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EVAN C. PETTIT
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THE DOUBLE BASSIST'S COMPANION TO BETTER PLAYING HEALTH

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BY

_____
Dr. Eugene Enrico, Chair

_____
Dr. Anthony Stoops, Co-chair

_____
Mr. Hal Grossman

_____
Dr. Sarah Reichardt

_____
Dr. Michael Bemben

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ABSTRACT

The world of double bass playing has been marred from its inception with issues of pain and discomfort. Over time stress caused by the size and weight of the instrument creates potential physical problems for the musician. Even with regular physical activity and exercise, without specific knowledge and exercises designed to target crucial musculature elements such as the muscles in the shoulders, lower back, and legs, issues will persist. This document presents the results of a survey of performers of the double bass, appraises common physical issues, and develops a specially designed stretching program that targets and increase flexibility in the muscles that are vital to playing the double bass. The goal is to reduce the potential of physical injury and decreasing the overall physical demands of practicing and performing on the instrument.

THE DOUBLE BASSIST'S COMPANION TO BETTER PLAYING HEALTH

CHAPTER ONE: INTRODUCTION

Statement of Purpose

This document has a dual purpose: first, to investigate the physical effects upon the human body of playing the double bass by presenting the results a survey on a sample of double bassists from National Association of Schools of Music as well as orchestras around the United States. The survey covers these topics along with these issues, such as musculoskeletal injuries, related to the physical aspects of playing double bass. Second the document applies relevant concepts of anatomy and physiology to the physical action of double bass playing and proposes a flexibility program to account for these issues.

Need for the Study

A multitude of opinions and a general lack of consensus about how the human body organizes itself to play the double bass exist in the world today. This idea of the body's "psychomotor"—knowledge of how one's body works or is oriented, its alignment—has been a hot topic among arts medicine in recent decades, but focus on the psychomotor when it comes

to playing the double bass specifically, is severely lacking. Such a focus, however, is warranted. If an unsuspecting student is taught posture and bowing technique incorrectly from a young age, an incredible amount of physical damage occurs. This damage is generally exacerbated as the student ages. Furthermore, bad habits established from a susceptible age can prove difficult to correct.

Unfortunately, the way in which young people learn to play musical instruments, especially in the United States, tends to initiate and perpetuate these problems. Most young double bassists begin their musical training in a public school setting between the fourth to sixth grades. The classes are often very large, and as a result, specific, one-on-one training is almost impossible. This kind of individualized attention is important though, not only from a musical standpoint, but from a physical one. Learning to play any string instrument is physically unnatural and awkward, due to the asymmetrical orientation of the instrument to the body when played. This awkwardness is especially true in the case of the double bass because of its mass and size. With the combination of rare specialized instruction and few to no private lessons in the early development of the musician, serious physical strain and other injuries often occur. Despite the limited time instructors have to spend with individual students at this stage, a large amount of responsibility for

preventing muscular overuse and misuse injuries is placed on the music educators. As William Dawson states, "The music teacher is our first line of defense."[1] In some respects, a child's body is much more forgiving on the musculoskeletal level than that of an adult. However, the perpetuation of bad technique and little physical exercise, both in terms of the playing an instrument and overall health, will continue to the university level of education if not corrected.

Young players are at the mercy of their instructors, and their instructors' time in terms of understanding how their body works with regard to playing the double bass. But even when it comes to adult musicians, ignorance of what is possible for the body physically, and how this applies to playing the double bass has become a serious epidemic. An unfortunate myth that has become a "known truth" in musician circles is that pain comes with the territory of playing the instrument, so that the "no pain, no gain" mentality permeates the landscape. For years the only foreseen possibility for the double bassist has been this: to continue your profession or passion means a life of discomfort and pain.

[1] William J. Dawson, "Playing without Pain: Strategies for the Developing Instrumentalist," *Music Educators Journal* 93, no. 2 (Nov. 2006): 36–41.

Physical discomfort experienced by double bassists can range from fatigue and tension to muscular pain and more. This is not to say that one who uses proper technique will never experience soreness or discomfort while playing the double bass. Some growing or learning pains can be expected, especially in younger students first learning the instrument. When teaching younger players positions on the A or E string, I have observed that they often show signs of tension, fatigue, and discomfort. Due to the additional pounds of pressure on those strings, more exertion is required to play them both in the horizontal movement of the right arm and in the downward force to depress the string in the left hand. These factors can cause similar effects in even the most seasoned professionals after a long day of practice and rehearsal. However, in no way should pain and discomfort be experienced in the larger muscle groups such as the neck, shoulders, back, or legs.

As has been discussed in many recent arts medicine articles, which are explored in chapter 2, pain and discomfort are the body's way of telling the mind that something is not correct and needs to be adjusted. If warning signs such as pain in the larger muscle groups are ignored for an extended period of time, symptoms of muscular overuse and injuries more than likely will occur.

Scope and Limitations of the Study

Following the literature review in chapter 2, this document is divided into two sections. The first section, chapter 3, begins with a discussion, through the results of the attached survey, into physical limitations and issues experienced by a select group of musicians who play the double bass. The survey investigates my hypothesis that the more physically active a person is and the more they work to increase their flexibility, the more likely they are to avoid pain or discomfort while playing the double bass. It is assumed that the preponderance of pain and discomfort experienced by double bassists would lie in the lower back and hips. To supplement the research findings, an interview with Dr. Randall Kertz, D.C., was conducted and is included along with a stretching regimen in chapter 4. Dr. Kertz recently self-published a book on injury reduction and other issues similar to those addressed in this document, although his focus is on physical concerns of electric bassists.

A goal of the survey was to have a large sample size of participants. To this end, data from forty-eight subjects were collected. The data supported the hypothesis of this document. The only limiting factors on the results of the survey are that respondents returned it in a timely manner and that the answers they provided are accurate.

Procedures/Methodology

Each participant in this survey responded to a fourteen-question survey that addresses physical issues related to playing the double bass. The questions cover the physical habits of the player outside of music and the frequency of those activities, the use of a German or French bow hold, the way in which the player situates himself or herself with the instrument, the musician's frequency of playing the instrument, and, most importantly, the musculoskeletal issues identified as being faced by the bassist and their severity. The completed surveys will be kept confidential in accordance with the Institutional Review Board of the University of Oklahoma. The double bass studio at the University of Oklahoma was used to trial test the survey. A summary and discussion of the data collected concludes chapter 3.

The second section of the document, chapter 4, describes a flexibility program created to help correct and prevent further issues related to findings that are prevalent in the data. The stretching section of the flexibility program consists of exercises that can be performed in a confined space, such as a practice room. The intention of this section of the document is to identify exercises that could benefit double bass players

of all physical ability levels and ages—whether they are young students just learning the instrument or seasoned professionals.

CHAPTER TWO: RELATED LITERATURE

General Performing Arts Medicine Literature

Most professional classical musicians experience problems in the neck, shoulders, and lower back due to physical demand of performance. Musculoskeletal overload results from high demand of certain unnatural and uncomfortable postures as well as unhealthy playing conditions. Frequent repetitive motions, fixed playing times, and the use of asymmetric instruments lead to more specific problems. Over the last twenty years, researchers interested in the relationship between musicians and the physical issues they face have been productive. However, most of the performing arts medicine literature that has been produced owes much of its inspiration to four main sources: Alice Brandfonbrener's 1991 article "Performing Arts Medicine: An Evolving Specialty," Richard Norris's 1993 book *The Musician's Survival Manual: A Guide to Preventing and Treating Injuries in Instrumentalists*, Barbara Paull and Christine Harrison's 1997 book *The Athletic Musician: A Guide to Playing Without Pain*, and Janet Horvath's 2002 book *Playing (Less) Hurt: An Injury Prevention Guide for Musicians*. While additional important studies have been published, these four are the pioneering works in the field. Beyond

this general category of performing arts medicine literature, additional areas of study developed, including exercise-based research and instrument-specific research, such as the few studies specifically related to playing the double bass.

In 1991, Alice Brandfonbrener's article, "Performing Arts Medicine: An Evolving Specialty," described the then new field of performing arts medicine and the credibility that it was beginning to gain in the general medical field.[1] Previously, Brandfonbrener wrote, arts medicine had not been practiced by doctors because of a lack of interest. For the first time, the physical—and physiological—stresses placed on the body of an artist while performing were beginning to be understood by the general medical population.

When it came to treatment, Brandfonbrener emphasized that every performer is different, and the impracticality of prescribing the same practice and performance habits to all. All muscle, tendon, joint, or nerve problems associated with musicians began to be seen as empirical and directly connected to the interaction of the musician and the instrument. Often, Brandfonbrener clarified, traditional treatments and diagnoses are little to no help for musicians as small issues in the muscle or joint can

[1] Alice G. Brandfonbrener, "Performing Arts Medicine: An Evolving Specialty," *Music Educators Journal* 77, no. 5 (Jan. 1991): 37–41.

cause serious problems. Arts medicine requires a much more hands-on approach by physicians, such as positioning the musician with the instrument in order to diagnose the problem. Threat of loss of income or employment on the side of the musician is a concern. Unless stipulated by an orchestra or performing company, a serious or chronic injury can cause unemployment due to being replaced. Using common sense on the part of the musician is necessary for the best results. Prevention is the most important key of arts medicine for avoiding injury.

Brandfonbrener's article inspired a book of the same title containing twenty-one articles by arts medicine doctors and practitioners. The articles range in topic from neurological problems to hearing loss, respiratory problems, and musculoskeletal issues faced by instrumentalists. However, there is little to no mention of double bass–related overuse problems or injury prevention in the book. Overall, though, the book is a great resource for better understanding anything arts medicine–related and a good supplement to the journal *Medical Problems for Performing Artists*.[2]

[2] The journal *Medical Problems for Performing Artists* began being published in December 1986 as a source of articles about arts medicine. These articles cover all arts disciplines, including music and dance.

Richard Norris's path-breaking 1993 book, *The Musician's Survival Manual: A Guide to Preventing and Treating Injuries in Instrumentalists,* opened the door for instrument-specific treatment.[3] The book was published with the help of the International Conference of Symphony and Opera Musicians, who are a continual source of participants for arts-medicine research. The chapters break down general medical problems faced by most instrumentalists. These problems include overuse injuries, thoracic outlet syndrome, back and shoulder problems, and stage fright. Norris, being a flutist, focuses much of the book on arm and hand issues of wind players. He includes some discussion of cellists and their problems related to the seated position. Norris offers a small sampling of stretches to help alleviate some of the ailments addressed in the book.

