

Authored by

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Commitment to Professionalism

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eISBN (Online): 978-1-68108-469-5

ISBN (Print): 978-1-68108-470-1

First published in 2017.

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CONTENTS

FOREWORD

In simple straightforward language, Dr. Boone has set forth important reasons for teaching anatomy in the exercise physiology curriculum. He believes that the students of exercise physiology cannot do their best in prescribing exercise medicine without an understanding of anatomy. This is especially true when it comes to flexibility training.

Anatomy: A Pressing Concern in Exercise Physiology presents the first-ever anatomical background to why there are good, useless, and dangerous flexibility exercises. Dr. Boone believes that without anatomy as part of the exercise physiology curriculum, exercise physiologists will continue to engage their clients and patients in useless and dangerous flexibility exercises. The result is a failure to increase their range of motion, a waste of time in achieving increased flexibility, and the possibility of damage to the muscles and joints. Such a practice is similar to prescribing exercise medicine without an understanding of exercise duration, frequency, intensity.

While it is possible that the students of exercise physiology can learn anatomy without hands-on dissection, it is not the desired approach. That is why Dr. Boone developed an Anatomy Laboratory with cadavers that were dissected by his students at Wake Forest University in Winston-Salem, NC, the University of Southern Mississippi in Hattiesburg, MS, and the College of St. Scholastica in Duluth, MN.

This book explains that we must close the door on yesterday's views of "what is exercise physiology" and keep it closed. We live today, not yesterday. We are healthcare professionals who prescribe exercise medicine to prevent and treat chronic diseases and disabilities. This book is a big step into the 21st century commitment to the professionalization of exercise physiology.

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PREFACE

For years the kinesiology course was the anatomy course in the health and physical education degree. Now, although students can still major in health and physical education, the title has changed in many academic institutions to exercise science, kinesiology, and numerous other degree titles. It is no secret that exercise physiology grew from this academic background of athletics and exercise in health and disease. Today, exercise physiology is increasingly recognized as the new 21st century healthcare profession. While exercise physiologists are educated to prescribe exercise medicine from a physiological perspective, there is the concern that they need an anatomy course to fully understand the depth and implications of flexibility training.

This ebook, ***Anatomy: A Pressing Concern in Exercise Physiology***, is the opportunity to promote the academic importance of anatomy as part of the professional development of exercise physiologists. It describes in detail the anatomical reasons for the good, useless, and dangerous flexibility exercises. Without question, academic exercise physiologists should teach anatomy to the undergraduate and post-graduate students, and the students should have the same opportunity as other healthcare students to study cadavers to grasp the significance of the musculoskeletal system. The hands-on laboratory opportunities will help the students of exercise physiology to safely prescribe exercise medicine and to work as a professional with athletes of diverse sports. This work should also encourage the support and recognition of the ASEP Board Certified Exercise Physiologists as healthcare professionals.

CONFLICT OF INTEREST

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

ACKNOWLEDGEMENTS

Declared none.

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Part I
Introduction to Anatomy and Exercise Physiology

CHAPTER 1

The Anatomy Challenge

Abstract: Although there is an explosion of computer-based human anatomy material available to teach anatomy, cadaveric dissection by students and the integration of knowledge from textbooks and didactic lectures are still the most popular methods of teaching anatomy. The volume of time dedicated to teaching anatomy has steadily decreased over the past several decades. This has resulted in more college graduates with an inadequate understanding of anatomy. Do you want students of exercise physiology to be taught by qualified teachers? If the answer is "yes" -- then you must act now. Commitment to professionalism is imperative.

Keywords : Applied anatomy, Biochemistry, Biomechanics, Cadavers, Exercise physiologist, Kinesiology, Physiology, Visualization.

INTRODUCTION

For the purpose of clarification, the term anatomy is the study of the structure of the human body. For decades, it has been synonymous with the content of the traditional kinesiology course in the physical education major. In fact, for many years, kinesiology was always the academic course that the majority of the physical education majors looked forward to studying. They understood that anatomy was necessary to teach and coach physical activities and sports.

From a historical perspective, when the name of many physical education departments was changed to kinesiology, exercise science, and numerous other similar titles during the 1960s and 1970s, the kinesiology course remained as part of the curriculum. After all, there was then and still is today the belief that kinesiology is understood to mean the "science of movement". Anatomy, as an integral academic area of study, has been firmly established in health and physical education.

Tommy Boone

The students were led to believe that the science of movement was synonymous with the anatomy of movement (Box **1**). That is why the kinesiology (*i.e.*, applied anatomy) course had been an important part of the academic course work in kinesiology and related academic majors. Most recently, in the late 1980s and 1990s, the emphasis away from teaching anatomy is clearly a radical change that reflects the emphasis on exercise physiology research.

Box 1. What is meant by the term anatomy?

The word **anatomy** is derived from a Greek word meaning "to cut up". The word anatomize was more commonly used than the word dissect. Human anatomy as a science has always been about dissection of the human body; whereas, the science of physiology is concerned with the function of the human body. The dissection of cadavers has served as the basis of understanding the structure and function of the human body. Most of the terms that make up anatomy are of Greek or Latin derivation. The study of anatomy has had a powerful influence on medicine and the understanding of how to take care of the body. Athletics in particular is linked to many forms of art and the sense of excellence in human form and movement.

With increased emphasis on research at the doctorate level, little to no attention has been given to applied anatomy. This has resulted in a significant decrease in doctorate prepared exercise physiologists, kinesiologists, and physical educators who can teach anatomy. Also, it is clear that the emphasis on biomechanics, graded exercise testing and prescription, and sports nutrition has served to some degree to diminish the teaching of bodily structure. Yet, an understanding of the structure and internal workings of the body is critical to a rigorous science-oriented education.

Hence, even though it was accepted years ago that anatomy was essential to the students' education, the exposure to anatomy today has decreased to essentially being non-existent in many academic majors. This means the majority of the students at academic institutions throughout the United States are unable to describe the muscles of the shoulder region and how they are different from the hip region. The students' education is inadequate and, therefore, is likely to have an adverse effect on their interaction with clients and patients. Most graduate without being able to identify specific muscles in the human body or attachment sites, innervations, functions, and variations.

While sport biomechanical principles are important, it should be obvious that an

understanding of anatomy even more is critical to the students' education. It is very likely that this view is understood by academic exercise physiologists without having to elaborate on it. However, given the emphasis on research while pursuing the doctorate degree, the majority of the graduates are either not interested or unprepared to teach anatomy. As a result, the students graduate from college without the ability to accurately apply anatomical concepts to the human body at rest, during exercise, and when correcting musculoskeletal disabilities. No doubt that is why Somerset Maugham wrote in his book, *On Human Bondage*, about a lecturer advising first-year medical students that, "You will have to learn many tedious things which you will forget the moment you have passed your final examination, but in anatomy it is better to have learned and lost than never to have learned at all."

A strong base of functional human anatomy is thought to serve as the foundation for all subsequent exercise physiology courses. That is why functional human anatomy is considered as a cornerstone for exercise physiology practice. Several decades ago no one would have thought about graduating students interested in fitness programs and/or sports training without a solid grasp of applied anatomy. In fact, it was believed to be so important that college teachers actually taught origins, insertions, and functions of all the major muscles. After all, anatomy is a discipline with its own language to describe structures of the body that, then allows for an increased understanding of the physiology of the body as well.

The Language of Anatomy

Only a small percent of the exercise physiology teachers know how to teach students the language of anatomy. This point is more complex than it sounds, especially since it is not the same as being well-informed. In many ways, it is an entirely new mental frame of reference. Understanding functional anatomy is not just about memorizing the facts about muscles. It is also about having the knowledge and understanding that allows for determining whether an anatomical comment or statement either makes sense or not.

Understandably, anatomy is complex. It requires intellectual effort and time to identify specific structures and relationships (Box **2**). But, unfortunately, the

CHAPTER 2

Why is Anatomy Important?

Abstract: Knowledge of anatomical structure of the body is basic to understanding musculoskeletal function and how both structure and function are modified by exercise or disease. Ironically, at a time when knowledge of anatomy is increasingly important, exercise physiologists are facing a major crisis in anatomical education. There is a major shortage of academic exercise physiologists willing to teach gross anatomy. Many faculty members are simply not academically prepared to teach anatomy. Yet, the students of exercise physiology need a thorough anatomy education to be credible healthcare professionals. This is true for professionals in physical therapy and athletic training and it is true for exercise physiologists too.

Keywords: Anatomical dissection, Athletic performance, Cognitive function, Functional anatomy, Human anatomy, Memorization, Straight thinking.

INTRODUCTION

Several decades ago, the study of the connection between structure and function was considered important. It was common practice for physical education teachers to impress upon their students the importance of learning anatomy and its connection to human performance. Physical education students did not graduate without passing the "kinesiology" course. Understandably, it was considered a difficult course, given that it covered all the major muscles of the body. Also, not all the students enjoy the required memorization of a muscle's origin, insertion, and function.

The Idea is Simple

The original approach to teaching anatomy was simple. If the students could recognize muscles and grasp the connection of one muscle to another, then likelihood of comprehending specific movements and athletic skills would be

Tommy Boone

increased. Since students are interested in sports and athletic performance, they are also interested in academic subjects that allow for an increased understanding skills and physical performance. This was especially the case with anatomy.

The majority of the students had the desire to understand the anatomy of sports skills, and so they rarely ever tried to get out of the course. Every major muscle in the body was memorized, thus raising the issue today. If it was the right thing to do decades ago (*i.e.*, expect students to memorize the origins, insertions, and functions of the muscles of the limbs, why did the history of doing so get lost across time? Was it due to the notion that memorization is not true learning? Or, was it that publishing research papers would help empower the professors' job? Maybe that is why there so little emphasis on the "specifics" of muscles today? It is strange but true that the majority of the exercise physiology and related degrees do not require the students to try something new (Box **1**), like learning applied anatomy? Perhaps, it is as simple as exercise physiologists are not comfortable with trying something new.

Box 1. Try something new.

> Never be afraid to try something new. Remember amateurs built the ark. Professionals built the Titanic.
>
> -- Author Unknown

To be rather blunt, why doesn't the academic major (whatever its name is, as an offshoot of the original physical education degree) have an anatomy laboratory with cadavers? After all, it is common sense given the perception of the situation college students find themselves in. There is no stand-in for cadaveric analysis in the learning of practical anatomy. Why aren't students taught the importance of visualization skills in learning anatomy? Why is there so little empirical evidence supporting the memorization and visualization in learning anatomy? Why isn't a thorough understanding of anatomy taught to students so that they can learn how to deal with forces that cause athletic injuries and improve human movement?

The Power of Memorization

Without memorization and visualization, it is extremely hard to learn anatomy.

And yet, another part of this chapter is to grasp why anatomy is the missing course in the study of exercise physiology and related academic majors? Perhaps, a piece of the answer rest with the teachers and their students who think that it is a waste of their time to memorize a list of anatomical facts. Others feel that it is utterly irrelevant and boring. Why memorize something when it is so easily forgotten? Memorization is believed to have little to no benefit in learning.

