2022

Playing-Related Medical Injuries and Health Conditions in Collegiate Saxophonists: A Survey of Saxophonists in North American Universities

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Playing-Related Medical Injuries and Health Conditions in Collegiate Saxophonists: A Survey of Saxophonists in North American Universities

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Doctoral Research Project submitted
to the College of Creative Arts
at West Virginia University

in partial fulfillment of the requirements for the degree of

Doctor of Musical Arts in
Saxophone Performance

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Morgantown, West Virginia
2022

Keywords: Saxophone, Woodwind, Music, Performing Arts, Playing-Related Pain, Musculoskeletal, Health, Medical, Orofacial, Craniofacial, Students

Abstract

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Michael Anne Tolan

When compared to other areas of musical performance, medical research on the performing arts is limited when it comes to studies on woodwind players, particularly saxophonists. The gap in research may be attributed to the circumstances surrounding selection processes and identifying subjects for study. For example, saxophonists are not salaried professionals in orchestras, which are commonly pooled for medical research. Establishing contact with saxophonists to conduct studies can prove difficult due to the wide range of genres that utilize the saxophone. Some issues may also be attributed to research methodology. To find the onset of injuries, researchers in previous studies approached universities to investigate playing-related injuries and health conditions in collegiate musicians. Studies reveal injuries can occur before students in music enter the professional realm, and sometimes as early as high school or middle school. Studies pertaining to collegiate saxophonists are limited to multi-instrumental studies or specific case studies. The purpose of this study is to identify the presence of playing-related injuries and health conditions among collegiate saxophonists.

For the purposes of this investigation, a survey was distributed to collegiate members of the North American Saxophone Alliance in 2018, asking students to respond to questions about whether they had experienced playing-related injuries or illnesses. To qualify for the survey, participants had to be at least 18 years old, be pursuing a music degree at a university in Canada or the United States, have saxophone as their primary instrument, and have been studying saxophone for at least one semester/trimester.

There were 87 responses analyzed using Qualtrics Stats iQ. A total of 79 students (90.80%) reported musculoskeletal playing-related pain. The neck (66.67%), thumbs (52.87%), and wrists (52.87%) were the most reported areas. There were 71 orofacial injuries (81.61%), which included difficulty maintaining the embouchure and/or lip pain (52.87%), jaw pain (49.43%), tooth movement (43.68%), and velopharyngeal insufficiency (31.03%). Eighty students (91.95%) reported other playing-related complications, including stage fright (85.06%), hearing loss (32.18%), dizziness/blackouts (31.03%), and chest discomfort (13.79%). Of the 46 students who reported thumb pain, 41 students (89.13%) reported pain in the right thumb, while 21 students (45.65%) reported pain in the left thumb.

While demographics, musical background, practice routine, and lifestyle correlated with some specific illnesses and areas with playing-related pain, there were not enough students free of playing-related complications to determine the significance of these findings. The survey did reveal that playing-related pain and health conditions are present among collegiate saxophonists. Therefore, it is necessary to educate students on the importance of seeking help at the onset of symptoms and to provide ways to mitigate them within performance practice. Further research is needed to determine the possible causation of playing-related pain in the right thumb, what preventative and treatment options students have used to resolve their symptoms and what factors or activities they have found worsen their symptoms, and lastly, to what extent injuries are prevalent among the saxophone community as a whole.

Dedication

To my parents, Michael and Debra Tolan, I can only imagine how scared you were when I was first born, knowing that countless surgeries and visits to hospitals were ahead. You had no idea what the future held for me, but you were both determined and fought for me every step of the way. Everything you did and sacrificed for me means more to me than you can possibly imagine. Without your unwavering strength, love, and support, I would not be where I am today or the person I am. Thank you for believing in me when no one else did.

To my big sister, Nicole, you are my hero. You showed me one can accomplish anything regardless of the circumstances, and because of that, I refuse to ever give up.