The world of understanding instrumental overuse injuries took a large step forward in 1997 with Barbara Paull and Christine Harrison's book *The Athletic Musician: A Guide to Playing Without Pain.*[4] It includes many illustrations that help make the overuse problem clear. Much like

[3] Richard Norris, *The Musician's Survival Manual: A Guide to Preventing and Treating Injuries in Instrumentalists* (San Antonio, TX: Crumrine Printers, 1993).

[4] Barbara Paull and Christine Harrison, *The Athletic Musician: A Guide to Playing Without Pain* (Lanham, MD: Scarecrow Press, 1997).

Norris's *Musician's Survival Manual*, the book includes descriptions of overuse injuries and treatments for them, such as stretching. The authors include a smattering of strength-training exercises, but not many. A large number of illustrations include details of skeletal systems, which are the root of most performance-related issues. The greatest improvement over Norris's book, in terms of addressing physical issues resulting from playing an instrument, is the wide range of instruments discussed, including flute, oboe, violin, harp, and even double bass. However, the double bass portions that included tips for avoiding injury are very unclear and somewhat incorrect with respect to current ideas about proper posture with the instrument.

The most recent book, and fourth of the pioneering studies published on the general health issues of musicians, is Janet Horvath's *Playing (Less) Hurt: An Injury Prevention Guide for Musicians.*[5] Much like in Paull and Harrison's book, each chapter lays out the definitions of overuse and stretches and exercises to treat these strains. Horvath spends much more time discussing the different warning signs one can look for in order to prevent major injury. The basic model the Horvath book provides for overuse injuries is "force and tension + repetition + poor posture + no

[5] Janet Horvath, *Playing (Less) Hurt: An Injury Prevention Guide for Musicians* (Minneapolis, MN: Horvath, 2002).

rest = R.S.I. (repetitive strain injury)."[6] Horvath includes a checklist for identifying a string player's susceptibility to injuries. The list includes important factors such as playing despite fatigue or pain, squeezing the bow or fingerboard too tightly, and playing with too much tension overall. Horvath also includes a variety of resources, from related journals and videos to material about doctors specializing in arts medicine. However, like the other books on the topic, much of the book is spent detailing upper extremity injuries experienced by violinists, flutists, and cellists.

While these four sources—Brandfonbrener, Norris, Paull and Harrison, and Horvath—have been key in helping arts medicine to become a better understood and respected field, other researchers have offered studies on more specific groups of musicians and the particular injuries they face. Paul Caldron et al.'s 1986 article presented what was at the time groundbreaking work on rapid controlled repetitive activities in musicians.[7] The study, a survey, was aimed at non-wind players such as string and keyboard players. Caldron and his fellow researchers classified the participants in their study as "high-level" musicians. The majority of

[6] Ibid., 29.

[7] Paul H. Caldron et al., "A Survey of Musculoskeletal Problems Encountered in High-Level Musicians," *Medical Problems of Performing Artists* 1, no. 4 (Dec. 1986).

participants were students, with 59 percent reporting performance-related issues. The locations of the body with the highest reported symptoms of pain were the fingers, shoulders, upper back, and lower back. Strangely enough, in this study, bassists reported one of the lowest numbers of performance-related issues. The low numbers may have been the result of a small or compromised sample size.

William J. Dawson's article "Playing Without Pain: Strategies for the Developing Instrumentalist" describes the importance of diagnosing performance-related injuries in both students as well as professional musicians.[8] Dawson breaks his argument down into six important factors related to physical problems: causes, types of difficulties, symptoms, diagnosis, treatment, and prevention. He identifies the cause of injury as overuse, which he defines as "any activity that exceeds the body's physiological limits."[9] Dawson also points out that misuse of muscles or technical problems are often seen in people with hypermobility and double-jointedness. The types of misuse problems produced are tendinitis and tearing of muscle fibers.

[8] William J. Dawson, "Playing Without Pain: Strategies for the Developing Instrumentalist," *Music Educators Journal* 93, no. 2 (Nov. 2006).

[9] Ibid., 36.

Dawson identifies pain as the obvious symptom of overuse; pain can vary in nature from dull to throbbing. Symptoms also can manifest in forms of weakness, tightness, fatigue, stiffness, tenderness, ache, heaviness, cramping, and warmth. Dawson stresses the importance of diagnosing pain properly and of musicians being under the care of skilled health-care professionals skilled in arts medicine. Pain should not be ignored or denied by anyone, he maintains, or it will lead to larger, more severe problems. Dawson advocates a twenty-five minutes on to five minutes off practice rule to help musicians avoid overuse injuries.

Another researcher, Valerie Trollinger, advocates proper technique and setup from the youngest possible age.[10] Problems generally are not developed at an older age, she says, but, rather, at a younger age; this includes the performance of the body's psychomotor in relation to playing an instrument. Often problems that occur because of improper technique at a young age can be avoided by closely monitoring a young person's playing and making sure the student is playing on a properly sized instrument. Music educators must familiarize themselves with the variety of performance-related injuries, Trollinger writes. Unhealthy habits for

[10] Valerie Trollinger, "Performing Arts Medicine and Music Education: What Do We Really Need to Know?" *Music Educators Journal* 92, no. 2 (Nov. 2005).

instrumentalists include improper holding of the instrument and repetitive motion.

While some researchers, like Trollinger and Dawson, have addressed young players, research on musculoskeletal problems for string players is sometimes also differentiated by gender. A woman's typically smaller musculoskeletal frame exacerbates more severe problems than those experienced by her male counterpart. Susan E. Middlestadt and Martin Fishbein's research shows that women constitute 9.5 percent of bass players, and that women are 10 to 20 percent more likely to have a prevalence of severe musculoskeletal problems.[11] The most common problems bassists experience lie in the regions of the neck, shoulders, and lower back. According to the researchers, the effect of gender on the prevalence of severe musculoskeletal problems for bass players was inconclusive because of too small a sample size. From the results, however, it can be seen that females seem to be affected by the sheer size of the instrument more than males. The injuries women encounter more than men include those affecting the left hand and left shoulder. However,

[11] Susan E. Middlestadt and Martin Fishbein, "The Prevalence of Severe Musculoskeletal Problems Among Male and Female Symphony Orchestra String Players," *Medical Problems of Performing Artists* 4, no. 1 (March 1989).

women do experience fewer injuries than men in the regions of the lower back.

University students serve as both an important resource and as an age group greatly affected by musculoskeletal problems. Lars Larrson and fellow researchers administered a survey to 660 musicians at the Eastman School of Music to determine joint laxity and its impact on health and performance.[12] The participants in the study ranged in age from fourteen to sixty-eight. Fifty percent showed loss of facility, strength control, and lack of tension as fatigue was experienced. String players experienced the highest amount of any other group with 77.3 percent. The largest percent of participants were students just beginning their studies. Larrson demonstrates that younger players, especially at the college level, are susceptible to overuse issues and need proper instruction on injury prevention. Larrson and his team's recommendations for preventing problems were to decrease playing time, change improper technique, and build up back muscles.

Another group of musicians—those who play while seated—is addressed in Rene Cailliet's 1990 article "Medical Problems for

[12] Lars-Göran Larrson et al., "Nature and Impact of Musculoskeletal Problems in a Population of Musicians," *Medical Problems of Performing Artists* 8, no. 3 (Sept. 1993).

Performing Artists." Prior to Cailliet's study, sitting postures had been addressed in other professions but not among musicians.[13] In an industrial setting, back and neck issues had resulted in medical care and compensation, but at the time, such care and compensation did not exist for musicians who often experience possibly more severe professional ramifications for these kinds of injuries. Since this article appeared, specialized chairs and pads for instruments such as the cello have been created to address such issues. However, for the double bass back and neck injuries are still on the rise. The problems result from the angle of the pelvis and its improper weight bearing while seated. In this article, an illustration details the physical issues bassists face from playing while seated on a stool.[14] The positioning of one leg up/one leg down creates unwanted torque on the lumbar spine. The asymmetrical positioning of the spine causes static stress over time and creates immobility from that position.

While Cailliet's 1990 study helped focus research in on specific musculoskeletal issues faced by musicians who play while seated, more recent work has been done in this area. Within the past year, Bronwen

[13] Rene Cailliet, "Abnormalities of Sitting Postures of Musicians," *Medical Problems of Performing Artists* 5, no. 4 (Dec. 1990).

[14] Ibid., 135.

Ackermann and Tim Driscoll developed a concise questionnaire to examine the musculoskeletal load of musicians.[15] Ideally, this study would be used by medical personnel to better diagnose and treat subjects. As the authors note, previous surveys were often limited in scope and lacked detail. A baseline assessment tool, such as this survey, was greatly needed for professional musicians.

Exercise-Based Research

After all of the preliminary studies done in the 1990s, many researchers applied the knowledge gained to examining the effects of exercise on the musician population to alleviate and reduce medical problems. Exercise regimens studied in conjunction with musicians range from instrument group–specific workouts to Alexander Technique, yoga, Pilates, and more.

While the health of musicians became an important issue in the 1980s, exercise was not perceived as an effective means of treatment until later. In a 2011 study, Christiane Wilke et al. explain that playing an

[15] Bronwen Ackermann and Tim Driscoll, "Development of a New Instrument for Measuring the Musculoskeletal Load and Physical Health of Professional Orchestral Musicians," *Medical Problems of Performing Artists* 25, no. 3 (Sept. 2010).

instrument often leads to excessive physical and mental demands.[16] Professional musicians often show musculoskeletal and stress-related disorders. The wide variability of disorders among the instruments makes it difficult to discuss broad generalities. Wilke et al. note that string players most often express medical discomfort. Two-thirds of all string players consult a doctor for aid.[17]

According to this study, string players' use of both arms for different, oppositional tasks leads to unique medical problems. Cellists often suffer disorders in the rotator cuff and body musculature in relation to the positioning and holding of the instrument. The bulkiness of the double bass makes high demands on playing technique. Wilke and her collaborators ultimately provide a sample of workouts for all string players. This article demonstrates that physical training—especially strength training—outside of musical activity has a positive effect on string players.

Bronwen Ackermann, Rodger Adams, and Elfreda Marshall studied whether participation in a strength and/or endurance program

[16] Christiane Wilke et al., "Motor Activity as a Way of Preventing Musculoskeletal Problems in String Musicians," *Medical Problems of Performing Artists* 26, no. 1 (March 2011).