Many college teachers believe that genuine thinking is described as something other than learning by rote. It is said that memorization is useless and unneeded. Or, perhaps, the reader has heard the more common expression. Memorization deflects from a higher measure of intellectual purpose. Although many teachers give the appearance that such statements are actually true, the single largest misconception is the belief that memorization is not important. It is not true that the time put into memorization is pointless. Also, it is increasingly clear that memorization and understanding are vitally important to the learning process (Box **2**). They are not mutually exclusive.

Box 2. Memorization increases cognitive function.

> The memorization and recitation of the classic utterances of poets and statesmen form part of a tradition of learning that stretches back to classical antiquity, when the Greeks discovered that words and sounds — and the rhythmic patterns by which they were bound together in poetry — awakened the mind and shaped character.
>
> -- Michael Knox Beran

To remember different parts of the body that have specific functions, it is important to have an extremely good memory. Many students and professors memorize a considerable volume of subject matter every day. How can students understand the functions of a muscle without knowing its origin and insertion? Similarly, how can students remember physiological calculations without first visualizing the component parts?

Does anyone believe that a person is not as smart as the next person because he or she memorized the Fick equation (VO_2 = Q x a-vO_2 diff)? To understand oxygen consumption (VO_2), students must grasp the significance of cardiac output (Q) and tissue extraction (a-vO_2 diff). Similarly, it isn't likely that a student can fix a musculoskeletal problem without knowing how the muscles and bones work

CHAPTER 3

Shortage of Qualified Instructors

Abstract: Given the presence of so many educated men and women today, one would expect that there would be a sufficient number of anatomy teachers. Point in fact though, there are too few healthcare professionals with a credible knowledge of and actual hands-on laboratory experiences in anatomy instruction and application to human movement and healthcare. While there are numerous reasons why anatomy is no longer taught in exercise physiology and related degree programs, one in particular is the cost, time, and challenges to maintain a dissection room. Another reason is the unsupportive academic infrastructure. None of these reasons is justified. Anatomy is obviously essential for exercise physiologists as credible healthcare professionals.

Keywords: Core curriculum, Healthcare professional, Integrity, Muscle function, Muscle insertion, Muscle origin.

INTRODUCTION

Knowledge of the structure of the human body is imperative for career success. There is no substitute for not achieving mastery of the subject. While the non-doctorate exercise physiologists do not need to know anatomy at the molecular level, they do need to know functional anatomy. Otherwise, how will they know what is safe and appropriate in developing individualized weight lifting and/or flexibility exercises to maintain health and fitness?

To understand the present situation, it is necessary to highlight the fact that doctorate prepared exercise physiologists do not take a gross anatomy course and know nothing about dissection. Also, they are not taught the methods of 3-D awareness that helps them conceptualize and visualize anatomy. Worse yet, they have little to no knowledge as to how they should teach anatomy or connect basic and clinical issues that pertain to regular exercise training, health, and wellness to

Tommy Boone

their exercise physiology students. For further progress to be made professionally speaking, the administration and faculty members must concede that anatomy is necessary in the exercise physiology curriculum.

A Credible Education is Important

Imagine this: A recent college graduate was hired to supervise the development of a muscular strength training program for high school athletes. On the first day, he entered into a conversation with the head football coach regarding the specifics of different weight lifting exercises to help decrease the frequency of injuries to specific muscles and joints and to significantly strengthen certain other muscles. To the coach's surprise, the discussion did not go well. When he asked about specific exercises to build certain muscles, the coach realized that the new hire did not have knowledge of anatomy or an understanding of which exercises would be better than others. Then, the coach said, "You did take an anatomy class in college, right?" The new hire said, "No, none of my teachers knew how to teach anatomy (Box **1**)".

Box 1. Difficulty in finding anatomy teachers.

> In a survey conducted by the American Association of Anatomists, it was noted that 83% of heads of departments had great or moderate difficulty in the recruitment of qualified gross anatomy teachers.
>
> -- American Association of Anatomists (2002)

Without an understanding of the human body, its actual parts, and how they relate to each other, it is essentially impossible to rely on an exercise physiologist (or anyone for that matter) to produce the right results. Every exercise physiologist must understand the origin, insertion, and function of muscles just as they are expected to know the rate-limiting enzymes of glycolysis or that cardiac output is the volume of blood the left ventricle pumps every minute. Ironically, at a time when knowledge of anatomy is important, students are graduating with a huge void in their education. It does not help that exercise physiologists understand the role hemoglobin plays in providing oxygen to the muscles if they do not understand the functional differences in the brachialis and the biceps brachii.

The lack of experienced exercise physiologists to teach anatomical knowledge

threatens the integrity of the profession. It is for this reason alone that changes in the education of exercise physiologists in the United States must improve. This is true at all levels of education, from the undergraduate degree through the doctorate program. Here, the point is that it is not a question of developing new methods to examine the molecular or genetic basis of cellular function. What is important is the knowledge of the human body. For example, how muscles work, how they move, and what is normal function? Having such knowledge will help the Board Certified Exercise Physiologist to better understand the application of exercise medicine.

Will cadavers cost the department? Yes, that is correct. Just as there is an expense to purchase metabolic carts and all the other rather common pieces of equipment in an exercise physiology laboratory, there is a cost factor. But, the expenses are necessary to expanding the department's professional infrastructure and the quality of the students' education. It is especially important that academic exercise physiologists understand this point, just as they realize that the physiology equipment is required to teach the students about the physiological functions of the body with increased clarity and precision. Hence, while faculty-centered didactic lectures are important, students are in a much better position to compete with other healthcare students when they have access to a qualified teacher with a cadaver-based anatomical education and experience (Box **2**).

Box 2. Qualified anatomy instructors.

Many exercise physiologists don't want to teach anatomy because it demands roughly twice as much time as other academic courses and yet, it is essential to the exercise physiology students' education. The bottom line is this: No exposure to dissection and dissected specimens is likely to compromise future exercise physiologists, which is also a recipe for malpractice.

Benefits of Teaching Anatomy

Learning by direct observation sets the path for creative and critical thinking. Just as Leonardo da Vinci and Michelangelo studied anatomy from cadavers to help them create impressive works of art, exercise physiology professors should study anatomy from cadavers to become the best professionals they can be. Those who will benefit from the teaching of anatomy will be their students, clients, and

Part II
An Anatomy Education

CHAPTER 4

Teaching Anatomy

Abstract: Anatomy is the study of the structures of the body. Physiology is the study of the function of the structures. The study of both provides a solid understanding of the body and how to develop it and rehabilitate it. There is a great divergence in exercise physiology departments in teaching exercise physiology in general and anatomy in particular. Exercise physiologists must not be disempowered from anatomy. To not have the power to influence the profession would be an appalling state of affairs. Yet, it is clear that students are graduating without knowing in detail which muscles are responsible for what actions.

Keywords: Academic preparation, Hands-on dissection, Language of anatomy, Meaningless stretching exercises, Science of physiology.

INTRODUCTION

When anatomy is not taught, there is little opportunity to understand anatomical principles and relationships. The decrease in anatomical content has led to an insufficient anatomical foundation that creates anxiety because of the perception of not being prepared. If the client's safety comes first, it is imperative that exercise physiologists know anatomy. This thinking should not come as a surprise because anatomy has always been an essential knowledge for healthcare professionals. Thus, it should be inseparable from physiology in that anatomical structure reflects physiology.

Have you examined the students' concerns when they have little to no access to anatomy in their curriculum? They are not comfortable with the notion of mortgaging their future to the whim of a law suit. The volume of anatomical knowledge that students should know but are not being taught is significant. Part of the problem stems from the idea that exercise physiology is said to be all about

Tommy Boone

physiology. After all, physiology is part of the "exercise physiology" title. But, there are no academic programs or professional titles for "exercise anatomy" or for the "exercise anatomy professional". Perhaps, there should be (Box **1**).

Box 1. The visionary!

"…the prophet is the visionary who imagines a desirable future and then declares it to the rest of the world."

-- Terry Pearce
Leading Out Loud

The vision and rationale for studying anatomy at the same level as studying physiology exist only in the judgment of a few exercise physiologists. Even more disconcerting, when anatomy is taught, it is clear that the majority of the exercise physiology faculty either lacks the academic preparation to teach anatomy or has no interest in doing so. Frankly, there is little incentive to teach gross anatomy.

Interestingly, Paalman (2000) points out "that the structure of the human form is being emphasized less and less…." It tends to be scant at worse and patchy at best. The fundamentals of applied anatomy are not being taught in the exercise physiology curriculum? If students express an interest in anatomy, teachers may refer them to the internet or an interactive anatomy software package, which only promotes the crisis we now face.

This brings up an interesting and overarching point of some faculty members. That is, the domain of what is often termed general anatomy in contrast to specific anatomy. In short, it has been said, "Why not stop with the memorization of origin and insertion? Exercise physiologists are not medical doctors! All they need is the practical knowledge of surface anatomy." This thinking is not new and, frankly, it is completely a wrong way to think.

Such thinking seems to be related to medicine's reliance on magnetic resonance imaging (MRI), computerized tomography (CT scan), and positron emission tomography (PET). The problem with such thinking is that many patients expect their primary care doctors to have a detailed command of anatomical structure and the technological means to obtain a detailed understanding of an intact body. The same thinking is (or should be) true for the exercise physiology professional.

The public sector would be startled to know how little knowledge of anatomical structures many healthcare practitioners have. They would be even more shocked to learn that the interactive DVD-Drive has replaced the anatomy laboratory. In fact, the evidence supports the trend of decreased time on cadaver dissection and of increased time on technology-based instruction. The impression is that today's physicians view their education resulting from the hot ticket items, which are very frequently expensive ways to identify an illness or dysfunction. Increasingly sophisticated equipment and technology are used to teach the essentials of anatomy, which is a problem for many doctoral students.

The new modalities (*e.g.,* plastic models, computers, and other diagnostic tools), imaging technologies (including the interactive functional anatomy DVDs), and body painting are giving shape to a new kind of an anatomy experience. Unless these cadaver free approaches are challenged or properly integrated with traditional cadaveric dissection, the future of anatomy will exist entirely in the classroom. The familiarity with real-time hands-on dissection experiences (Box **2**) will be pushed to side for computer course-specific-assisted instruction (CAI) modules (Reidenberg & Laitman 2002).

Box 2. 3-dimensional anatomy *vs.* hands-on cadaver anatomy.

"You can only do so much with a computer. To train properly, there is no substitute for a cadaver," said Eric Reichman, PhD, MD, director of the Surgical and Clinical Skills Center and associate professor of emergency medicine. "Some medical schools are supplementing cadavers with computers and reducing the number of cadavers, but it's not good — especially for spatial training. You can look at a cadaver and see where a muscle starts and ends and what's around it. You need to be able to see it 3-D and feel it."

--http://www.uthouston.edu/Media/newsreleases/nr2007/grossanatomy.htm

The challenge for educators is to not walk away from anatomy, but rather to expand the curriculum accordingly to teach human anatomy to the students of exercise physiology at all levels. There should be no debate or disagreement on this point, given that anatomy still has a place in educating students. A sound knowledge of anatomy is essential if the profession of exercise physiology is going to accurately define and successfully work with clients.