To Sarah Avery, my best friend, you are one of the most remarkable individuals I know. You befriended me during one of the most difficult periods of my life, when others judged me on the basis of my appearance. You were there for me when I needed advice, encouragement, and a swift kick in the rear. There are not enough words to express how much your presence in my life means to me.

To my Lucky Ducky, thank you for being my four-legged companion and best friend. For loving me unconditionally, for all the times I was practicing at school and you were at home, and for all the times you came with me to practice. Thank you for enduring the numerous all-nighters when all you wanted to do was sleep. We did it!

In Memory of

Dick "Poppy" Clarke, Jaynie Jewell, and Dr. Timothy Weeks

For you, I am fearless, vivacious, and compassionate.

Acknowledgments

Dr. Michael Ibrahim, I appreciate your support and guidance throughout my doctoral studies. You have taught me to appreciate all genres of music and to think outside the box when performing. You showed me that the repertoire I thought was unattainable was, in fact, achievable. I can't thank you enough for all of the tools you have shared with me, which I share with my own students.

My committee members, Dr. Jared Sims, Dr. Katelyn Best, Dr. Damien Clement, and Dr. Jeffrey Siegfried, for your support, guidance, and insight. Dr. Andrew Kohn, for fostering my passion for music theory. Dr. Travis Stimeling, for providing a unique and entertaining journey through music history. Cynthia Anderson, for all of your advice and patience during my doctoral program. Dr. Michael Vercelli for assisting me through the final portion of this journey and its unexpected turns.

My surgeons, Dr. Michael Sadove and Dr. Ronald Hathaway, for working around my music career for the past two decades. Without you, playing the saxophone would not have been possible.

Rick Wagoner, my 6th grade band director, who took a chance and ignored all the educational textbooks that said I should never have played the saxophone. You changed my life that day.

Robert Burns, in 6th grade, during our first lesson, you asked, "How good do you want to be?" I replied, "The best." You then asked, "The best in what? The school, the town..?" and my enthusiastic response was, "The world." Thank you for not skipping a beat and for fostering those aspirations. Thank you for your continued guidance and support today.

Karl Hartman, for responding to that email first. Thanks for sharing your passion for the saxophone with me and providing me with opportunities some can only imagine. I cannot thank you enough. I am honored to have once referred to you as my teacher and to now call you my friend.

Dr. Paul Bro, I will be forever thankful for all the guidance and encouragement you have given me over the years. I am honored that you were there to cheer me on in the final leg of this journey.

Scotty Stepp, thank you for helping me grow as a saxophonist and as an individual. You challenged me when I needed it the most, and for that I am truly thankful.

Willem van Merwijk, thank you for accepting my own playing-related injury. For teaching me not to find fault with myself but to figure out how to make the saxophone work for me.

Karen Wagoner, Stan Storey, Matt Harloff, and Jay Webb, for everything you taught me as a student and for everything you continue to teach me as a colleague.

The Avon Hornline Staff, for motivating me and making me laugh, especially on the days I needed it the most: Matt Abbey, Sarah Alexander, Jared Emmons, Corey Gates, Susie Harloff, Andrew Moran, Emma Remley, Stefan Roose, Matt Rusnak, Vivian Szymkow, and Cathy Klemmensen.

My closest and dearest friends, who motivate and support me every day. Ariel Detwiler, Kristy Ross, Caitlin Spaulding, and Steven Georges, thank you for giving me the confidence to be who I am.

My students, who inspire me each and every day.