[17] Ibid., 24.

would help improve the playing ability of eighteen undergrad music majors.[18] As these authors point out, the physical requirements and demands of music performance are often comparable to those physical requirements and demands faced by athletes. Large muscle groups as well as small ones are required for sound production and fine tuning the instrument. The authors note that previous traditional thought suggested that musicians' participation in additional physical activities outside of playing their instrument was unnecessary because playing an instrument is enough exertion already on the body. By this thought process, a direct correlation exists between overuse of specific areas and the weakness of distal areas of the body. Ackermann thinks an exercise program for musicians should include strength, endurance, and flexibility. The study was a six-week program consisting of two forty-five-minute workouts a week at the school. The exercises were created to focus on upper-extremity and trunk muscle groups. Results showed a great increase in strength and flexion in the endurance group of the study.

[18] Bronwen Ackermann, Roger Adams, and Elfreda Marshall, "Strength or Endurance Training for Undergraduate Music Majors at a University?" *Medical Problems of Performing Artists* 17, no. 1 (March 2002).

Scandinavian music schools have been at the forefront of studying exercise and musicians. The goal of an experiment by Mathieu de Greef et al. was to change the limited repetitive motion and playing habits of musicians and to stimulate increased motion to reduce the overuse of muscles.[19] De Greef and his colleagues assigned the Groningen Exercise Therapy program in which exercise is used in a therapeutic manner, to a group of musicians to see if it helped change any of their physical disorders. This kind of therapy is designed "improve the physical competence of employees through an enhancement of their control capacity and decrease of physical and emotional stress."[20] The model used with the musicians is designed to detect the strong and weak points of a participant's movement and positioning when playing an instrument, to identify the differences in the body from rest to activity, to find the most advantageous way for the musician to hold the instrument, to train the body for movement patterns, and to learn to adjust for issues. Warm-up, general and specialized exercise, and cool down are four phases of the program. The results showed a decrease in musculoskeletal disorders in the overall study population. Overall, the most important tool this

[19]Mathieu de Greef et al., "Impact of the Groningen Exercise Therapy for Symphony Orchestra Musicians Program on the Perceived Physical Competence and Playing-Related Musculoskeletal Disorders of Professional Musicians," *Medical Problems of Performing Artists* 18, no. 4 (Dec. 2003).

[20] Ibid., 157.

program teaches is body awareness. One should discover his or her own posture and body issues with only slight direction from the therapist. Sufficient space around the body and instrument is critical for optimum body usage.

Laura Speck's 2009 dissertation offers a guide for music educators on what issues need to be addressed in the health of string players and also an outline for a semester-long course on these issues with an annotated bibliography for anyone interested in teaching a course.[21] Speck lays out a clear plan, starting with basic anatomy and overuse symptoms much like Randall Kertz's book. She highlights the importance of exercise and stretches to consider, discusses injury recovery, and provides the outline of a syllabus for a course on the subject. Speck references the Norris, Horvath, and Paull and Harrison books in the bulk of her research.

Several studies have considered alternative holistic medicine such as Alexander Technique, yoga, and Pilates in relation to injury prevention. One of these many studies was created by Kristin Mozeiko, who analyzes

[21] Laura Speck, "Overuse Injury and Body Awareness in String Players: A Resource Guide for Educators and Performers" (D.M.A. diss., Arizona State University, 2009).

the effect of Alexander Technique on female violinists and violists.[22] The technique is meant to help practitioners improve posture and other ingrained habits in order, in part, to reduce tension, stress, and stiffness. Mozeiko's 2011 dissertation posits that female musicians often face injuries and asks whether Alexander Technique may help them. The study results showed that participants in Alexander Technique gained significant body awareness and improvement in pain management. This research and others like it give precedence for alternative means of pain relief. Developing unconventional remedies for musicians is not only important in and of itself, but it also gives injured musicians hope outside of possibly losing their jobs due to taking time off because of a surgery.

Shao-Chin Chien looks at the benefits of following Alexander Technique and its correlation to violists.[23] The primary use of Alexander Technique in this paper is in applying it to violists to avoid overuse or misuse injuries. For this application to work, however, one must to be versed in Alexander Technique and have a firm understanding how one's psychomotor works while playing the instrument. Overall, according to

[22] Kristin Mozeiko, "The Effects of participation in the Alexander Technique on Female Violinists and Violists: A Mixed-Methods Study" (D.M.A. diss., Boston University, 2011).

[23] Shao-Chin Chien, "Application of the Principles of the Alexander Technique to Viola Playing and Performance" (D.M.A. diss., University of Miami, 2007).

Chien's study, the improvement of posture and body awareness proved helpful to upper extremity issues such as with the neck and shoulders.

Another dissertation with an alternative approach to arts medicine, written by Malgorzata Leska, applies doing yoga to violin playing.[24] Leska acknowledges that musicians today are under increasing amounts of stress physically and mentally, and she notes there is growing acceptance of yoga as a preventative and treatment for injury. With this in mind, Leska identifies the injuries associated with string players, mainly violinists, and the proper yoga regimen to help with these issues.

Pilates exercise also has recently been shown to improve performance health in artists such as dancers as well as musicians. In her 2009 dissertation, Veere Asher applies total-body exercises to singers, as important for both strengthening of the body and the cardiovascular system.[25] The improvement of posture and the impact of this on the musculoskeletal system helped to increase breathing ability and control. Ultimately, this idea of improving body awareness is a pivotal conclusion that all performing arts medicine studies center around.

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[24] Malgorzata Leska, "Violin and Yoga: Benefits of Yoga for Violinists" (D.M.A. diss., University of Alabama, 2010).

[25] Veera Khare Asher, "The Olympic Singer: Integrating Pilates Training into the Voice Studio" (D.M.A. diss., University of Nevada, Las Vegas, 2009).

Existing Bass Literature

Of all the research that has been done into performing arts medicine since Brandfonbrener's groundbreaking 1991 article, four sources in particular focus on issues pertinent to bass players. Of these, Randall Kertz's 2005 book, *The Bassist's Guide to Injury Management, Prevention and Better Health*, is most applicable to understanding injury and prevention of injury on a broader scale. While Kertz primarily addresses issues faced by electric bass players, many of his ideas on injury and prevention can be applied to the double bass.[26]

In the first sections of his book, Kertz outlines repetitive strain injuries and their effects on the body along with the stress often associated with playing. Then he outlines specific overuse symptoms, their causes, and ways to reduce the symptoms. The various symptoms include tendinitis, nerve impingement, muscle tightness, thoracic outlet syndrome, and low back pain. Some of these symptoms affect double bassists more than others. Kertz does include a short section on "upright" players, which would include double bassists, but this is not the focus of the book. In the back of the volume, Kertz includes a short section on stretches that can be

[26] Randall Kertz, *The Bassist's Guide to Injury Management, Prevention and Better Health (*Niles, IL: Randall Kertz, 2005).

performed to alleviate pain and discomfort, but again, these stretches are designed to address the specific ailments of electric bassists.

A few studies have focused specifically on double bassists, however. In their 1986 article, Steven Mandel, Stephanie Patterson, and Caryn Johnson discuss a case study about a double bassist who had chronic left thumb pain.[27] This pain was so debilitating that the patient was often unable to play. The player was given a regimen of general muscle and joint relaxing procedures to follow, such as taking Ibuprofen and doing muscle-strengthening exercises. This article demonstrates how even in the mid-1980s, arts medicine was basically a modified form of general practice medicine that would be practiced on the general population.

A decade later, in her 1994 dissertation, Kathleen Horvath addressed the biomechanics of posture in relation to double bassists.[28] She designed her study around observation of several bassists of different ages and experience, whom she videotaped in order to watch their body alignment with the bass. The experiment asked the participants to play a

[27] Steven Mandel, Stephanie Patterson, and Caryn Johnson, "Overuse Syndrome in a Double Bass Player," *Medical Problems of Performing Artists* 1, no. 4 (Dec. 1986).
[28] Kathleen Ann Horvath, "Biomechanical Analysis of Double Bassists' Performance Postures" (Ph.D. diss., Ohio State University, 1994).

scale that would cover “shifting”—a change in left hand position—and multiple other adjustments while playing. Horvath and her staff then analyzed the tapes based on Horvath’s “I frame” model. The idea is that when the body is in perfect alignment, the shoulders, spine, and pelvis make an “I” shape. The conclusion from this study is that most bassists need to be more aware of their body arrangement, especially when working with the bass.

A dissertation by Allen Dennis, which also looks into bass players’ posture, was not so conclusive. Dennis addresses three possible alignments of the bass with the body, intending to demonstrate the alignments’ effects on muscle tension.[29] The three alignments were two versions of standing with the bass and one while sitting. Dennis’s experiment required participants to play the recitative excerpt from Ludwig van Beethoven’s Symphony No. 9 while hooked up to an EMG machine, in order to evaluate muscle use. The results of the study showed little to no variation in muscle tension between the three positions and thus were inconclusive.

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[29] Allan Walter Dennis, “The Effect of Three Different Methods of Supporting the Double Bass on Muscle Tension” (D.Mus.Ed. diss., Indiana University, 1981).

The topics covered in this chapter have included general arts medicine research, exercise-based research, and bass-player-specific research. These key topics and resources are helpful; however, additional material could be added to identify the specific problems facing double bassists and how to alleviate them. The survey presented in chapter 3 attempts to fill that void.

CHAPTER THREE: METHOD, DATA, AND DISCUSSION

Method

As the literature review in chapter 2 revealed, there is room for better understanding the physical challenges faced by double bass players as a result of playing their instrument. The survey created for this document attempts to help fill that void. The survey created for this document was administered to double bass players at several NASM institutions and professional orchestras from October to November 2011. Designed to be completed in approximately five to ten minutes, the fourteen survey questions had to yield answers that were concise yet informative. Recruiting of participants was done primarily through the author's personal and professional connections. Participation was completely voluntary and followed all Institutional Review Board requirements. Forty-eight individuals completed the survey. Many of the individuals who participated were excited about this project, expressing enthusiasm and support, along with interest in the results.

The survey questions covered topics such as the participants' physical activity level and types of exercise activities outside of playing the double bass, bow hold, posture orientation to the instrument, genres

and professional fields of music played, and hours of playing in and out of rehearsal each week. Most importantly, the survey asked respondents to diagram areas of the body where they felt discomfort and/or pain as a result of playing. For the purpose of this study, the body was broken down into the following areas: neck, shoulders, arms, elbows, wrists, hands, lower back, hips, legs, knees, and feet. Several questions were multiple choice, but many were open-ended to allow for more detailed answers. All the questions of the survey were answered by all participants.