CHAPTER 5

Teaching Anatomy to Exercise Physiology Students

Abstract: "The taboo against desecrating the bodies of the dead goes back many centuries; it was prohibited by both ancient Greek and Roman religions. Cadaver dissection is essential for the acquisition of anatomical language. The first recorded instance of medical dissection of human bodies is in the sixth century BCE, when the Greek philosopher Alcmaeon began his research. In 275 BCE, Herophilus of Chalcedon founded the first school of anatomy at the Museum of Alexandria, in part to encourage his students to overcome their fear of dissecting human bodies" (http://knarf.english.upenn.edu/Contexts/dissect.html). Given the significance of this quote, students, teachers, researchers, and surgeons are still asking questions: Is dissection the *only* way to learn anatomy? Why don't they have cadavers to dissect? When teaching anatomy, which is best – cadavers or computers? Can the YouTube help students learn anatomy? Is it better than dissection? Do students have sufficient knowledge of clinical anatomy with just lectures?

Keywords: Anatomic software, ASEP, Exercise medicine, Medical dissection.

INTRODUCTION

Teaching the principles of cadaver dissection is an important part of the history of medicine. The first recorded dissection was around 300 B.C. by Herophilus. He is known as the father of anatomy. In the school of Alexandria, the use of anatomic dissection was the primary method of learning anatomy. During the 14th and 15th centuries, French and Italian professors used cadavers to teach anatomy. After that, only a few cadavers were dissected until the 17th and 18th centuries (Korf & Wicht 2004). The first medical school in United States was founded in 1765 at the College of Philadelphia. In 1767 and 1782, additional medical programs were created in New York and Boston, respectively. Michelangelo and Leonardo da

Tommy Boone

Vinci carried out dissection to enhance their artistic work (Dyer & Thorndike 2000).

Before dissection became legal, anatomy schools relied on grave robbers to obtain cadavers. Some bodies were illegally circulated to other countries. In 1831, the Anatomical Act of Massachusetts was passed. It allowed medical schools to receive unclaimed cadavers. The Act moved cadavers into the laboratory setting (Stimec *et al.* 2010). Additional legislation resulted in better controls that brought anatomy education into hospitals and colleges. The body donation program was gradually accepted. Cadavers were regarded as scientific assets.

In 1882, the College of Physicians and Surgeons of Chicago offered a three-year curriculum that included the dissection of cadavers. Because anatomic material was difficult to obtain, the Anatomical Gift Association of Illinois was founded in Chicago in 1968 with the aim to legally embalm and disperse cadavers throughout the state, using deeds signed over by soon-to-be donors. Deed-based programs now exist in all states except Wyoming. Today, the Anatomy Gift Act produces cadavers every year for medical education and research.

Aside from the *Body-Worlds* that exhibits anatomical art of phenomenal dissections and plastinations created by Gunther Von Hagens in Germany in 1978, anatomists are still very much interested in cadavers. They understand that the plastinated bodies and body parts along with the anatomical software, and other imaging methods are increasingly being used to teach and do research. But, once again, their interest is in anatomy taught by cadaveric dissection, prosection, and other anatomical materials (and the functional dynamics of bones) (Box **1**).

It is important that interest in cadaver dissection be sustained not only to benefit members of the healthcare professions, but to help ensure that the professionals thoroughly understand anatomy and its application to healthcare diseases and disabilities. Removing cadavers from the academic setting is likely to cause a major shift in a time-honored tradition, which in turn will have a negative effect on anatomy education. Cadavers allow students to gain unique insights into human body, which have thus far (for the most part) been reserved for a select few medical professionals at best (Box **2**).

Box 1. The osteology of a gymnastics dismount.

The upper and lower limbs are characterized by their mobility and ability to grasp and conduct motor skills, such as dismounting from the parallel bars in men's gymnastics. Note the grasp of the left hand on the bar, which is made possible primarily by the muscles of the anterior forearm. The knee flexion is controlled by the anterior thigh muscles (known as the quadriceps femoris) that insert on the tibia tuberosity. The dorsi-flexion of the ankle joint is controlled by the plantar flexors (6 from the posterior side of the leg and 2 from the lateral side of the leg).

Box 2. Why is dissection important?

"Dissection of the human body is the only method of direct observation and measurement of the structures, organs, bones, ligaments and tendons that allow the body to function. Direct dissection is a fundamental part of the training of physicians and other care providers. Physicians cannot treat disease or trauma without a complete understanding of anatomy."

--Anatomical Gift Association of Illinois 2016

Changes in exercise physiology such as using cadavers in addition to other laboratory functions enhance the core curriculum and increase the importance placed on learning through dissection. The ASEP leaders maintain that a in-depth appreciation of anatomy by cadaver dissections should be part of every exercise physiologist's academic major.

Anatomy in Exercise Physiology

When students undergo cadaver-based learning by dissecting cadavers, their ability to conceptualize anatomical structures is significantly better than without the hands-on experience. The dissection experience itself is awesome. It provides students with the actual thickness of muscles, how they are oriented to each other, as well as the layering of muscles. They can see and touch the origins, insertions, and nerves that go to the muscles, thus help to understand specific functions.

CHAPTER 6

Use of Imagery in Anatomy

Abstract: Teachers must acknowledge that rote memorization is rather useless when students are not encouraged to visualize the structures. There is a huge volume of detail and integrated content when anatomy is blended with mental pictures. The mind can be taught to scan the origins, insertions, and functions of muscles just as computers can scan and create three-dimensional pictures. The brain does not know the difference between what is real and what is not real. Thus, when you visualize (*i.e.,* see with the mind's eye) the latissimus dorsi muscle and its origin and insertion, the electrical signals of the thinking-visualization process are essentially the same as seeing it on a cadaver.

Keywords: Blink transformations, Creating images, Image rotation, Imagery, Mental scanning, Stored information, Verbalizers, Visualizers.

INTRODUCTION

The mental image is one of the oldest, left alone issues in intellectual science. It is so misunderstood that psychologists have both maintained and rejected its existence, even though it has always been with us. Few would dispute the ability to produce a mental image. Everyone generates images and, yet evidently, many professionals disagree on what is an image. To mull over what is an image is to ask questions without an obvious answer. Few people feel comfortable speaking about a topic when there is little agreement (Boone 2001).

About all a person can say is that a mental image appears to resemble the experience of seeing an object that is not actually present. Controversy, neglect, and speculation provide little support in understanding the "experience of seeing" a mental image. How a mental image (or mental visualization) helps with the learning of anatomy is not easily explained. Yet, anatomy teachers argue that

Tommy Boone

creating a mental image of the pectoralis major is helpful in understanding its functions. As an example, close your eyes and "see with your mind's eye" the clavicular part of the anterior chest muscle as it helps to flex the shoulder joint.

Critics disagree by asking, "How is it possible to see an object and then rotate it?" Hence, the question: Does the brain create mental pictures? If so, what are the specifics for defining a mental picture and, equally important, what types of information does the picture provide? Finding an answer to these questions is not easy even among the best of psychologists and exercise physiologists.

Recalling an Image

If human mental imagery exists, can we be taught to recall specific images? Is the neural status of an image based on memorization and/or visualization? Or, is it simply a function of the memory process? If we can recover and reconstruct information at will, we can learn to modify it. That is, if a student is asked to imagine the quadriceps and assuming the student sees the quadriceps in his or her mind's eye, can the student recall images of functional association (such as hip flexion and/or knee extension by specific muscles) (Box **1**)?

Box 1. The anterior thigh muscles.

Take a moment and look at the picture of the muscles of the thigh. Do you see the vastus medialis, rectus femoris, and the vastus lateralis? Understandably, you cannot see the vastus intermedius. But, you can imagine "seeing" it as well as the points of origin for each of the four muscles. One of the muscles originates from across the hip, which is the rectus femoris (specifically, its origin is the anterior inferior iliac spine). Imagine the greater trochanter and lateral lip of the linea aspera and you will have the origin of the vastus lateralis, which inserts *via* common quadriceps tendon. Note the muscle cross the thigh from the hip region to the medial side of the knee joint. This is the sartorius muscle. It arises from the ASIS to flex the thigh and inserts *via* the proximal anterior medial aspect of the tibia. It works with the gracilis to flex the knee joint.

The idea of seeing the knee extensors with image vividness is first linked to

specific information acquired from an instructor or an anatomy book. The mental image of the quadriceps is not like looking at a picture in a book or even the quadriceps of another person. Instead, one would conclude that the quadriceps is a visualized construction that is considered a rough copy of the actual muscles. The muscles exist as an image that takes a lot of practice in visualization to see the small details that are obvious only after a disciplined approach to creating images. For example, the image of the short head of the biceps brachii at the shoulder joint is better in the person who works at creating images.

To assert further that mental images do exist, take a moment to picture a car but not just any car. Picture a black Ford truck and then a yellow Ford truck. Very likely, you were able to pictured a Ford truck and, if so, a black Ford truck and then a yellow one. This means you created the image in your mind's eye. Now, picture the same truck in red. It should be clear that images exist regardless of the fact that it is hard to explain or define them.

What is important is when a person visualizes something, such as the quadriceps muscles, the image is specific to the thighs of the lower limbs. Now, to further demonstrate this point, when the same person is asked to visualize the vastus medialis muscle, the image is that of what one would see in the anatomy picture of the quadriceps. The image may be taken from a stored memory of a textbook picture or an anatomy dissection at some point in one's past. With practice, there isn't much difference between the textbook and what one sees by way of a mental picture.

Think about volleyball, soccer, and baseball. With the recalling back of a sport, the mind creates mental images consistent with known or stored information specific to each athlete. This is not to downplay the role of language in generating thoughts and/or ideas, but rather to highlight the part that visual thinking plays in recalling information. Visual thinking plays a vital role in recall and memory of facts. Again, as an example, visualize a motorcycle and now visualize a bicycle. In less than seconds, the stockpile of information explains the differences between the two. It is also true with learning anatomy or the multi-factors of life in general.

Remember the brain does not know the difference between what is real and what

Part III
Flexibility Truths

CHAPTER 7

The Importance of Flexibility Training

Abstract: The quality of professional development of exercise physiologists is determined by the quality of their professional thinking, which in turn is determined by the quality of their critical thinking - for critical thinking is the driving force behind professionalism. Without critical thinking skills, there is little reason to think of exercise physiologists as healthcare professionals. In fact, it is obvious that all the scientific papers, presentations, and posters by exercise physiologists at national and regional meetings cannot define exercise physiology as a profession. This point is within their understanding if they work at critical thinking as they have taught their students to think scientifically. Yet, many exercise physiologists continue to present their scientific papers without internalizing the concepts and principles essential to the underlying concepts of critical thinking and professionalism in exercise physiology. Despite having the doctorate degree and after teaching years of college and university courses, it is apparent that relatively few professors have the desire to become self-directed, self-monitored, and self-corrective critical thinkers to guide their students' path towards a professional understanding of flexibility training.

Keywords: Adaptive shortening, Adductors, Flexibility training, Hamstrings, Myocardial oxygen consumption, Oxygen transport, Plantar flexors, Stretching exercises.