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Introduction

Playing-related injuries and health problems among musicians have been widely studied across nearly all instruments, with the exception of the saxophone. Studies pertaining to playing-related injuries in saxophonists are limited, and most studies investigate a broad area of instrumentalists, where the responses of saxophonists may not be apparent. Resources that have broached the topic with respect to the saxophone have been published in journals like *Clarinet and Saxophone*, *Saxophone Journal*, and *Instrumentalist*. Most of these articles address embouchure discomfort, neck pain, and sometimes thumb pain. Academic studies examining playing-related injuries common to saxophonists have primarily been individual case studies, with the exception of "Medical Problems of Saxophonists: A Comparison of Physical and Psychosocial Dysfunction among Classical and Non-Classical Performers," by Michael Thrasher and Kris S. Chesky; "Playing-Related Injuries and Posture Among Saxophonists," by Chelsea Shanoff et al.; and the French article "Problèmes de santé et facteurs de risqué chez les saxophonistes" by Stéphane Bihan, all of which were large scale studies focusing on the health of saxophonists.

The purpose of this study is to confirm the presence of playing-related injuries and health problems in collegiate saxophonists, to identify external factors that may lead to medical complaints, and to determine appropriate action to prevent them. The first and foremost question is: do collegiate saxophonists experience playing-related complications? Do demographics, such as sex, age, height, or BMI, have higher incidences of playing-related complaints, thus those physical characteristics are more predisposed than others? Does the type of music education

(degree, major, genre studied) which a student pursues determine reported incident rates? Will the musical background, practice routine, or lifestyle of a student influence whether a student reports playing-related complications or not?[1]

There has not been a study that focuses solely on collegiate saxophonists and how the environment in a collegiate setting can impact their health. The aim of this research is to 1) Identify the prevalence of playing-relating pain and health complications in collegiate saxophonists, 2) Discover if they have sought treatment from a medical professional and/or preliminary advice from their applied professor, 3) Investigate which anatomical areas and illnesses are most reported, and 4) Establish correlations and/or statistical significances between the demographics, saxophone background, playing habits, and lifestyle of collegiate saxophonists.

[1] This study will focus on the practices of the individual and how those practices may prevent or increase the risks of playing-related injuries and health conditions. There are studies that focus on institutions and their approach to injury prevention and management. Future studies may also investigate which types of tertiary institutions have the highest rate of injuries and health conditions among their students, given that each type of institution requires a different workload for the student.

Chapter 1: Literature Review

There have been many studies investigating the prevalence of playing-related injuries among collegiate musicians. In 1987, H J H Fry conducted one of the earliest studies examining collegiate musicians at seven Australian music schools. The minimum incidence rate of overuse injury syndrome at all seven schools was 9.3%. At two of those schools, where the study was more controlled, the incidences were 13% and 21%.[2] Since then, many studies have been done on injuries among collegiate musicians. These include comparisons of injury rates, anxiety, and depression between music majors and non-majors, and studies on PRMDs in specific groups of students based on the instrument they play.

Music Students versus Non-Music Students

There are a number of cross-sectional studies comparing the rates of musculoskeletal discomfort between music students and non-music students. In addition to studies examining musculoskeletal pain, researchers have investigated the overall wellness and mental health of music students compared with non-music students. Several European countries, such as Germany, Norway, the Netherlands, and the United Kingdom, have conducted cross-sectional studies on musculoskeletal pain (Ginsborg, 2009; Steinmetz, 2012; Kok et al., 2013; Kok et al., 2015).

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[2] H. J. H. Fry, "Prevalence of Overuse (Injury) Syndrome in Australian Music Schools," *British Journal of Industrial Medicine* 44, no. 1 (January 1987): 35, http://doi.org/10.1136/oem.44.1.35.

In 2013, Hatheway and Chesky published the results of a survey comparing health issues among music majors and non-music majors. The survey was administered to members of the University of North Texas "Green Brigade" marching band. At the time of the survey, there were 310 students, and 246 students participated in the study. The students answered a seventy-item epidemiological questionnaire related to the current semester.[3] Music majors reported significantly higher levels of pain in all categories, as well as significantly higher levels of discomfort during non-marching-related playing. Woodwind and brass music majors were significantly more likely to quit marching band owing to pain than non-music majors. The playing skills and daily activities of brass music majors were significantly more affected than those of brass non-music majors. Woodwind music majors and non-music majors reported comparable frequencies of short-term hearing loss, but music majors reported a considerably greater impact on their playing abilities. Brass music majors reported experiencing "ringing in the ears" more frequently than non-music majors. Compared to non-music majors, woodwind and brass music majors reported that marching band had substantially less of an overall health benefit.[4] Hatheway and Chesky stated that their findings support the assumption that the marching band experience for music majors differs from that of non-music majors.