Survey Data and Discussion

The following paragraphs summarize the results of the survey questions according to the content and also discuss relevant cross-tabulations with other questions. The answers given to the survey were compiled into the PASW Statistics 18 program to aid with cross-tabulations, frequencies, means, and t-tests.[1]

Gender and Survey Results

In order to properly analyze the survey results, it was necessary to first determine whether or not the gender of double bass players correlated to frequency of injury or location of injury. If a significant, separate

[1] The acronym PASW stands for Predictive Analytics Software. The software was created by IBM for statistical analysis, collaboration, and deployment. T-tests are a statistical hypothesis test that shows distribution between two values.

correlation existed in the data across categories such as age, physical activity level, and hours of playing time for each gender, it would make sense to separate and analyze the results independently for men and for women.

The gender of participants in the survey showed a significant bias toward males. Thirty-six males took part (75 percent), leaving twelve (25 percent) females. Despite the bias toward male participants, it was significant to see 25 percent of the study population consisting of females, which coincides with a rise in female double bassists in the last few decades.

The mean age of males who participated in the survey was 26.67, while the average age of females was slightly lower at 24.92, with a standard deviation of 12.5 for men and 6.9 for women. The standard deviation shows a wider variation in age among men than women by almost twice the amount and reflects that the average women in the study were college age.

The number of physical activity hours of respondents per week was almost one and half times higher for men (4.6) than for women (2.9). The number of hours spent playing the double bass each week was also higher among men (21.3) than women (16.7). However, even with these

differences, t-tests run with PASW showed no statistical significance between the genders in these categories.[2] As a result, there was no reason to run comparisons of physical activity or playing time with injury separated by gender. This created a higher statistical power for the correlations that follow in this chapter.

A chi-squared cross-tabulation was performed that examined injury locations between men and women to explore the non-statistical significance of injury between genders.[3] The cross tabulation showed that there was no significant difference in the frequency of responses for injuries and their locations between men and women. As a result, there was also no reason to run separate comparisons for men and women with regard to injury and injury location.

Age and Survey Results

As part of the survey, respondents were asked to provide their age. Out of the forty-eight participants in the study, 71 percent fell into the 18- to 25-year-old range with the mean of the entire data population being 26.23. This can be explained by the high number of college-age

[2] Statistical significance is represented by having a popular level less than 0.05.

[3] Chi-squared, represented by the symbol $\chi 2$, establishes the strength of the association between two variables.

participants involved in the study. Of the 71 percent in this age range, the highest percentages of participants were college freshmen and sophomores, 18 and 19 year olds with 21 percent and 24 percent, respectively. The second largest sample group was 36 to 45 year olds at 13 percent. This age range accounted mainly for the college-age group's teachers and professors. Statistically, this group was so segregated across the age range that no particular age was more predominant than any other. Thirdly, 26 to 35 year olds made up 10 percent of the study population; these participants were mainly graduate students and younger professional musicians. Lastly, three participants were 50, 60 and 70 years old. These three participants, representing the remaining age demographic, were teachers and orchestral players.

One of the dominant assumptions going into this study was that age would have an effect on double bassists with regard to injury. It was assumed that the older one becomes, the more likely one is to have an injury. The chi-squared test showed this was most likely to be true for only two areas of the body: the neck and the elbows. The average age for those who experienced neck injury was 31.3 years over that of those who did not at 24.6 years of age. The average age of positive elbow injury report was 32.3 and the negative was 25.7. All other possible locations of injury

investigated by the study displayed a higher likelihood of injury at a *younger* average age.

Four separate locations of the body showed statistical significance for injury reportage at a younger age: the wrists, lower back, hips, and knees. The average age of bassists reporting wrist problems was 21.7, while the average age of those who did not report wrist problems was 27.9. In the lower back, the average age of participants reporting injury was 22, while the age of those who did not report injury was 29.8. Similarly, in the hips, 20.2 was the average age of bassists who expressed experiencing pain or discomfort, while 26.9 was the average age of respondents who reported non-injury.[4] Lastly, the average age of those who indicated injury in the knees was 19.8, while the average age of participants who had no knee pain or discomfort was 27. Other locations of the body that displayed high probability for pain or discomfort being reported at a younger age were the arms, hands, legs, and feet.

In summary, within this overall data sample, there was no statistical difference between men and women bass players in regard to location of pain or discomfort. Statistical significance was found across

[4] The terms "pain" and "discomfort" are used to describe general overuse injuries. The responses in the survey for these sensations varied widely, from indicating slight tightness to acute, throbbing pain.

the entire population in pain or discomfort associated with the wrists, lower back, hips, and knees. Although one might expect older bassists to report injuries at a higher rate than younger musicians, based on the data collected in *this* study, the older one is, generally the less likely one is to develop an overuse injury.

What can explain this seemingly paradoxical statement? A possible explanation is that a young learner or student of any discipline will usually unquestioningly follow the guidance of the mentor. So if the mentor does not portray the proper technique to the student or if the educator's information is not digested accurately, the student will still incorporate the incorrect technique into his or her routine. Even if this guidance causes pain or discomfort to the student, he or she will often persist through the issue. As a young learner, one is also prone to making mistakes—incorrect movements or positions—more often than an experienced professional or teacher. In combination with ever increasing dedication and practice time, these potentially incorrect movements or positions grow increasingly more ingrained. In turn, the incorrect motion gets repeated ad nauseam and overuse injury often occurs.

Stretching and Frequency of Pain/Discomfort Areas

In addition to age, the survey also asked about respondents' stretching habits before or after playing their instrument in order to assess any correlation between stretching and injury. Seventy-five percent of subjects reported stretching prior to or after playing the double bass. In hindsight, this question was highly subjective. It was difficult to tell from the responses the effectiveness of the stretching and to what parts of the body the stretches were applied. The high percentage of those who reported stretching as part of their routine provided hope that there would be correspondingly low pain or discomfort ratios across the survey population. The reality, however, was the opposite in the responses to the survey regarding pain and discomfort.

The statistic most alarming, yet also enlightening, of the entire survey was that 92 percent of subjects reported some form of pain or discomfort in the body as a result of double bass playing. For the population of the study that showed pain or discomfort; 25 percent showed pain or discomfort in the neck, 56.3 percent in the shoulders, 20.8 percent in the arms, 8.3 percent in the elbow, 18.8 percent in the wrists, 22.9 percent in the hands, 45.8 percent in the lower back, 10.4 percent in the

hips, 8.3 percent in the legs, 10.4 percent in the knees, and 23 percent in the feet.

A comparison between people who stretched and did not was tabulated looking at those who stated they stretched and these injury locations. The two locations of the body that showed statistical significance for injury by non-stretchers were the hands and the knees. Of those who did not stretch, 43.8 percent reported hand pain or discomfort. Those who did not stretch also showed statistical significance in the knees, with 25 percent conveying pain or discomfort. Other areas of the body showed little to no significance in those who stretched or did not.

In general, stretching or physically warming up the body before playing appears to have a positive impact on several areas. A possible explanation of why statistical significance is present in the hands and knees is that warming up before any activity that increases blood flow may reduce lactic acid and therefore reduce cramping in the hands and soreness in the knees. One issue that needs to be addressed in order to have a clearer picture of any correlation between stretching and injury prevention is what areas of the body are being stretched and how. In examining these preliminary figures, it becomes apparent that the lower back, shoulders,

and neck are the most afflicted areas of the body for the double bass player.

Physical Activity Frequency

If stretching might have a positive impact on double bass players, what effect, if any, might additional physical activity have on them? Of the participants, 86 percent reported having been engaged in physical activity outside of playing the double bass in the past twelve months. Activities that were reported by participants broke down into several categories. Running, walking, hiking, biking, and swimming were reported; these all constitute aerobic activities.[5] Activities such as football, rugby, soccer, volleyball, badminton, and other court activities that engage fast twitch muscles were also indicated, as well as endurance/resistance training such as rock climbing, weight lifting, and P90x. These all fall under anaerobic activities.[6] Martial arts, yoga, and Pilates programs, where some respondents reported participation in, constitute activities that include stretching and toning of the muscles.

[5] Aerobic activity is defined as any continuously maintained activity that involves large muscle groups and that is rhythmic in nature.

[6] Anaerobic activity is defined as any activity that consists of short-exertion, high-intensity motion that is often strength-based.

The frequency of participation in these activities on a weekly basis was discussed. Out of the forty-eight participants who reported engaging in physical activity outside of playing the double bass, participants trended to a low number of total hours a week. 80 percent of the respondents stated they exercised one to five hours a week, with the majority of these respondents exercising three hours a week. This overall result of low exercise frequency was expected and may shine light on the high percentage of the sample's reported experience of overuse pain and discomfort, which will be discussed in more detail later.

Overall, after performing chi-squared tabulations on hours of physical activity and injury locations of the body, no locations were found to show statistical significance. However, with the exception of the arms, elbows, hips, and legs, generally those who exercised more frequently had less-reported pain and discomfort. For those experiencing issues in areas such as the elbows and hips, this is more than likely the result of tendinitis in those locations from repeated overuse. The average difference in time spent in these locations of the body had a mean average of 1.4 hours. Even though almost one and half hours does not seem to represent a large difference, it could represent an extra one to three days a week of activity overall.

Another set of chi-squared calculations was performed on the effects of aerobic and anaerobic activity on injury frequency. The purpose was to see if any statistical significance would arise with the combination of multiple physical activity categories. Also, to increase the statistical power, the areas of the body were combined into shoulder/neck, lower back/hip, elbow/arm/wrist/hand, and leg/knee/ankle/foot categories. Creating these four larger location categories seemed appropriate for evaluating two categories of overall physical activity.

The results for the aerobic calculations showed no significant statistical difference in any location in the body. However, looking at the frequency percentages created a larger picture for understanding likelihood of pain or discomfort. Based on the frequencies of injury in all four locations, the participants who reported being involved in aerobic activity consistently had lower percentages of pain or discomfort. The mean average of difference between activity and inactivity and location of pain or discomfort was 13 percent. The largest discrepancy between activity and inactivity and injury reportage was in the arm group, with 50 percent in those who engaged in aerobic activity compared to 80 percent in those who did not. The smallest difference was in the pelvic girdle (lower back/hips), with a 47.4 percent to 50 percent ratio. When it came to participants who took part in anaerobic activity versus those who did not,

there was almost no perceivable or statistical difference in injury reportage. The mean difference between the two possibilities was only plus or minus 8 percent.

Overall, in regard to physical activity levels and varieties of activities, the more active one is, the higher the likelihood that one will have less pain or discomfort. One to three days of activity outside of double bass playing can decrease one's risk of overuse injuries. Also according to the data in this study if the activity is an aerobic one, such as running, walking, swimming, or biking, may reduce that risk by about 13 percent.