INTRODUCTION

During my first year of college, I decided that I wanted to be a gymnast. What I did not know was the importance of flexibility in learning gymnastics. I thought that gymnastics was all about strength and determination. I learned rather quickly that while both are important, being a gymnast meant that I needed above average flexibility. I had become rather strong from years of football training and lifting weights. Baseball and various track and field events (such as pole vaulting and

Tommy Boone

low hurdles) helped me develop the ability to focus my attention and perform with a certain degree of skill. But, in terms of the required range of motion a gymnast should have, I was at rock bottom. Forget about dropping into a side splits or even touching my toes from a standing position, I simply did not have the flexibility to do so.

The idea of training for flexibility in the same way one trains for strength or to run faster was not part of my earlier athletics and yet, it is clear in retrospect that if I had been more flexible I would have achieved more in gymnastics (Boone 1971). For certain, I would have been able to avoid certain injuries that delayed maximizing my gymnastic abilities. Also, with increased flexibility, I would have been physically prepared to be a better all-around gymnast (Box **1**).

Box 1. Flexibility training.

Flexibility is defined as the allowed range of motion at any given joint throughout the skeletal and muscular structures. There cannot be any question that everyone, especially athletes must engage in flexibility training.

As you might understand, my first year as a gymnast at Northwestern State University in Natchitoches, LA was a difficult period of mental and physical adjustment. I was strong so strength skills were easy to perform. Also, I was determined and eventually I learned to perform at a certain level. I learned the gymnastics skills very quickly, which helped me to stay motivated. However, it did not take too long to figure out that without the flexibility to perform certain gymnastic moves, being successful as an all-around gymnast was not possible.

When a gymnast fails to have the range of movement in a joint or series of joints to do, for example, a side splits, the athletic performance is constrained by the limitation in joint motion. In short, this means that either the performance is not possible or it is performed below an acceptable standard. To perform the skill with the desired execution, the athlete's degree of suppleness of the muscles and related connective tissues must be increased. Therefore, the objective is to engage the athlete in flexibility training with the same vigor as one would do for strength, speed, and endurance training.

Knowledge of not only the specifics of the sport is important, but also an understanding of the body and how it moves. As an example, when performing on the parallel bars, it is standard practice to perform an "L" support (*i.e.,* while in the upright position on the bars, the lower limbs are raised to the horizontal position). If the gymnast has difficulty in raising the lower limbs (legs) to the "L" position, is the problem too little strength in the hip flexors or too little flexibility in the hamstrings? Or, is the problem specific to the strength of the quadriceps? Perhaps, it is the gymnast's inability to perform dynamically (also called dynamic or kinetic flexibility)? Is it a problem of static-active flexibility (*i.e.,* the agonists lift the lower limbs while the antagonists are being stretched)?

Understanding the way in which muscles originate and insert on specific bones, and how they function individually and collectively help the athlete figure out the right answer to the question is part of coaching athletes. For example, if the hip flexors are weak, what is the best way to strengthen them? If it is poor flexibility of the hamstring muscles, how long will it take to increase the range of motion at the hips (Box **2**)? What is the best stretching exercise to increase the range of motion of the muscles that arise from the ischial tuberosity? Without the right information, the gymnast may try to strengthen the hip flexors to compensate for the poor hip flexion and, therefore, fail to correct the lack of range of motion in the posterior thigh muscles (*i.e.,* the hamstring muscles in particular).

Box 2. Factors that distract from flexibility.

Aside from failing to systematic trained to develop a greater range of motion, there are certain factors that distract from flexibility. They are the different joint structures, the size of the individual muscles, and the related connective tissue. There is also the question of motivation to do what is necessary to be more flexible. It is important that static stretching be performed more so than dynamic stretching, especially during the warm-up.

While coaches and athletes understand the importance of muscle strength, speed, and endurance, developing flexibility is often reduced to whatever time is left in the exercise program (*e.g.,* the last 5 minutes of a 60-minute workout is dedicated to flexibility training). Given that flexibility training is important, one would assume that coaches, athletes, and exercise physiologists are aware of the best means to increasing the athletes' range of motion?

CHAPTER 8

Methods of Flexibility Training

Abstract: Flexibility refers to the range of motion of the musculoskeletal system. It is trainable, but only when it is done correctly. Warming-up should not be confused with training for an increase in range of motion. Flexibility is a logical prerequisite to performing athletic skills with ease, efficiency, and safety. If stretching is done on a regular basis, there will be an increase in the range of motion at specific joints. The stretching will help to improve human movement, whether it is athletics or engaging in physical activity, the circulation of blood and oxygen to the active tissues, and the pain and soreness that results from using the muscles. In general, there are four methods to increase and maintain flexibility: (1) static stretching; (2) ballistic (or dynamic) stretching; (3) contract-relax stretching (also called PNF, proprioceptive neuromuscular facilitation); and (4) passive stretching.

Keywords: Ballistic stretching, Contract-relax stretching, Human movement, Muscle soreness, Passive stretching, Static stretching.

INTRODUCTION

There are three popular methods to increase and/or maintain flexibility: (1) static stretching; (2) ballistic (or dynamic) stretching; and (3) contract-relax stretching (also called PNF, proprioceptive neuromuscular facilitation). These stretching methods can be done alone without additional help from a partner or special exercise device. A fourth method is referred to as passive stretching. It involves the use of external force that is usually provided by a partner to apply the additional pressure to achieve and/or maintain a range of motion throughout the musculoskeletal system.

Static Stretching

Static stretching is the slow and continuous holding of a stretched position. It is

Tommy Boone

the most common method of stretching. It is the method most commonly used by gymnasts and dancers. Most users believe it is as effective as the other methods for increasing flexibility. There are several advantages of static stretching when compared to ballistic stretching, which involves bobbing, bouncing, and rhythmic types of movements to position muscles and joints through a progressively greater range of motion (Box **1**) (Boone 2014).

Box 1. Static stretching.

The static stretch is also referred to as the static-passive stretch whereby a person assumes a position and holds it with some part of the body or with the assistance of a partner. It remains an effective, relatively safe, and popular method of stretching. The static method allows for the elastic components of the connective tissues to lengthen very slowly with little danger of damage. This method is also known as the slow stretch and hold method in which, following the stretch, the position is held for 10 to 30 seconds (or even longer, such as 60 seconds). Stretching of the muscles as far as they will go and holding the position stimulates the muscles and related structures to relax and elongate.

When the stretching of a muscle group is at its farthest point, the position is maintained. It should be done slowly and carefully. When done correctly, there is very little likelihood of injury to the muscles and/or connective tissues. The stretching exercises are usually performed without the help of another person or device, which decreases the danger of going beyond the safe range of motion. The exercises are simple, easy to perform, and result in the less energy expended, which leaves energy to perform other activities. When the stretch is held long enough at its farthest point, it can induce muscle relaxation *via* the firing of the Golgi tendon organs (GTOs). These are important advantages and differences

between the slow, controlled stretch of the relaxed muscles and the bouncing type (ballistic) stretching exercises.

A slight variation of the static stretch method is used by experienced athletes who perform an additional stretch that goes beyond the initial stretch-hold position. In this case, the static stretch is comprised of two parts. Firstly, the initial stretching and holding position, which takes 10 to 30 seconds or longer. Secondly, then stretch slightly further and hold for another 10 to 30 seconds or longer. The second part is often referred to as the developmental stretch. If the first part is done correctly, then, it is not necessary to over-stretch. In fact, this second part could set the stage for an injury and should not be done until the temperature of muscles and the lubrication around the joints are increased. This is why it is best done during the cool-down phase while the body temperature is still elevated.

Ballistic Stretching

Ballistic stretching (also referred to as dynamic stretching) consists of using the momentum of the body or a limb in bouncing, bobbing, swinging, rebounding, or rapid warm-up calisthenics movements to increase flexibility, whether controlled or uncontrolled (Box **2**). There are many examples of this type of stretching in fitness centers and throughout the sports programs. One popular ballistic stretch is the person who stands with the knees straight, leans forward, and bounces several times in effort to reach further each time to touch the toes.

Box 2. Ballistic stretching.

Ballistic stretching is generally not considered as wise or useful in creating a greater range of motion. Failing to allow the muscles and associated tissues adjust to the bouncing, there is an increased likelihood of injury.

Interestingly enough, most athletes are not aware of the fact that ballistic stretching increases the chances of an injury. Actually, it does not take very many red flags to realize that the bouncing down repeatedly toward the toes, for example, results in excessive loading of the muscles across the posterior aspect of hips and knees. There is no secret that ballistic stretching may cause damage to the connective tissues when forced to stretch beyond their elastic capabilities.

CHAPTER 9

Developing a Flexibility Program

Abstract: Improving flexibility is primarily the result of performing stretching exercises. The right flexibility program will provide the athlete with the knowledge to increase range of motion, maximize efficiency of movement, supplement training, and enhance recovery. A good flexibility program concentrates on muscle groups most likely to experience adaptive shortening. In the majority of the cases, just three flexibility exercises will produce the range of motion required to optimize the musculoskeletal system for almost any sport. Be sure to remember that there are "good, useless, and dangerous" flexibility exercises. The useless and the dangerous exercises must be avoided. An excellent example of the latter point is the hurdler's stretch exercise during which the position of the knee and leg stretches the medial collateral ligament while putting pressure on the medial meniscus.

Keywords: Anatomy, Flexibility training, Hamstring muscles, Musculoskeletal joint, Muscle spindles.

INTRODUCTION

It is assumed that the athlete, coach, and/or exercise physiologist understands the ethical and practical reasons for flexibility training. Let us also assume that the static method of flexibility training is chosen as the method to increase flexibility. Implied in the decision is that the stretching exercises are important to maximize performance, and that static stretching is the preferred training method since it is safe. The protection of clients and patients must be held as the highest priority.

Since academic exercise physiologists cannot afford to produce negligent graduates, it is not necessary to push the musculoskeletal joint to the point of pain during stretching. Feeling the tension of the stretch is good, but not pain. Staying injury-free with predictable benefits require a proper stretching program. Aside

Tommy Boone

from the mental benefit of being prepared, the musculoskeletal benefits are increased range of motion, decreased muscle stress, decreased muscle soreness, decreased risk of injury, improved circulation, improved sports performance, and good posture.

To get these benefits, the following assumptions should act as a guide for the use of different stretching exercises: (a) all athletes have similar flexibility needs; (b) Board Certified Exercise Physiologists know anatomy; (c) most stretching exercises are useless; (d) some stretching exercises are dangerous; (e) flexibility training is focused; (f) flexibility training is progressive; (g) frequency of flexibility training is essential; (h) flexibility training follows a warm-up; (i) flexibility is joint specific; and (j) flexibility training is not about isolation.

All Athletes Have Similar Flexibility Needs

Regardless of the sport, flexibility is important (Box **1**). Whether it is weight training, soccer, gymnastics, or tennis, flexibility is necessary for optimal performance. While other factors may cause problems, such as the failure to train the cardiorespiratory system if you are a track athlete, the lack of flexibility may decrease performance efficiency and may increase the likelihood of an injury (Knapik *et al.* 1992). It is also true that stretching may not prevent an injury in every athlete in every sport (Thacker *et al.* 2004).