Bow Hold and Positioning of the Instrument

So far, we have addressed factors such as gender, age, and physical activity level. How might an even more integral aspect to playing the double bass—one's method of holding the bow—correspond to injury reportage, if at all? Two different bows exist for double bassists to use, the French bow and the German bow. The French bow is held overhand much like the bow hold of all other string instruments. The German bow hold has the hand placed in a horizontal fashion in relation to the bow. From the participants gathered in this survey, more than half (54 percent) used French bow exclusively. The majority of the other half of subjects

used German bow (29 percent), and 17 percent reported use of both styles. The teachers, professors, and orchestra members selected for participation in the survey had an influence on these overall percentages. However, many bass players maintain a specific bow hold from their early stages of playing; this is especially true of players pursuing graduate school and professionals.

Chi-squared tabulations were run comparing bow hold type with each location of the body defined above. Overall, there was no statistical significance with bow hold in relation to pain or discomfort reported in any part of the body. The one location of the body that was closest to proving statistical significance was the shoulders with a p-value of .051. Perhaps with a sample size larger than forty-eight, this number would have been lower than .05. Even without proven statistical significance between bow hold and injury report, some observations can be made about bow hold type and injury.

In the neck, the exclusive use of French or German bow showed lower percentages of reported injury (23.1 percent and 20 percent respectively) than use of both types (42.9 percent). In the shoulders, the opposite relationship exists between the French and German techniques, represented by a 61.5 percent and 66.7 percent injury rate, while the use of

both bows corresponded to only a 14.3 percent rate. The arms showed a similar trend with 23.1 percent, 20 percent, and 14.3 percent rates respectively across the three options. With regard to the elbows, the French bow showed a much lower rate of pain and discomfort reportage at 3.8 percent, compared to 13.3 percent reported by those who use the German hold and 14.3 percent who use both types. Wrist issue percentages were very similar at 19.2 percent, 20 percent, and 14.3 percent. Hands also had a close statistical significance at .165, with 40 percent of those who use the German bow reporting pain and discomfort while players who use French and both bow types reported percentages of 15.4 percent and 14.3 percent. The lower back showed high percentages of reported injuries in all three categories of bow hold with 42.3 percent, 53.3 percent, and 42.9 percent respectively. The hips, legs, knees, and feet all showed much lower percentages of injury reportage than the upper body. In all of these locations, no one category scored higher than a 20 percent report rate.

On the other hand, the results of posture or positioning of the instrument with the body were more even. Fifty-two percent of the participants expressed that they sit exclusively; several respondents included the type and height of their stool. Thirty-five percent reported standing all the time, and 13 percent indicated their posture including a

mixture of both sitting and standing. This group of subjects more often than not reported sitting during orchestral work while standing during solo, chamber, and jazz playing. Due to the large percentage of student participants, these positioning choices are often dictated by the preference of their teachers. Most professional-age participants fell into the combination category, perhaps demonstrating that as an individual ages, there is a tendency to sit through lengthy orchestra rehearsals.

The tabulation of instrument positioning and injury location yielded two statistically significant results in the neck and the wrists. In the neck, the highest percentage of pain and discomfort was reported by participants who used a mixture of sitting and standing at 62.5 percent. This result was significantly higher than the neck pain reported by those who only sit or stand at 22.2 percent and 13.6 percent respectively. With the wrists, the result was the same, with the population that engages in a mixture of sitting and standing reporting a much higher percentage of wrist injury (50 percent) than those who sit (5.6 percent) or stand (18.2 percent) exclusively.

Even though they did not produce statistically significant results, the other locations of the body yielded interesting outcomes. The shoulders returned extremely high percentages of injury reports in all three

categories of posture with 66.7 percent for those who sat, 40.9 percent for those who stand, and 75 percent for those who do some mixture of the two. The arms produced surprisingly low percentages of pain or discomfort: 16.7 percent reported pain who sit, 22.7 percent who stand, and 25 percent who do a combination. The elbows and hands produced low percentages for all three categories. Another surprising result involves the lower back with a higher reported percentage of pain associated with standing (54.5 percent) compared to 38.9 percent for sitting and 37.5 percent for those who sit and stand. Similarly to the cross-tabulations with bow hold injuries, there was little to no correlation between positioning and pain or discomfort for locations in the hips, legs, knees, and feet.

The most important reality apparent from this study population was the high level of reported neck and shoulder pain and discomfort by those who sat. It appears that often the pain that might be reported in the lower back by those who stand is deferred to higher locations in the body for those who sit. This also may be illustrated by the higher shoulder position with regard to the bow-string relationship depending on stool height. In general, the use of French bow produced slightly lower frequencies of pain and discomfort than the use of German bow or a combination of both types. However, with a different study population, these statistics may differ.

Genres and Hours of Playing

The five genres or professional fields of playing the participants selected from to identify their academic or professional environment were orchestra, solo, chamber, jazz, and commercial/pit work. Most participants reported playing several categories. The most common genre by far with 98 percent was orchestra. Solo and chamber playing followed with 85 percent and 62 percent respectively. Jazz and commercial gigs were both close in response rate with 29 percent and 27 percent respectively. The overwhelming responses to orchestra, solo, and chamber work can be attributed to the high number of college-level subjects surveyed. The curriculum of most academic institutions requires instrumentalists to be involved in orchestra and often chamber groups. Also, most degrees in music require a solo recital of varying length—hence the high amount of solo work reported.

Cross-tabulations were processed comparing all five playing categories and injury locations to find any areas of statistical significance. The results proved fairly enlightening in regard to where certain overuse injuries occur. In the category of orchestral playing, the wrists showed statistical significance. The one individual in the survey who reported not playing orchestral music had wrist problems while only 17 percent of the

other forty-seven participants reported problems. However, even with the statistical significance, the result may be skewed because of the low number of non-orchestral musicians who participated. Other locations of the body that showed a high number of injuries in orchestral musicians were the shoulders with a 57.4 percent rate and the lower back with a 46.8 percent rate. All other locations of the body had minimal injury rates.

Among participants who reported solo playing as a genre, only lower back pain or discomfort registered statistical significance. Of the twenty-two solo-playing participants, 53.7 percent reported having lower back pain or discomfort. All other locations of possible injury showed little to no link to solo playing.

For those who reported playing chamber music, no location of the body showed any statistical significance for injury. Areas that showed a high likelihood for injury, though, were the shoulders, at 60 percent of chamber musicians reporting pain or discomfort, and the lower back with, 53.3 percent reporting issues. Similarly to chamber players, the genre of jazz produced no statistical significance with regard to injury location. The only area of the body that represented a higher probability in likeliness for overuse injury was the neck. Among those who play jazz, 38.5 percent indicated neck pain or discomfort compared to 20 percent among those

who do not. All other locations of the body displayed little to no difference.

On the other hand, bass players who engage in commercial or pit gigs showed statistical significance with regard to injury in the elbows, hips, and feet. Those professionals who reported pain or discomfort in the elbow were almost ten times more likely to have the injury (21.4 percent) than those who did not play the genre (2.9 percent). Similarly, those who play commercial or pit gigs showed a much higher rate of injury in the hips (28.6 percent) as opposed to those who did not (2.9 percent). . Areas that showed high probability of injury were the hands at 35.7 percent and the lower back with 57.1 percent. Also, the ankle and feet area showed a 25 percent injury rate among the commerical musicians compared to 5.5 percent among those who did not report being a commercial musican.

How does playing time relate to these various groups of double bass players? The hours of playing reported varied from as little as one hour a week to forty hours a week. Due to the large variance among the responses, the frequency of injury in relation to hours spent playing is difficult to discern. One thing that can be seen from the data is higher percentages of pain and discomfort being were reported for those logging ten, twenty, and thirty hours of total playing, with twenty hours

corresponding to the highest injury reports of all at 17 percent. Again, with a high number of college-age participants, twenty hours can be understood by the week divided into six hours of orchestral playing a week and two hours of practicing each day.

The data from comparing hours of playing a week to individual injuries revealed statistical significance in the location of the elbow. On average, the hours spent playing by those who reported elbow overuse was 31 hours compared to 19.2 for those who had no injury. The only other area of the body that showed a high correlation of hours playing and injury were the legs with 26.8 as an average amount of hours identifying injury while those who did not averaged 19.6 hours. All other locations of the body showed no major association between hours of playing and pain or discomfort.

Taking all this into account, a few important summations can be made about genres double bassists play or their academic or professional environment and the hours spent playing. First, the shoulders and lower back have the highest frequency rate of injury regardless of genre, especially for orchestral, solo, and chamber double bassists. Second, musicians who engage in commercial and pit orchestra gigs, which require remaining in a static position for extended periods of time, saw high rates

of overuse or repetitive injuries. Finally, those who practice several hours a week on average are less likely to report repetitive motion injuries such as in the elbow than those who practice more on average

Summary

After examining all the frequencies in this data set and the results of the cross-tabulations, it is clear which locations of the bass player's body are most afflicted by pain and discomfort, and what causes may be at the root of these injuries. The most stricken areas of the body for the double bassists, based on frequency of reported pain or discomfort in the data population, are the neck, shoulders, and lower back. However, except for the ankles and feet, all other locations of the body were also found to have statistical significance.

Age proved to be an important definer of these injury locations, as well as tied to reported frequency of pain or discomfort. In general, the older one is, the survey results showed, the less likely one is to suffer from overuse problems. The quantity of quality stretching or warming up of the body before playing appears to have a positive impact on several locations. In addition, the data indicate that the more frequently one is

active, especially in aerobic activity, the less likely one is to confront injury.

Based on these conclusions, it is evident that a proper stretching program could be constructed to better aid and extend the playing lives of double bassists. Such a stretching routine is introduced in chapter 4.

CHAPTER FOUR: APPLIED STRETCHING PROGRAM

Interview with Randall Kertz

Before I present the stretching regimen based on the results of the survey, a summary of the interview conducted with Randall Kertz on the topics addressed by the survey is included. Dr. Kertz has become an important source for information on bass overuse injuries and solutions. He has published his own book, *The Bassist's Guide to Injury Management, Prevention and Better Health,* and has had articles published in *Bass World*, the International Society of Bassists' magazine. According to Kertz, the two main issues facing bassists in general are trigger points and tendinitis.[1] Trigger points are the same as having knots in the muscles; these knots cause tightening and cramping. Tendinitis relates specifically to the tendons that connect our muscles to the bone. Both trigger points and tendinitis are a result of overuse and repetitive motion.