Box 1. Flexibility is key to optimal performance.

> "Proper flexibility is necessary for optimal performance. If a joint does not have normal range of motion due to overactive/tight muscles, performance will suffer. For example, if your calf muscles…are tight… your ankle range of motion will be limited. This means you cannot flex your foot enough to get all your power on push off, which would mean a slower race time, a missed rebound, a missed pass, inability to get to the net quick enough, and the list goes on. No matter the sport, proper flexibility is key if you want to perform at your absolute best."
>
> -- Yusuf Boyd, NASM Elite Trainer

What is not well understood is that athletes in different sports do not need to train for increased flexibility using so-called stretching-specific exercises to the sport. In fact, unless there is a prevailing clinical issue, just three flexibility exercises will produce the range of motion required of every athlete. Yes, it is true that

some athletes will need to work on their stretching exercises more than other athletes, but they can and should train using the same flexibility program.

The design of the program is essentially the same regardless of the need for more or less range of motion and regardless of the sport. There are no scientific data to support the notion that the soccer player must focus on lower limb exercises while the tennis player must concentrate on upper limb exercises. Both athletes are able to do what they do because of their total body flexibility not because of the range of motion of a specific part. A good flexibility program concentrates first on muscle groups most likely to experience adaptive shortening and then on the most frequently used muscle groups, which may also cause them to shorten.

Knowledge of anatomy provides the understanding that flexibility exercises do not need to be different from one sport to the next in spite of the popularity for sport-specific flexibility training. A highly individualized approach to flexibility training is only necessary for special cases where an obvious musculoskeletal deficiency or injury is limiting the athlete's or client's ability to perform.

Board Certified Exercise Physiologists Know Anatomy

If anything should be apparent to an athlete or a coach today, it is that the number of stretching exercises is very large. The notion that "more is better" is driven by the lack of an understanding of the anatomy of the body. Flexibility training must be built on sound anatomical facts. Only then, can a balanced program in both number and type of exercises result in a significant gain in flexibility.

Without this knowledge, the instructor is likely to encourage the use of a dozen or more stretching exercises. Not only will the stretching session waste time doing useless exercises, it will decrease the benefits of flexibility training. Also, it is likely that dangerous exercises will be introduced. Both can be avoided by doing just "three" exercises to increase the range of motion of all the major muscle groups used by athletes (Box **2**). This is an extremely important point. More is not better. For those who disagree with the statement, it only serves to underline what is already apparent.

Too few instructors, trainers, athletes, coaches, and exercise physiologists have

CHAPTER 10

Common Stretching Mistakes

Abstract: Just as the lack of flexibility can lead to muscle and joint injuries and posture issues that influence athletics, health, and wellness, engaging in the common stretching mistakes is a waste of time and a failure to train for an increase in range of motion. It is important to avoid flexibility exercises that are useless. Avoid those that increase the risk of injury, especially the dangerous exercises with questionable value. Only good stretching exercises should be performed by athletes and others. At no time should the joints and muscles be forced into a stretched position. It is always better to engage in a brief, light form of aerobic exercise such as walking or jogging just prior to a commitment to stretching. Also, it is important to recognize the discomfort associated with flexibility training by not over-stretching. When engaged in flexibility training, remember to breathe, to stretch regularly, and to avoid the stretching mistakes.

Keywords: Abduction, Hurdler's stretch, Shoulder extensors, Shoulder flexors, Warm-up.

INTRODUCTION

Flexibility training is not a generalized musculoskeletal warm-up. To improve performance, athletes and others must increase their range of motion across multiple joints. The problem that many coaches, athletes, and others make in training for flexibility is that they fail to understand the infrastructure of the musculoskeletal system. They are not aware that there are useless flexibility exercises, and that some exercises actually increase the chances of an injury. That is why important guidelines exist when engaged in flexibility training.

Avoid Useless Flexibility Exercises

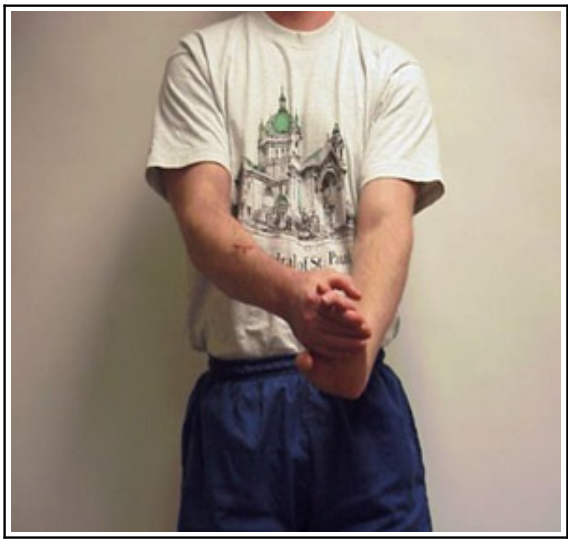
Do not stretch joints and muscles just because someone else is observed doing so. Certain joints and muscles need stretching while others do not. As an example, the

Tommy Boone

shoulder flexors and extensors need stretching while the anterior forearm muscles do not need stretching. To understand which joints and muscles need stretching requires an understanding of why muscles undergo adaptive shortening.

The short answer to adaptive shortening is when the origins and insertions of a muscle group are moved closer together, such as when positioning the wrist in an acute extended position (perhaps, due to an injury). The decreased tension placed on the posterior forearm extensors (Box **1**) will set the stage for a loss of motion.

Box 1. This is a useless stretching exercise.



Unless there is an injury or entrapment of the median and ulnar nerves to the forearm flexors, there is little reason to stretch the anterior forearm muscles. To stretch them is to take time away from muscles that need stretching. Thus, this is a useless exercise.

Avoid flexibility exercises that are useless, which is defined in this book as exercises that result in little significant range of motion about a joint(s) because the muscles associated with the joint(s) are not likely to experience adaptive shortening. Aside from the forearm flexors, the quadriceps femoris is another muscle group that athletes and others waste time stretching. Why not use the time to engage in a good stretching exercise?

Avoid the Dangerous Flexibility Exercises

Not all flexibility exercises are safe. Avoid those that increase the risk of injury. They are dangerous and have questionable value. For example, in the track and

field sport, there is the running event in which athletes hurdle (jump) numerous obstacles in their path while running at near maximum velocity. The position of one limb that passes over the hurdle is characterized as abducted at the hip while the knee is flexed. The second limb is flexed at the hip with the knee extended over the hurdle. The abducted position of the hip has given rise to the flexibility exercise while sitting called the hurdler's stretch in which one leg is flexed at the knee and laterally rotated. This position places a stretch on the tibia collateral ligament, which is connected to the medial cartilage within the knee joint (Box **2**).

Box 2. The hurdler's stretch is a dangerous stretching exercise.

The hurdler's stretch is not the best way to stretch the hamstrings plus it is a very inefficient exercise. The posterior thigh muscles are not stretched since the knee is flexed. So, why is the flexibility exercise still popular? Because hurdlers use the stretch since it approximates the position they are in the air when clearing the hurdles. Aside from this connection with a sport and the fact it has been done forever, there is no logical reason for athletes doing it. Most coaches, exercise physiologists, and athletic trainers recognize the danger of doing this exercise since it also places pressure on the medial meniscus and can cause slippage of the kneecap.

CHAPTER 11

Good Flexibility Exercises

Abstract: A good flexibility program requires no more than "three" stretching exercises (sit-straddle-reach stretch, shoulder and chest stretch, and the standing hip flexor stretch) to maximize the range of motion of the muscles that undergo adaptive shortening. Increased flexibility in the anterior chest and shoulder muscles, the low back, adductors, hamstrings, and plantar flexor muscles, and the hip flexors, help an athlete or client to engage in athletics or recreational programs, with an increase in skill performance and movement efficiency with less degree of difficulty as compared to earlier musculoskeletal limitations.

Keywords: Athletic performance, Dorsi-flexion, Erector spinae, Hyperextension, Linea aspera, Plantar flexion.

INTRODUCTION

Flexibility training is believed to include many stretching exercises, but such thinking is antiquated and a mistaken reality (McAtee 1993). Books and articles describing dozens upon dozens of stretching exercises abound (Alter 1998). The truth is that a good flexibility program requires no more than "three" exercises to maximize the range of motion of the muscles that undergo adaptive shortening and limit athletic performance, help prevent injury and improve circulation.

Spending a few minutes doing slow, deliberate stretches of 10 or more exercises is very time consuming. Moreover, the time spent in the exercises will do very little to help ensure an increase in range of motion. This means that the exercises are either useless or dangerous. However, it is difficult to accept that with just three "good" stretching exercises, a gymnast can acquire all the range of motion necessary to perform at an elite level is true. Given that this is true for a gymnast,

Tommy Boone

why are other athletes wasting their time doing dozens of useless and dangerous stretching exercises? The only logical answer is that it was the way the athletes were taught by their coaches, trainers, and exercise physiologists.

While what was conveyed to them was perhaps well-intentioned, it is nonetheless unacceptable. That is why the following three flexibility exercises are analyzed anatomically so the reader can conclude for him- or herself the genuine truth of the matter: (a) Sit-Straddle-Reach Stretch; (b) Shoulder and Chest Stretch; and (c) Standing Hip Flexor Stretch.

Sit-Straddle-Reach Stretch

Note that the person is sitting with his legs in a straddle position (Box **1**). The objective is to lean forward first on one thigh for 30 seconds and then on the other thigh for 30 seconds followed by leaning forwards in the middle for 30 seconds. The exercise is repeated three times for ~5 minutes of controlled and focused stretching.

Box 1. The sit-straddle-reach stretch.

It is a good stretching exercise because it is safe, and because the tension placed

on the erector spinae and hamstring muscles is under the athlete's control. Also, when leaning forward, the feet should be in a dorsi-flexed position to help stretch the plantar flexors of the posterior leg. Of course, the idea is to gradually increase the width of the lower limbs, which will place more stress on the adductors of the thighs.

This exercise counteracts the adaptive shortening that occurs with years of sitting and inactivity. The muscles that undergo a decrease in range of motion are the: (a) erector spinae; (b) hamstrings; (c) adductors; and (d) plantar flexors. The arching of the lower back when sitting encourages the low back muscles to shorten, which often results in low back pain (due to the increase in anterior convexity of the spine). The constantly flexed position of the knees with the legs held close together encourages the hamstrings and adductors of the thigh to shorten. The decrease in range of motion of the plantar flexors occurs primarily among women who wear high heeled shoes.

Erector Spinae

The erector spinae (or extensor spinae) is a group of muscles made up of the spinalis (medially), longissimus (center), and iliocostalis (laterally) (Box **2**). Collectively, they arise from a broad and thick tendon that attaches to the crest of the sacrum, the spinous process of the lumbar and the 11^{th} and 12^{th} thoracic vertebrae, and related sacral ligaments. The erector spinae runs along the spine in the thoraco-lumbar and the mid-thoracic area. The muscles are generally the largest in the lumbar region with decreasing size as they move vertically to insert along the vertebrae and ribs. They are innervated by the dorsal rami of the cervical, thoracic, and lumbar spinal nerves. Unilaterally they produce lateral flexion and rotation to the opposite side. Bilateral they help to extend the spine.