Kertz's observations in regards to age are consistent with the findings of this study. Kertz stated that if bassists are taught the right technique and posture at a young age, fewer problems will occur as they grow older. Due to the fact that bad habits become ingrained over time,

[1] Randall Kertz, e-mail message to author, January 11th, 2012.

good habits such as taking breaks during practice and learning to stretch properly should be taught, as well. With regard to stretching, Kertz said he has seen short- and long-term benefits from instituting stretches into one's playing routine. In the short term, much like any form of exercise, stretching helps the body become conditioned and flexible. It also helps give muscles proper circulation for repair and stamina. Kertz stated that some recent studies claim that stretching is unnecessary and possibly harmful, but in his experience this makes little to no sense.

In addressing the difference between sitting and standing postures, Kertz identified some salient concerns. Overall, posture plays a huge role in injuries, he noted. Slouching or other compromising positions can put extra load on incorrect areas of the body, and over time, this can produce career-ending injuries. Hunching over the bass in both the seated and standing positions creates concerns because it causes lower back issues, but Kertz notes hunching is more rampant in the seated position. With the seated position, the player must be aware of his or her posture and the height of the stool to ensure proper load bearing. Also, while seated on the stool, the bass player's positioning of feet with both on the floor or one foot placed on the rung of the stool has implications on posture. The standing position also has its own issues, according to Kertz, because often the weight of the body is favored to one side. Over a long period of

time, this asymmetrical position can cause back musculature problems, as well. For more in-depth information from Kertz on these topics, consult his book or any of his numerous published articles.

Disclaimer

It is of the utmost importance during all of the following stretches to keep several guidelines in mind. Always exercise caution when performing a new physical activity for the first time. This goes even for the most seasoned athlete. Second, always continue breathing throughout the stretch, using slow, deep breaths. Breathing during stretches relaxes the muscles and improves flexibility. Holding one's breath only hinders movement and does not allow a full stretch. Third, always begin each stretch with adequate room around you to avoid injury to yourself, others, and possibly your instrument. Also, begin each stretch from a comfortable or neutral stance, with relaxed neck, shoulder, and back posture, and a slight bend in the knees. Performing these important steps before beginning a stretch will help you avoid injury or harm. Lastly, never perform a stretch by overextending or holding it too long. The purpose of the stretches is to increase flexibility and blood flow and to prevent overuse injuries facing double bassists. If pain or discomfort results during a stretch, stop immediately and reassess your positioning or posture. None

of the stretches demonstrated in this chapter should cause any bodily pain. In the stretches that follow, two levels of progression, for both beginners and advanced, are explained, so there are stretching possibilities for everyone's ability level. Practice and patience with the stretches will improve your flexibility and decrease the likelihood of your experiencing pain and discomfort while playing the double bass.

Muscle Implications

Many of the muscles that are addressed by the stretches in this chapter are connected to the pelvic girdle. Most of the lower back overuse problems reported by participants in the survey, unless created by spinal or disc issues, result from issues related to the pelvic girdle. Due to the complementary nature of how these muscles work together, the solution to relieving discomfort is often more complicated than simply stretching the ailing muscle. For instance, tight upper leg muscles such as the hamstrings can often create lower back tension. Therefore, stretching opposing muscles of the body like these can reduce pain and discomfort in the appropriate locations. A closer analysis of injuries experienced by double bassists also displays a connection to the muscles attached to the spinal column. The neck muscles, and several of the shoulder and back muscles,

are oriented in this fashion. All the stretches that follow have been selected to address and hopefully alleviate all of these issues.

The Stretches

After an in-depth analysis of the data collected from the survey in chapter 3, the stretches included in this chapter are designed to address the major problem areas identified by the study results. According to the survey population, the areas of the body that need the most attention in order to relieve pain or discomfort are the neck, shoulders, and lower back.

This specific stretching program is divided into two parts: five stretches that are a must before any practice or performance session and five other stretches that are to supplement the first group of stretches if time permits or more stretching is needed. All the stretches were designed to be done in a confined space such as a practice room or backstage of an auditorium and so the individual does not have to get on the ground or his or her back. Designing a program in this user-friendly way also increases the likelihood that it will be implemented on a daily basis and when it is needed the most.

The stretches described in this chapter are broken down into two categories: static and ballistic. Static stretches are stretches that involve positions that are held for long counts or periods of time. Ballistic stretches require holding a position for slight amounts of time and can be perceived as constant, rhythmic motion. Both types of stretches help increase flexibility and range of motion. As a rule of thumb and for safety, ballistic stretches should generally be preceded by static stretches.

For the purpose of continuity through all the stretches that follow, it is important to clarify the starting point or "neutral position." Begin every stretch in a comfortable stance with feet about shoulder-width apart unless otherwise specified. There should be a slight bend in the knees, and the shoulders and neck should be in a relaxed, comfortable state (see figure 1). Figures are provided to help clarify and illustrate the proper technique for neutral position and every stretch description that follows.

Figure 1. Two views of neutral position

Five Must Stretches

The stretches that have been selected address the pain and discomfort areas such as the neck, shoulders and lower back. In addition to these three main locations, the hands, wrists and legs will be stretched as well.

Neck Rolls, static, three repetitions per side: In neutral position with relaxed shoulders, slowly lower your head to your chest (see figure 2). With your head still down to your chest, slowly roll your head forward to the right shoulder.

Figure 2. Head down for Neck Rolls

Hold to the side for a count of ten. Slowly drop the head back to the center of the chest but continue to the left (opposite) shoulder and hold for a ten count (see figure 3). Repeat this motion back to the right shoulder and so forth till you have had three reps on each shoulder. After the final roll to the left side, with the chin still down, return to the center of the chest and very slowly roll the head back up to a neutral position.

Figure 3. Head Roll to the side

Arm Circles, ballistic, twenty to thirty repetitions in each direction: In a comfortable stance, place arms straight out to the side at a 90-degree angle to the body while creating a 90-degree angle in the hands in relation to the arms (see figure 4).

Figure 4. Hand and arm positioning for Arm Circles

Begin rotating the arms forward, making medium circles while maintaining arm to hand relationship. Then reverse direction of while still

making medium circles. After twenty to thirty seconds, continue rotating the same direction but begin making large circles and point the hands to

Figure 5. Large circle rotation with hands down

the floor (see figure 5).Finish the stretch by reversing the direction of the large circles from the back to the front for another twenty to thirty seconds.

For a beginner approach to this same stretch, while maintaining a comfortable stance, place the hands on their corresponding shoulder on

Figure 6. Hands on shoulders version of Arm Circles

either side and slowly rotate the shoulders and arms forward (see figure 6). To rotate the opposite direction, maintain the same hand and arm position and rotate backwards.

Huggers Stretch, ballistic, fifteen to twenty repetitions: Starting in neutral position, slowly bring both arms across the chest as if giving oneself a hug. Then open the arms back up as if to give a hug. Bring the arms back across the body, this time reversing the arm that is on top from the previous "hug."

Figure 7. Demonstration of the Huggers Stretch

Upper Back Stretch, static, fifteen- to twenty-second hold in each direction: Place the arms in front of body while reversing hands one over the other till they are palm to palm, creating a child's portrayal of a seal (see figure 8). While pointing the fingertips towards the floor with arms in a comfortable position, drive the points of the deltoids (shoulders) together to stretch the upper back. Release after fifteen to twenty seconds.

Figure 8. Arms in front for Upper Back Stretch

To stretch muscles in the opposite direction, add a Chest Stretch. Beginners should grasp opposing elbows behind the back with each opposite hand, creating a square shape. For more advanced stretching, clasp the hands behind the back and drive them towards the buttocks (see

figure 9). Repeat both stretches again for a combined total of two repetitions per direction.

Figure 9. Three views of either the beginner or advanced Chest Stretch

Wide Feet Forward Bend, static: In this and any leg stretch, always lead with the chest and not the head. Begin with feet wider than shoulder-width apart, and slight bend in the knees. Lift the arms up into the air till they are vertical overhead. With a flat strong back, spread arms out to the side and bend forward at the waist with the head up until you feel a comfortable stretch in the hamstrings (see figure 10).

Figure 10. Swan Dive Forward

For a beginner stretch, simply place the head down and place the hands on the quadriceps or the shins (see figure 11, left photo). Only go as

far as it is comfortable. Hold this position for a twenty to thirty count. To get out of this position, place your chin on your chest and slowly roll your torso up till you reach the beginning position. It is important to keep the chin tucked until you are back to a neutral position in order to protect your back.

Figure 11. Hands on shins or in basket position

For a more advanced stretch, you can place your hands on the floor, behind your ankles. Or with your head down, clasp each of your hands around the opposite elbow to create a basket shape and gently rock from side to side (see figure 11, right photo). Hold for a twenty to thirty count. To return to neutral position, place your chin on your chest and

slowly roll your torso up until you are vertical again. Again, it is important to keep the chin tucked until you are back to a neutral position in order to protect your back.

Five Advanced Auxiliary Stretches

Arm behind Neck Stretch, static, thirty seconds per side: Grab the right wrist with the left hand behind the back and pull slightly on right arm creating a “chicken wing” on the left side (see figure 12). Gently lean your head to the right side.

Figure 12. Chicken wing position

After ten seconds with your head facing forward, slowly rotate the head toward the floor till a change is felt in the stretch and hold for ten seconds. Slowly rotate the head to the ceiling till another change is felt in the stretch and hold for ten seconds (see figure 13). Return the head to the beginning stretch position and slowly release your wrist. Repeat these actions in reverse to stretch the other side of the neck.

Figure 13. Up and down head positions

Side to Side Torso Stretch, three repetitions per side: From the starting neutral stance, raise your arms into the air (see figure 14). Slowly

twist the body to one side. At the apex of the twist, slightly tilt the trunk upward with the head (see figure 15).[2]

Figure 14. Raising of the arms

Repeat the same motion in the opposite direction and continue till you have completed three repetitions per side. Return to the center and slowly lower the arms to your sides.

[2] The “trunk” can also be described as the torso or the central part of the body, generally the area below the neck to the waist.

Figure 15. Twisting of torso

Straight-Arm Twisting Torso Stretch, ballistic: Starting in the neutral position, place arms into the air overhead. Grab the right wrist with the left hand (see figure 16). Rotate trunk over left leg and slowly bend over at a 90-degree angle. While continuing to pull on the right wrist, continue rotating across until the torso is over the right leg and slowly rise up to the beginning position. Repeat the entire action two more times.