The sit-straddle-reach exercise is an excellent way to stretch the erector spinae muscles. To gain full benefit of the stretch, it is important to keep the lumbar and thoracic region as straight as possible when leaning forward. There will be a natural roundness of the mid-thoracic region. Nonetheless, it is best to try to keep the full length of the back straight when flexing at the hips.

CHAPTER 12

Useless Flexibility Exercises

Abstract: Useless flexibility exercises are done by athletes, trainers, and other practitioners with the intention of increasing their range of motion. Unfortunately, the time taken to stretch the muscles across specific joints is time wasted that could have been used to obtain benefits from the three good flexibility exercises. This outcome is primarily due to the lack of anatomical knowledge as to whether the range of motion of specific exercises actually produces a significant stretch on the muscles. When an exercise cannot place a stretch on the muscles, it is useless and ineffective and should not be part of the flexibility training program.

Keywords: Anterior forearm flexors, Crooked thinking, Good stretching exercises, Median nerve, Straight thinking.

INTRODUCTION

Although flexibility training is believed to include dozens of different stretching exercises, such thinking is antiquated and anatomically incorrect. Books and articles describing 30 or more stretching exercises abound. Yet, the truth is that an excellent flexibility program requires no more than "three" exercises to maximize the range of motion of the muscles that undergo adaptive shortening and limit athletic performance. However, it is difficult to accept that only three "good" stretching exercises are necessary, it is nonetheless true. Gymnasts can acquire all the range of motion necessary with these three stretches. Given that this is true for a gymnast, why are athletes wasting their time doing useless and/or dangerous stretching exercises? The only logical answer is that it was the way the athletes were taught by their coaches, trainers, and exercise physiologists.

It is unfortunate that there is so little scientific rigor when it comes to doing 10 or

Tommy Boone

more stretches. While many coaches and athletes place a high premium on self-expression, the time spent doing at random exercises will do very little to increase range of motion and the exercise may be dangerous! This is not smart training.

Anterior Forearm Stretch

This is a very common exercise that athletes do. They are under the impression that the exercise produces an increase in the range of motion of the forearm flexors. In general, the muscles of the anterior side of the forearm flex the elbow, wrist, and fingers (Box **1**). They also pronate the hand (*e.g.,* when the elbow is flex at a 90° angle, pronation occurs when the hand is rotated from a palm up position to the down position). The anterior forearm muscles are divided into three layers: superficial, middle, and deep.

Box 1. The anterior forearm stretch exercise.

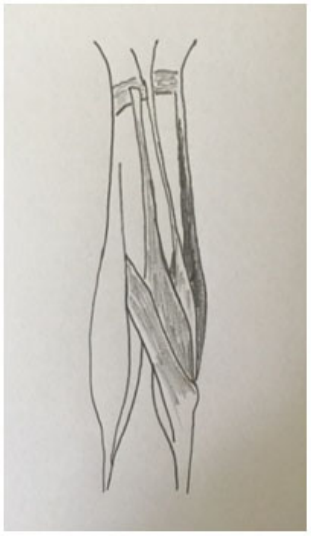
Superficial Layer

With the hand in the supinated position (*i.e.,* palm up when the elbow joint is flexed 90°), the superficial compartment of the anterior forearm consists of the following muscles from lateral to medial: pronator teres, flexor carpi radialis,

palmaris longus, and flexor carpi ulnaris. All four muscles originate from the medial epicondyle of the humerus.

The pronator teres originates not only from the medial epicondyle of the humerus, but also from the coronoid process of the ulna (Box **2**). It inserts on to the proximal lateral aspect of the radius. It is innervated by the median nerve, which causes the muscle to contract (*i.e.,* shorten). Given that the points of origin are more stable than the radius, the force of contraction turns the radius medially *via* its long axis. This action on the radius and forearm is called pronation.

Box 2. The forearm muscles of the superficial layer.



The anatomy illustration of the left forearm is simple but to the point. The four muscles in the superficial layer from lateral to medial are:

1. Pronator teres
2. Flexor carpi radialis
3. Palmaris longus
4. Flexor carpi ulnaris.

While they all originate from the medial epicondyle of the humerus, #**1** does not cross the wrist, #**2** crosses the wrist to attach to the anterior surface of the base of metacarpals 2 and 3, #**3** crosses the wrist to attach to the palmar aponeurosis, and #**4** crosses the wrist to attach to the pisiform and hamate bones of the wrist and then to the base of metacarpal 5 *via* the pisohamate and pisometacarpal ligaments.

Unless there is an injury to the radial nerve on the dorsal side of the forearm that would position the wrist in an acute flexed position, these muscles do not undergo adaptive shortening. Therefore, stretching them is a useless exercise.

As indicated earlier, the flexor carpi radialis arises from the medial epicondyle of the humerus to attach to the proximal anterior surface (*i.e.,* base) of the second and third metacarpals. When the muscle contracts, it flexes the elbow joint and wrist, and abduct the hand at the wrist relative to the forearm. It is innervated by the median nerve. The palmaris longus is the third muscle from lateral to medial in the superficial compartment of the anterior forearm. Interestingly, ~15% of the population does not have this muscle. The primary reason appears to be that the muscle consists of a tendon that is essentially 90% of the muscle's length. The muscle originates from the medial epicondyle and inserts into the palmar

CHAPTER 13

Dangerous Flexibility Exercises

Abstract: A dangerous flexibility program consists of exercises that place unusual and unnecessary stretch and/or force on muscles, joints, and nerves. Many so-called stretching exercises have the potential to do more harm than good. No one should do an exercise that has the potential to result in degenerative changes in joints and nerves over time. Dangerous flexibility exercises that involve placing the head and neck (such as the plough and shoulder stand bicycling), knees (*e.g.,* the deep knee bends and quadriceps stretch), and low back in an awkward or questionable position should be avoided. It is unfortunate that so little credible information is available to athletes, coaches, and individuals interested in flexibility training. The content in this chapter should help lay a solid foundation for thinking straight about which flexibility exercises should be avoided.

Keywords: Controversial flexibility exercises, Dangerous flexibility exercises, Questionable flexibility exercises.

INTRODUCTION

Exercise, whether it is aerobic dance, jogging, or stretching, is filled with the "do this" and "don't do this" type of exercise. In the first place, the "do this exercise" (whatever it may be) and you can expect beneficial results is more often than not highly questionable. If it is the latter case, for example, do not jog in the middle of the day at a temperature of 105° because you can expect a negative result makes sense. But, the certainty should be questioned and/or considered in light of other factors that might also contribute to a benefit or an injury.

When an athlete, college student, or middle-aged person goes to the doctor for an injury from what seems to have resulted from the performance of a skill or, in this case, a flexibility exercise, the verdict is usually a condemnation of the skill or

Tommy Boone

exercise. Seems logical but considering the contribution of other factors (such as inadequate physical preparation or incorrect execution technique) that might have contributed to the result, condemning the exercise may be premature.

Does this mean that there are no dangerous flexibility exercises? The answer is "yes" if the performer's body is capable of adapting to the exercise. The answer is "no" if the performer's body is not capable of adapting to the exercise. Hence, if the person has the prerequisite flexibility to perform a side or front splits, there is no reason to expect an injury from doing either exercise. But, if the person is not ready to do a side splits, then forcing the exercise is very dangerous.

Where there is not a lot of medical evidence to link specific detrimental effects to a particular exercise, then logic (or common sense) must prevail. That is why this book has become so important. There are no absolute answers. There are only possibilities that may or may not surface depending on the appropriateness of the flexibility exercise. For example, a person with a history of back problems should not do exercises that increase the risk of injury to the back. The same is true for a person with knee problems. There is no reason for this person to get into the lotus or the half-lotus position.

Although flexibility training must be tailored to the individual to be safe and effective, the task of doing so is not all that complicated as long as the training program is progressive and guided by common sense. The latter criterion has a lot to do with looking at an exercise and evaluating whether the risks of doing it outweigh the benefits. The potentially dangerous exercises commonly mentioned throughout the scientific literature include the following exercises:

1. Plough
2. Neck circles
3. Bridging
4. Standing toe touch
5. Back hypertension
6. Hurdler's stretch
7. Quadriceps stretch
8. Full squat

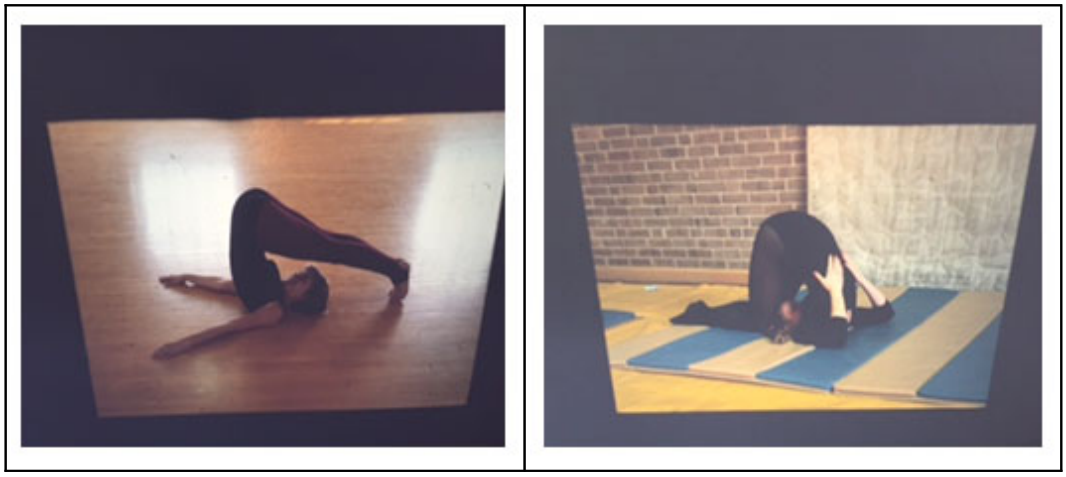
The first three exercises address potential problems in the neck region. Exercises four and five are associated with back problems while exercises six, seven, and eight are likely to cause knee problems. In fact, any exercise that produces pain or discomfort or requires unnatural or unusual range of motion should be avoided.

Controversial Neck Exercises

Plough

The plough is performed by lying on the back, raising the lower limbs and hips up and overhead to a point that the feet touch the ground beyond the head (Box **1**). The arms are usually positioned against the ground to keep the body position. The purpose of this exercise is to stretch the back, particularly the mid-thoracic and upper back. The problem with the exercise is that it may result in significant compressive forces on the cervical and upper thoracic vertebrae.

Box 1. The plough stretching exercise.



Having coached and taught gymnastics for many years, I can contest to the fact that the plough is not generally a dangerous exercise for the healthy individual or athlete. Of course the position required of the exercise, with increased pressure on the cervical spine, is potentially dangerous for anyone who is overweight and obese. The transfer of body weight over the neck may also be a concern with the elderly. Although they may not have the extra weight to compress the spine, they

Part IV
Professional Development

CHAPTER 14

Historical Issues and Concerns

Abstract: The professional development of exercise physiologists is determined by the quality of their professional thinking, which is in turn determined by the quality of their critical thinking, for critical thinking is the driving force behind professionalism. Without critical thinking, there is little reason to think exercise physiologists are meaningfully interlocked with other healthcare professionals. In fact, it is obvious that all the scientific papers, presentations, and posters by exercise physiologists at national and regional meetings cannot define exercise physiology as a profession. This point is within their understanding if they work at critical thinking as they have taught their students to think scientifically. Yet, many academic exercise physiologists continue to present their scientific papers without internalizing the concepts and principles essential to the professionalism in exercise physiology (*i.e.,* code of ethics, accreditation, and a career specific Board Certification). Despite having the doctorate degree and after teaching years of college and university courses, few professors have the skills to become self-directed, self-monitored, and self-corrective critical thinkers to guide their students' path towards professionalism.

Keywords: Accreditation, ASEP vision, Code of ethics, Exercise physiology, Integrity, Profession, Professional, Professionalism, Traditional thinking.

INTRODUCTION

What constitutes exercise physiology, the issues and pressing concerns of exercise physiologists, and the importance of professional membership? It is not just doing research and publishing. This is the 21st century and many exercise physiologists continue to define exercise physiology as they did in the 20th century. Their failure to get past yesterday's thinking is responsible for the continuation of meaningless academic majors as well as the failure to teach anatomy on the same level as they do exercise physiology (Boone 2010). So much has gone wrong since the 1960s

Tommy Boone

that the traditional thinking associated with getting a college degree is being questioned by students and their parents.

Straight Thinking

While the physical education major was once the primary path for students interested in sports and athletics, that changed as the academic major came under attack for lack of substance. Many departments either dropped the physical education major or changed it to health and kinesiology or exercise science. Others adopted one of 40 different titles. Overall, the change occurred without consistency or a philosophy to ensure academic quality. The well-entrenched failure to think straight has grown in influence, but without professional integrity. Students of exercise science graduate and call themselves exercise physiologists or personal trainers (Ciccolella *et al.* 2008). It is a problem in the United States that stems from decades of exercise physiologists failing to think straight (Box **1**)

Box 1. The importance of thinking straight.

The possibility of thinking differently, changing conditions for students, and attracting colleagues from other fields of work rests entirely with the thoughts of exercise physiologists. Thinking straight is important, as was expressed by Melvin J. Ballard: "Above all else, brethren, let us think straight."

Breakaway thinkers such as the ASEP leaders (American Society of Exercise Physiologists 2016f) and the leadership of the Clinical Exercise Physiology Association (CEPA 2010) assert that the "career needs" of their membership are not being met. If it is true that **what we are to become depends upon what we are thinking**, then, given the smorgasbord of academic degrees students find themselves enrolled in, **the problem is in failing to think straight**. In short, while exercise science graduates may decide to work as a personal trainer, they are not an exercise physiologist unless they pass the "Exercise Physiologist Certified". To think otherwise is wrong and, frankly, it is a very unfortunate outcome of the lack of leadership at the collegiate level that has allowed for the development of a huge list of undergraduate degrees without academic specificity or credibility (Rademacher & Pittsley 2001).

A person who graduates with a nursing degree is rightfully a nurse. Then, too, a

person with a degree in physiology is a physiologist. But, clearly, a physiologist is not an exercise physiologist and vice versa. Equally true is the fact that a person with a chemistry degree is not a biologist. The point is a college graduate with a kinesiology or sports science degree is not an exercise physiologist even if he or she has an academic minor in exercise physiology. This thinking applies equally as well to college graduates with a human performance degree. Suppose, for example, if it is true that the kinesiology graduate is a kinesiologist and the sports science major is a sports scientist, it would then make sense that neither is an exercise physiologist (Box **2**).

Box 2. It is all about the title.

"Be honest with yourself, do you want to be a personal trainer or a Board Certified Exercise Physiologist? Perhaps now is the time to take a closer look at the ASEP Exercise Physiologist Certified (EPC) exam. All I know is, if an exercise science instructor tells you it's not about the title, rest assured that it is all about the title. What's more – if you want to be an exercise physiologist, then you must either graduate with an academic degree in exercise physiology or sit for the EPC exam and pass it. Remember, your future is at stake here… your family's home, your income – your paycheck!"

-- PEPonline
August 2016

Nothing about this chapter is for the purpose of recrimination of individuals and/or academic departments for what they are. Rather, it is about what can be learned of the mystery of where students, faculty, and exercise physiologists find themselves today? Thoughts have the power to objectify themselves, but a person does not have the right to call him or herself what he or she is not. This is true in law, religion, engineering, occupational therapy, and so on. It should be true in exercise physiology as well.

Students should not be exploited either for the institution's financial incentives or for the politics or business priorities of an organization. And yet, during the past several decades, it has become all too common to encourage students to locate an internship to finalize their academic requirements for graduation. Here is the question: Is it a "good thing" for students? While it appears on the surface to be 100% the right course of action, is it? The truth is this: It is only a good thing up to a point. There isn't any doubt that many students benefit from the hands-on experience that an internship provides. But, unfortunately, it has become too

CHAPTER 15

Professionalization and Healthcare

Abstract: Exercise physiologists should focus on the professionalization of exercise physiology by supporting the American Society of Exercise Physiologists (ASEP), particularly in regards to their role in prescribing exercise medicine? Secondly, the non-academic community of non-doctorate exercise physiologists must provide a stronger voice for exercise physiology as a healthcare profession. It is important that exercise physiologists should focus on healthcare employment, and they must be taught the exercise physiologists' code of ethics and professional standards. For the profession of exercise physiology to become equal to physical therapy and other healthcare professions, members must help ensure that professionalism is at the core of the academic curriculum. The exercise prescription must be properly prescribed with specificity to promote positive outcomes and reduce complications. Age-related changes in human organ subsystems can be improved by regular exercise, but only if it is safely administered by ASEP Board Certified Exercise Physiologists.

Keywords: Credibility, Dishonesty, Entrepreneurs, Exercise science, Healthcare, Health promotion, Legal liability, Professionalization, Professional values.

INTRODUCTION

It is obvious that research is important for all the obvious reasons. This includes published papers with a molecular and cellular focus on exercise training as well as research that helps to explain the effects of regular exercise in the etiology and treatment of diseases (Baldwin 2000). So, where do exercise physiologists go from here? It is the author's perspective that research must continue for all the obvious reasons. However, exercise physiologists should also focus on the professionalization of exercise physiology, particularly in regards to their role in prescribing exercise medicine? Note that "exercise is medicine" and, therefore, exercise medicine can improve health and well-being. In fact, it is tragic that so

Tommy Boone

little has been done by exercise physiologists to emphasize the healthcare factor of the profession.

At this point in time, physical inactivity is a much more pressing issue than the athlete's physical performance (Box **1**). Not only is it a critical healthcare need to find a way to get society to exercise, it is absolutely critical that Board Certified Exercise Physiologists are the key exercise-healthcare providers in the 21st century. The scientific evidence is clear that exercise can help prevent (and treat as well) chronic diseases and disabilities (such as diabetes, high blood pressure, colon and breast cancer, osteoporosis, depression, and dementia) (Boone 2016).

Box 1. Exercise medicine.

Exercise physiologists have known for decades that exercise is medicine. The scientific evidence is clear. Regular exercise helps to prevent chronic disease and premature death. Exercise physiologists are "the" healthcare providers of exercise medicine.

So, given this information, what are academic exercise physiologists waiting for? Why are they so slow in supporting ASEP as their professional organization? Exercise physiologists who are not members of a professional infrastructure will not be able to compete with healthcare professionals who are supporting their own professions. This is why exercise physiologists of the 21st century must develop and promote a strong and diverse knowledge base in both the science of exercise medicine and the professionalism of exercise physiology.

Type 2 diabetes patients can either be cured or markedly improved by engaging in regular exercise and a proper diet. But, it is important that with an increase in emphasis on exercise medicine the right healthcare professionals are involved. The ASEP Board Certified Exercise Physiologists are the right healthcare professionals to get clients and patients more active (Boone 2016). For this reason, the ASEP leaders are doing everything they can to ensure that Board Certified Exercise Physiologists are engaged in promoting professionalism.

Two critically important issues need to be addressed. Firstly, academic exercise physiologists need to promote the professional development of exercise physiologists by supporting the American Society of Exercise Physiologists.

Secondly, the non-academic community of non-doctorate exercise physiologists must provide a stronger voice for exercise physiology as a healthcare profession. As it stands, the lack of full support of the ASEP organization is the primary failing of the academic exercise physiologists in the United States.

As a parallel concept, historically, it was believed that drinking water during athletic training and performance was a sign of weakness (Stone *et al.* 2004). Now everyone knows that there are important reasons to drink water during training and/or a sporting event. Coaches are much better leaders today because they have learned to think outside the box. The group with the right ideas is the one with the power. Clearly, there are exercise physiologists without a plan and, consequently, they have no power. Moreover, they are their own worst enemy when it comes to not writing about professionalism. If their existence is only for publishing research papers, one has to wonder why they fail to realize the value in building their own profession of exercise physiology. It is obvious that exercise physiology meets the definition of a *profession*. The question is whether exercise physiologists know it or know what to do with the information.

Exercise physiologists provide society with an essential service (*i.e.,* exercise medicine), which is scientifically designed to benefit the recipients of that service (Box **2**). The professional service requires a mastery of a body of knowledge that is defined by the ASEP scope of practice and is regulated by the ASEP code of ethics (Begun & Lippincott 1993); all of which has been address dozens of times in professionalism articles published in the ASEP Professionalization of Exercise Physiology-online electronic journal (Boone 2004).

Box 2. Exercise physiology = exercise medicine.

Exercise physiologists have an important responsibility to be the glue that keeps exercise medicine at the very center of its professional development. After all, as John Maynard Keynes said, "The difficulty is not so much in developing new ideas as in escaping from the old ones."

The first step on the journey to success is no doubt the hardest. Whether it is three 50-minute periods of low to moderate exercise each week or the creation of professional development course in the exercise physiology curriculum, it is imperative that the first-step is taken. This is true for exercise medicine, and it is

CHAPTER 16

The Future: Curriculum Change

Abstract: Is it realistic that academic exercise physiologists teach anatomy in the exercise physiology curriculum? If so, is it necessary that they studied anatomy in their doctorate program? If they did not study anatomy and/or dissect cadavers, is it reasonable to expect them to know anatomy? If it is not reasonable, then, should the exercise physiology doctorate curriculum change to better educate the students of the 21st century? After all, exercise physiologists are healthcare professionals and, therefore, they must have the opportunity to study and dissect cadavers in the same way that other healthcare professionals have. The power of anatomy in identifying the right and the wrong way to lift weights, to increase range of motion, and to develop the motor aspects of physical skills is testament to its importance. This requires exercise physiology educators to take seriously the learning of anatomy as a dynamic basis for solving health and athletic problems.