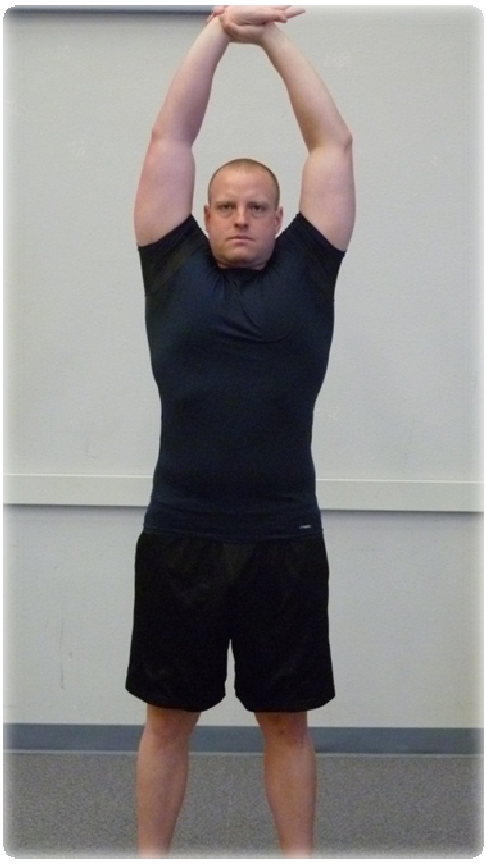

Figure 16. Grasping of the wrist

On the fourth time, rotate over the left leg as before but continue past 90-degrees to an angle as low as comfortable and come across the body as before (see figure 17 for progression). Slowly rise up and return to neutral position. Repeat the four repetitions in the opposite direction to stretch the other side.

Figure 17. Progression of torso rotation

Chest Expansions, ballistic, three repetitions of stretch: Starting in neutral position, raise the arms and head up to the sky. Turn the palms out to the side as you slowly drop the elbows to the floor and bring head down at the same tempo as the arms. While pulling the arms down slowly, focus

on opening up the chest and bringing the elbows comfortably behind the torso (see figure 18).

Figure 18. Arm position during Chest Expansion

As the elbows reach the middle of the torso, slowly let the hands fall toward the floor until you reach neutral position.

Split Leg Hamstring Stretch, static: Place one foot in front of the other at a comfortable distance while placing the back foot at a slight angle for balance. Square up the hips by driving the inner thighs together so they are touching (see figure 19).

Figure 19. Squaring of the hips

Lift arms straight into the air horizontally and swan dive over the front leg with head up. Again, always lead with the chest and not the head. Once a comfortable stretch in the hamstrings is achieved, drop the head down and place the hands on the front shin or floor (see figure 20 for progression). To get out of the stretch, tuck the chin into the chest and put your weight on the back supporting leg. Slowly roll the torso up to protect the back. Only raise the head up after neutral position has been reached.

Figure 20. Progression of Split Leg Hamstring Stretch

When combining all ten stretches together, the routine should take a mere eight to ten minutes. After this routine of stretches, the double bassist will have increased flexibility and lower the likelihood of encountering any pain or discomfort.

CHAPTER FIVE: SUMMARY AND CONCLUSIONS

Through this document, I have ventured to examine the physical aspects of playing the double bass in several ways. An enormous amount of evidence indicates that double bassists experience physical pain and discomfort and often continue to play through these ailments, causing evermore damage and overuse injuries. Every double bassist is different on a musculoskeletal and physical level; however, certain common ailments and issues still persist throughout the majority of players. Therefore, a stretching regimen that addresses most to all of these ailments could provide untold benefits to bass players. By surveying a sizable sample of double bassists, interviewing a well-known expert on the physiological issues faced by bass players, and examining the related literature on the subject, this document contributes to an otherwise under-examined area of research concerning the physical aspects of playing the double bass in a healthy manner.

This project began with the creation and administration of a survey to double bassists that included questions ranging from physical activity level outside of double bass playing to bow-hold type, instrument positioning, genres and situations of playing, and the physical,

musculoskeletal injuries respondents experienced related to bass playing. Upon completion of the surveys, the data garnered by them were run through the PASW Statistics 18 program to inspect frequencies and chi-squared tabulations. Several important factors became apparent. The majority of the survey population was male, at 75 percent; however, there were no statistically significant differences between the results generated by males and females. Therefore for the remaining chi-squared tabulations, gender was not used as a variable, which in turn increased the statistical power of the tabulations. The majority of participants were undergraduate age, skewing the average age of the survey population towards twenty-five.

The sample size was reasonably healthy with regard to participating in physical activities. Those who engaged in one to three times more hours of physical activity per week showed an increased likelihood of avoiding overuse injuries. In addition, the results showed that engaging in aerobic activities such as running, biking, and swimming reduces the frequency of pain or discomfort bass players experience.

Results from this particular survey show a high correlation between the positioning of the instrument and location of pain or discomfort in the body. Based on the statistical analysis given in chapter 3,

overuse injuries seem often to defer to a higher location in the body, such as the neck or shoulders, when the bassist utilizes a seated position. Pain and discomfort were reported as occurring lower, in the lower back or legs, among those who stand. Those participants who employ French bow experienced less frequency of injury compared to bassists who use German bow or a combination of both, but not at a statistically significant level.

Previous to receiving the results of the survey, I assumed that the preponderance of pain and discomfort experienced by double bassists would lie in the lower back and hips. The results showed occurrences of overuse injuries in the lower back and hips, but also prominence in the neck, shoulders, wrists, and hands. It was also assumed that these overuse injuries would occur more frequently as one ages. However, in reality, youthful or novice players experience higher incidences of pain or discomfort, according to the sample population. What causes this? As discussed previously, neglectful or improper teaching of a student, especially who is of a young age, can result in the player ingraining incorrect technique or orientation to the instrument. This in turn causes the musculoskeletal issues listed above.

Minor amounts of tension in the hands or forearms are to be expected from practicing the double bass, and especially in learning the instrument. However, as discussed previously, in no way should a person experience pain or discomfort in the large muscle groups as a result of playing the double bass. Statistical significance was seen, though, in reportage of pain or tension in the lower back and shoulders by orchestral and solo players. The curriculum of performance degrees at universities and conservatories require high amounts of orchestral and solo playing. While this is necessary and part of musical instruction, it is also consistent with a higher frequency of pain or discomfort seen at a younger age.

Based on the results of this particular survey, ten stretches were created to facilitate the alleviating of overuse injuries in double bassists. Included were a combination of static and ballistic stretches that were divided into two separate regimens—five stretching "musts" and five other supplementary stretches. All of the stretches are designed to target the primary locations of physical pain and tension indicated by the results of the survey.

FURTHER RESEARCH

After completing this document and project, I have a much clearer picture and of what needs to occur next in order for me to further the

research in this area. Redesigning the survey and including a larger overall sample size would be the next logical step. Several of the survey questions, in hindsight, were either too vague or could be combined with other relevant questions. Also, having a much larger sample population would benefit my next study tremendously. An optimum number of participants would be closer to one hundred in order to give the results a much higher statistical power. Also, attempting to include a more diverse survey population that includes more women, bow type, and variance in genre or playing environment would be a priority.

Based on the results of this particular study, the most imperative group that needs to be addressed and focused on in further research is younger double bassists. It is clear that due to the vulnerability and susceptibility of younger players to injury, it is important to educate this demographic. The inclusion of high school players as well as undergraduates in injury prevention discussions, activities, and research is the first step in alleviating pain and discomfort for double bassists into the future. Most musicians, especially younger ones, are unaware of their body's psychomotor, so illuminating these issues and creating proper solutions should be the ultimate goal.

In addition to conducting a study exclusively for the demographic of fourteen- to twenty-five-year-old players, a study of professional players age thirty and older would also be beneficial. These individual studies could provide definitive supporting results to further the conclusions of this particular document and study. My intention upon completing and administering a revised survey is to get the information published in book form for wider dissemination of the material. In addition, presenting this information at workshops, conferences, and face-to-face with the intended audience will be crucial. Eventually, including other string instrument players into the research, and designing the appropriate stretching regimens for them, will also be an important pursuit.

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APPENDIX A: SURVEY QUESTIONS FOR STUDY

Survey Questions for Study

Please tick boxes or fill in black spaces as appropriate

1. **Age: _____ years**

2. **Sex: ____ Male ____ Female**

3. **During the last 12 months have you engaged in any physical activity such as exercise or recreational sports? ____ No _____Yes, if so what activities?**

_____

_____

4. **If you answered yes to Question 3, how many times per week/hours a week do you spend doing physical activity outside of musical activities?**

_____

5. **Which bow do you play? _____ French _____ German _____Both**

6. **Do you sit or stand while you play, or if both describe in which context you sit or stand_____**

_____

7. **Put a "X" next to genres of playing are you involved in?**

____Orchestra ____Solo Work _____ Chamber Music ____Jazz _____ Commercial gigs/Pit

8. **In an average week, how many hours do you rehearse?**

_____

9. **In average week, how many hours do you practice outside of rehearsal? _____**

10. **Do you ever stretch before practicing/playing? ___No ___ Yes**

11. **Have you ever experienced any pain or discomfort while playing bass? ___No ____ Yes**

12. **If so, is the pain temporary or chronic? _____**

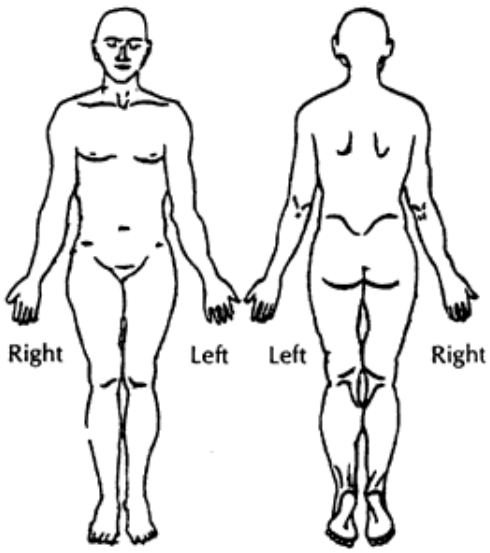
13. **In a general sense describe the intensity of the pain on an average day and when it is most acute._____**

_____

_____

14. **In the diagrams below, circle the areas that you experience pain or discomfort and inside the circle put a number from 1-10 demonstrating the levels experienced; 1 being minimal discomfort to 10 representing debilitating pain.**

FRONT **BACK**



This is the end of the survey, thank you very much for participating!

APENDIX B: INTERVIEW TRANSCRIPT WITH RANDALL KURTZ

Interview Transcript with Randall Kurtz

Q: What are the most common issues you have found in the large muscle groups?

A: The most common issues in large muscle groups themselves would be trigger points, i.e. knots in the muscles, which cause them to shorten and tighten the muscles, causing pain, cramping and discomfort. This can be caused most commonly by repetitive motion, i.e. playing, overuse, poor posture or technique. Tendinitis relates to the tendons which connect the muscles to bones, and this also is a big concern for the same reasons.

Q: In your experience, does stretching and exercise have short or long term effects on musculoskeletal issues?

A: Stretching and exercise have both short and long term effects on musculoskeletal issues. Exercise keeps the body in optimal condition, strong, healthy, and flexible, which is good short term for muscles that may not be getting proper circulation for example, and long term for the above reasons and stamina. Stretching is important short term to release tight musculature, and to alleviate possible pain or tightness concerns. Long term, it can prevent those problems from happening. While some studies recently have shown that stretching is unnecessary and can even be harmful, anything done incorrectly or too much can be harmful, while the

idea that one should not stretch at all because it doesn't do any good to me makes little sense.

Q: How much does posture play in the role of overall playing health?

A: Posture is supremely important in that it keeps the body from slouching or putting itself in positions that may cause short or long term discomfort due to muscles being compromised by these positions. Posture is also a large part of playing technique for most instruments, and proper posture can keep one from having career threatening or ending injuries if severe enough.

Q: What role does age play in musculoskeletal factors?

A: Age is important in that if one pays attention to proper technique and posture and avoiding injuries when they are young and just beginning, this will make them less likely to have problems as they grow older. Bad habits become ingrained early and are hard to break later on in life. This includes not only posture but learning to take breaks, stretch properly, etc.. For a more mature musician, your body changes as you grow older and it is more important than ever to pay attention to it, to stretch and take breaks when necessary in order to help stave off arthritis and other issues.

Q: What similarities have you seen between electric and upright players?

A: Similarities include wrist angle and shoulder issues most commonly, as well as the usual repetitive motion and postural issues.

Q: Have you noticed a difference between standing and sitting postures while playing the instrument?

A: Standing and sitting each have their own challenges. It is easy to hunch over the bass, causing back problems with both positions, but seems to be more prevalent with the seated position. It mostly depends on the performer, on their postural awareness, and also body positioning when seated, for example if they are on a high stool or lower one, if their feet are flat on the floor, if they rest one foot on a rung of the stool, and other concerns. With standing position, the player tends to lean to one side and stay there for the bulk of the performance, and this also is not good for the back musculature.

Q: How much do overuse/fatigue issues factor in the overall situation?

A: Fatigue and overuse factors are the overall situation. Any serious player is going to have issues with both of these factors, it is how they deal with them in terms of prevention before and management when they do occur that makes all the difference.

APPENDIX C: SURVEY RESULTS AND FREQUENCIES

Survey Results and Frequencies

Questions and Choices	Response %
1. Age:	
18-25	71%
26-35	10%
36-45	13%
46-70	6%
2. Male or Female?	
Male	75%
Female	25%
3. During the last 12 months have you engaged in any physical activity such as exercise or recreational sports? And if so what activities?	
No	13%
Yes	87%
4. If you answered yes to Question 3, how many times per week/hours a week do you spend doing physical activity outside of musical activities?	
A) Hours	
1-2 hours	30%

3-4 hours	35%
5-7 hours	25%
12-15 hours	9%

B) Type of Exercise

Aerobic Activity	79%
Anaerobic Activity	46%

5. Which bow do you play?

French	54%
German	29%
Both	17%

6. Do you sit or stand while you play, or if both describe in which context you sit or stand?

Sit	35%
Stands	52%
Both	13%

7. What genres of playing are you involved in?

Orchestra	98%
Solo	85%
Chamber	62%

Jazz	29%
Commercial/Pit	30%

8. In an average week how much do you rehearse/practice?

0-10 hours	20%
11-19 hours	20%
20-30 hours	42%
31-40 hours	18%

9. Do you ever stretch before practicing/playing?

Yes	75%
No	25%

10. Have you ever experienced any pain or discomfort while playing bass?

Yes	92%
No	8%

11. Where do you experience pain or discomfort?

Neck	25%
Shoulders	56.3%
Arms	20.8%

Elbow	8.3%
Wrists	18.8%
Hands	22.9%
Lower Back	45.8%
Hips	10.4%
Legs	8.3%
Knees	10.4%
Feet	23%

APPENDIX D: CHI-SQUARED ASSOCIATIONS

Chi-squared Associations

Chi-squared Association	P Value	Statistical Significance
Age and Neck	**.08**	**NS**
Age and Shoulder	**.80**	**NS**
Age and Arms	**.42**	**NS**
Age and Elbow	**.64**	**NS**
Age and Wrists	**.01****	**S**
Age and Hands	**.25**	**NS**
Age and Low Back	**.01****	**S**
Age and Hips	**.001****	**S**
Age and Legs	**.28**	**NS**
Age and Knees	**.001****	**S**
Age and Feet	**.49**	**NS**

Chi-squared Association	P Value	Statistical Significance
Hrs of Playing and Neck	**.95**	**NS**
Hrs of Playing and Shoulders	**.74**	**NS**
Hrs of Playing and Arms	**.55**	**NS**
Hrs of Playing and Elbow	**.02****	**S**
Hrs of Playing and Wrists	**.49**	**NS**
Hrs of Playing and Hands	**.33**	**NS**
Hrs of Playing and Lower Back	**.69**	**NS**
Hrs of Playing and Hips	**.81**	**NS**
Hrs of Playing and Legs	**.16**	**NS**
Hrs of Playing and Knees	**.60**	**NS**
Hrs of Playing and Feet	**.69**	**NS**

Chi-Squared Association	P Value	Statistical Significance
Physical Activity and Neck	.38	NS
Physical Activity and Shoulders	.264	NS
Physical Activity and Arms	.98	NS
Physical Activity and Elbows	.47	NS
Physical Activity and Wrists	.85	NS
Physical Activity and Hands	.07	NS
Physical Activity and Lower Back	.90	NS
Physical Activity and Hips	.93	NS
Physical Activity and Legs	.80	NS
Physical Activity and Knees	.18	NS
Physical Activity and Feet	.73	NS

Chi-squared Association	P Value	Statistical Significance
Bow Type and Neck	.49	NS
Bow Type and Shoulders	.051	NS
Bow Type and Arms	.88	NS
Bow Type and Elbow	.47	NS
Bow Type and Wrists	.946	NS
Bow Type and Hands	.17	NS
Bow Type and Lower Back	.78	NS
Bow Type and Hips	.42	NS
Bow Type and Legs	.59	NS
Bow Type and Knees	.29	NS
Bow Type and Feet	.55	NS

Chi-squared Association	P Value	Statistical Significance
Stretching and Neck	1.00	NS
Stretching and Shoulders	.22	NS
Stretching and Arms	.62	NS
Stretching and Elbow	.46	NS
Stretching and Wrists	1.00	NS
Stretching and Hands	.015*	S
Stretching and Lower Back	.41	NS
Stretching and Hips	.74	NS
Stretching and Legs	.46	NS
Stretching and Knees	.019*	S
Stretching and Feet	.15	NS

Chi-squared Association	P Value	Statistical Significance
Sit/Stand and Neck	.02*	S
Sit/Stand and Shoulders	.13	NS
Sit/Stand and Arms	.85	NS
Sit/Stand and Elbows	.10	NS
Sit/Stand and Wrists	.03*	S
Sit/Stand and Hands	.69	NS
Sit/Stand and Lower Back	.54	NS
Sit/Stand and Hips	.31	NS
Sit/Stand and Legs	.17	NS
Sit/Stand and Knees	.69	NS
Sit/Stand and Feet	.31	NS

Chi-squared Association	P Value	Statistical Significance
Orchestra and Neck	.56	NS
Orchestra and Shoulders	.25	NS
Orchestra and Arms	.60	NS
Orchestra and Elbow	.76	NS
Orchestra and Wrists	.04*	S
Orchestra and Hands	.58	NS
Orchestra and Lower Back	.35	NS
Orchestra and Hips	.73	NS
Orchestra and Legs	.76	NS
Orchestra and Knees	.73	NS
Orchestra and Feet	.67	NS

Chi-squared Association	P Value	Statistical Significance
Solo and Neck	.24	NS
Solo and Shoulders	.96	NS
Solo and Arms	.64	NS
Solo and Elbow	.39	NS
Solo and Wrists	.74	NS
Solo and Hands	.56	NS
Solo and Lower Back	.01**	NS
Solo and Hips	.33	NS
Solo and Legs	.39	NS
Solo and Knees	.33	NS
Solo and Feet	.98	NS

Chi-squared Association	P Value	Statistical Significance
Chamber and Neck	.73	NS
Chamber and Shoulders	.50	NS
Chamber and Arms	.85	NS
Chamber and Elbow	.59	NS
Chamber and Wrists	.63	NS
Chamber and Hands	.54	NS
Chamber and Lower Back	.18	NS
Chamber and Hips	.90	NS
Chamber and Legs	.59	NS
Chamber and Knees	.90	NS
Chamber and Feet	.75	NS

Chi-squared Association	P Value	Statistical Significance
Jazz and Neck	.19	NS
Jazz and Shoulders	.39	NS
Jazz and Arms	.82	NS
Jazz and Elbow	.28	NS
Jazz and Wrists	.64	NS
Jazz and Hands	.12	NS
Jazz and Lower Back	.98	NS
Jazz and Hips	.49	NS
Jazz and Legs	.28	NS
Jazz and Knees	.49	NS
Jazz and Feet	.92	NS

Chi-squared Association	P Value	Statistical Significance
Commercial and Neck	.71	NS
Commercial and Shoulders	.47	NS
Commercial and Arms	.40	NS
Commercial and Elbow	.04*	S
Commercial and Wrists	.76	NS
Commercial and Hands	.18	NS
Commercial and Lower Back	.31	NS
Commercial and Hips	.01**	S
Commercial and Legs	.34	NS
Commercial and Knees	.11	NS
Commercial and Feet	.08	NS

Chi-squared Association	P Value	Statistical Significance
Aerobic and Shoulders/Neck	.69	NS
Aerobic and Low Back/Hip	.88	NS
Aerobic and Elbow/Arm/Wrist	.09	NS
Aerobic and Leg/Knee/Feet	.42	NS

Chi-squared Association	P Value	Statistical Significance
Anaerobic and Head/Shoulders	.90	NS
Anaerobic and Low Back/Hips	.40	NS
Anaerobic and Elbow/Arm/Wrists	.34	NS
Anaerobic and Leg/Knees/Feet	.68	NS