Keywords: Board certification, Career opportunities, Curriculum, Osteological, Specialist, Teachers.

INTRODUCTION

A colleague stated it is unrealistic to expect that academic exercise physiologists will teach anatomy. They are not interested in anatomy. They are interested in research and physiology. A student who heard the professor asked: “How can exercise physiologists simply avoid teaching anatomy?” “Knowledge of anatomy is critical to the practice of exercise physiology. Isn’t anatomy a critical part of becoming a healthcare professional?” Another student asked, “Why is ECG and graded exercise testing more important than anatomy?” She felt that the comment by the faculty member did not make sense. They felt it was important to teach anatomy, and that the emphasis on anatomy in sports and healthcare should be equal to other subjects in the exercise physiology curriculum.

Tommy Boone

Updating and managing curriculum changes is never an easy process or otherwise more college teachers, chairs, and directors would be more inclined to review existing courses in lieu of new courses (Boone 2009). The purpose of this book is to help exercise physiologists recognize that there are critical issues in exercise physiology that need timely and purposeful consideration. Students who want to be exercise physiologists need the appropriate time and commitment to anatomy and the physiological inroads into understanding human movement (*i.e.,* regular exercise and/or athletics). It is the experience of most healthcare professionals that anatomy is critical to the students' education and career opportunities.

The Re-Examination Process

The review process offers the opportunity to examine what is taught and to ask questions whether change is necessary. What is critical to understand is that the curriculum must allow for accomplishing the desired outcomes that allow for the graduate to perform as a professional. It also provides the impetus for changing the emphasis on certain courses in consideration of what is believed more important (Boone 2007). The point is this: The curriculum should match up with the purpose of the degree itself, which raises the following questions:

1. What is the reason for the degree in exercise physiology?
2. Why does exercise physiology exists as an academic major?
3. Is it a technical degree?
4. Is it a research degree?
5. It is a clinical degree?
6. Is it a sports-oriented degree and, if so, which sport?
7. Is it an exercise instructor's degree?
8. Is it a personal trainer degree?
9. Is it a healthcare degree?
10. Is it a professional degree?

Shouldn't the design of the curriculum be driven by the definition of exercise physiology? If so, what is the professional definition of exercise physiology? Who is an exercise physiologist (Boone 2005)? The definition of exercise physiology by the American Society of Exercise Physiologists (ASEP 2016) bears repeating.

"Exercise Physiology is the identification of physiological mechanisms underlying physical activity, the comprehensive delivery of treatment services concerned with the analysis, improvement, and maintenance of health and fitness, rehabilitation of heart disease and other chronic diseases and/or disabilities, and the professional guidance and counsel of athletes and others interested in athletics, sports training, and human adaptability to acute and chronic exercise." Clearly, the exercise physiology academic major is a professional healthcare major.

Also, as previously described, the ASEP leaders (Boone 2001) defined the **"**Exercise Physiologist as a person who has an academic degree in exercise physiology, or who is certified by ASEP to practice exercise physiology [*via* the Exercise Physiologist Certified exam (EPC)], or who has a doctorate degree with an academic degree or emphasis in exercise physiology from an accredited college or university." Once again, it is clear that the graduate of an exercise science major is not an exercise physiologist unless he or she engages additional study and passes the ASEP Board Certification (EPC) exam. Although at present there are a number of ways in which a person can achieve the objective of earning the professional title, Exercise Physiologist, the ASEP intent is to move towards the adoption of only graduates from the academic exercise physiology major as having the right to call themselves exercise physiologists.

The whole process of curriculum review must be built upon a 21st century philosophy of exercise physiology (Boone 2014). The sports medicine approach is outdated, particularly since it has also failed to acknowledge the key role of anatomy in exercise physiology. It is the experience of the author that the presence of one of more exercise physiologists with training in cadaver dissection is beneficial not only in the important aspect of curricular review, but also in the subsequent agreement as to what should be taught. The purpose is to help facilitate the objective that anatomy is important and that the strengths of anatomy further define the credibility of the exercise physiology practice.

A detailed knowledge of anatomy forms the basis for much of the healthcare work that Board Certified Exercise Physiologists will do with patients and clients. The latter is especially the case common among athletes interested in specific muscular development. The power of anatomy is the identification of the right

Epilogue: A Vision to Realize

INTRODUCTION

The right education contributes to professional and social change that is a critical step towards replacing present-day thinking with new ideas and possibilities. A major responsibility of the academic exercise physiologists is to help students realize their full potential as healthcare professionals. When the education of students includes anatomy (and, yes, cadaver dissection), exercise physiology will move closer to the reality of being a credible healthcare profession. Naturally, this is not going to happen overnight, but it must happen because anatomy teaching is an integral part of the students' professional education.

Hegelian scholar J. Glenn Gray (1984), in Re-Thinking American Education, makes a similar case when he said, "Only to the degree that we become educated, do we gain relationships of depth and intimacy to the encompassing world." "Becoming educated" is more than getting a college degree or even a doctorate degree. Without gaining the relationship of depth and intimacy to the exercise physiologists' world of scientific knowledge and hands-on experiences and the role of each in helping clients, one cannot help but feel loss and confused.

The education of exercise physiology students should be thoroughly thought out and implemented. It is about uncovering the entire complexity of the body, not just the physiology or even the biomechanics or nutritional needs of athletes. It is about the interconnection between anatomy, physiology, and the foundational sciences necessary to understand the vital connection between the mind and the body. Hence, it is by studying anatomy in the classroom and in the laboratory that the students of exercise physiology can be, as Greene (1988) said, "…empowered to think about what they are doing, to become mindful, to share meanings, to conceptualize…".

It is paramount that academic exercise physiologists see to it that their department produces exercise physiologists who are professionally competent and who have hands-on knowledge of anatomy. Indeed, college graduates need a new vision of the whole person, mind, muscles, and physiology. It is no longer sufficient for exercise physiologists to be anything less than what the ASEP vision entails.

To understand this point, the reader must grasp the exercise physiologists' vision (ASEP 2010). It is the most fundamental fact of why ASEP was founded in 1997. The vision is believed to be a much better idea whose time has come. Exercise physiology is not exercise science. Too many academic exercise physiologists go through their work every day clueless about what to do to empower the students and promote the profession of exercise physiology. Fortunately, ASEP exercise physiologists are defining these issues and problems whether it is

in regards to health, fitness, rehabilitation, or athletics. They understand the vision of teaching anatomy generates hope and motivates the discouraged to stay the course.

That is why the ASEP vision explains what the ASEP leaders want (Box **1**), which is to be recognized as the leading professional organization of American scholars and practitioners in the study and application of exercise physiology to fitness, health promotion, rehabilitation, and sports training. ASEP is dedicated to unifying exercise physiologists in the United States by promoting and supporting the study, practice, teaching, research, and development of the profession of exercise physiology. Through proactive and creative leadership, the Society empowers its members to serve the public good by making an academically sound difference in the application of exercise physiology concepts and insights.

Box 1. A vision is magical and innovative.

The right vision can change everything about exercise physiology. It is the motivator to get exercise physiologists in the right frame of mind. It is the force that will impact and change the lives of thousands of students forever.

The essential point is this: The ASEP vision is a way of life to be lived. To be successful and appealing to exercise physiologists, it must not be viewed as impossible to attain. The ASEP leaders believe it is challenging and believable. Clearly, to make an academically sound difference in the application of exercise physiology concepts and insights, particularly in regards to exercise medicine, the exercise physiology educators must tackle the formidable problem of little to no anatomy instruction. One way of doing so is to make large-scale changes in the curricular. In short, this means doing what can be done with what one has until the process is well underway year after year. This is especially true during times of transition – such as when exercise physiologists are moving away from status quo and paying special attention to professionalism.

It is especially important to get the commitment of the academic professors who are directly responsible for implementing the change with their actions and words. It is they who will be responsible for conveying the visionary message that it is not possible to fully teach exercise physiology students without teaching anatomy and finding a balance among the exercise physiology courses and hands-on skills.

Also, an important point is that while computer programs and plastic models can be useful adjuncts, the primary focus should be on the use of cadavers. But, of course, understanding that the benefits of using cadavers in teaching and learning anatomy at the non-doctorate level will not happen overnight, the immediate concern is to ensure that the doctorate level exercise physiology students will have the opportunity to study anatomy (Box **2**) with the use of both

prosections and cadavers in the exercise physiology curriculum.

Box 2. Dissection of some of the muscles of the anterior, lateral, and posterior leg.

Note the five tendons from left to right.
1. **extensor digitorum longus** (originates from the anterior-lateral part of the leg)
2. **tibialis anterior** (originates in the upper two-thirds of the lateral surface of the tibia)
3. **peroneus brevis** (originates from the lower one-half of the lateral shaft of the fibula)
4. **peroneus longus** (originates from the head of fibula, upper one-half to two-thirds of the lateral side of the fibular)
5. **gastrocnemius** (originates from the lateral and medial condyles of the femur)
Question: Which one is a combination of two muscles?

Where possible both the undergraduate and the graduate students should be taught structural anatomy by lectures and complete dissection of the human body (Box **3**). Thus, to deal appropriately with this issue, there should be a full debate at every level of higher education to highlight areas of concern, to explore in depth the challenges, and to define a minimal core curriculum for the study of anatomy. The teaching of anatomy in exercise physiology must be valued, pursued, and experienced. Otherwise, it is more than reasonable to expect that the departments and institutions will be held liable for their training and teaching if they are shown to be insufficient for the safe practice of exercise medicine.

Box 3. The learning of anatomy is a visual and tactile experience.

Anatomical dissection is the systematic exploration of a preserved human cadaver by the sequential division of tissue layers and the liberation of certain structures by removal of the regional fat and connective tissue with the aim of supporting the learning of gross anatomy by visual and tactile experience.

-- Andreas Winkelmann (2006)

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SUBJECT INDEX

D

E

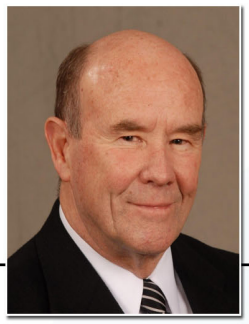
F

G

H

I

K



Tommy Boone

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 the Master of Public Health (MPH) degree to further integrate exercise physiology with health and disease prevention strategies. In 1993, Dr. Boone was appointed the 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 plus an Anatomy Laboratory for graduate students to dissect cadavers. In 1997, he founded the American Society of Exercise Physiologists (ASEP) to promote professionalization of exercise physiology as a healthcare profession. While at St. Scholastica, he completed the Master of Arts in Management (MAM), in 1999 and the Master of Business Administration (MBA), in 2010, to help with 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 a college textbook, Introduction to Exercise Physiology, which is used for the ASEP Board Certification Exam. In 2016, Bentham Science published Dr. Boone's eBook, ASEP's Exercise Medicine Text for Exercise Physiologists as credible content for Board Certified Exercise Physiologists. Dr. Boone has taught ~6,000 students in more than 250 college courses while published 20 books, 75 research articles, and ~500 professionalism articles while presenting at regional and national meetings throughout the United States.