In 2021, Bruder, Ballenberger, Villas, et al. presented their results from a study conducted from 2016-2018, evaluating the physical and mental health of Canadian music students compared to non-music students. The cross-sectional study included nineteen undergraduate

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[3] Melissa Hatheway and Kriss Chesky, "Epidemiology of Health Concerns Among Collegiate Student Musicians Participating in Marching Band," *Medical Problems of Performing Artists* 24, no. 4 (December 2013): 243, https://doi.org/10.21091/mppa.2013.4046.
[4] Ibid, 246.

music students and fifty undergraduate non-music students.[5] Self-reported nutrition and physical activity were considerably lower among music majors than among non-music majors. The RAND 12 was used to measure self-reported quality of life, which revealed statistically significant differences for physical pain. Students majoring in music exhibited a lower pressure pain threshold at each of the 18 testing points, as well as a weaker core.[6] Those who reported higher levels of stress and mechanosensitivity also reported higher degrees of discomfort. Students who did not participate in physical activity reported considerably lower pain thresholds.[7]

In 2021, Chang, Boone, and Gold published their findings about musculoskeletal pain in Canadian music majors, non-music majors who played an instrument, and professional musicians.[8] The research was conducted between the fall of 2017 and the winter of 2019 at McGill University. There were a total of 585 replies, of which 403 (69%) were from music majors, 132 (23%) from non-music majors who played an instrument, and 50 (9%) from professional musicians. Music majors (35%) had a higher prevalence of playing-related musculoskeletal discomfort (PRMD) compared to non-music majors (18%), and professional musicians had the highest prevalence (56%).[9] The number of PRMD locations was substantially

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[5] Julius Bruder, Nikolaus Ballenberger, Bethany Villas, et al., "MusicCohort: Pilot feasibility of a protocol to assess students' physical and mental health in a Canadian post-secondary school of music," *BMC Research Notes* 14, 441 (2021): 2, https://doi.org/10.1186/s13104-021-05829-9.
[6] Ibid, 3.
[7] Ibid, 5.
[8] Chang identifies participants as the following: students—undergraduate students enrolled in a music program; non-students—undergraduates enrolled in a program other than music; and professionals—members of an academic or professional music organization and/or artists with a music degree.
[9] Allen Ying-Lun Chang, Hannah Boone, and Phil Gold, "Physical Health Status of Music STudents in a Post-Secondary Institution: A Cross-sectional Study," *Work: a Journal of Prevention, Assessment, and Rehabilitation* 70, no. 4 (January 2021): 1101.

higher among music majors and professional musicians than among non-music majors who played an instrument. In addition, there was a substantial difference between music students and professional musicians. There was a considerable increase in the prevalence of PRMDs among music majors in year two compared to year one, which remained the same in year three but declined significantly in years four and five.[10] The mean number of PRMDs was considerably higher among female professional musicians, female music majors, and male professional musicians than among non-music majors who played an instrument.[11] The study found no correlation between reported PRMDs and age, length of practice, or instruments played.

In 2018, the American Psychological Association (APA) released its 12th annual Stress in America survey. The APA evaluated the level of stress found among members of Generation Z, born between 1997 and 2003, aging from 15 to 21 years old.[12] Compared to older generations, Gen Z (27%) was significantly more likely to report their mental health as fair or poor. However, more than one-third of Gen Zs (37%) were more likely to report receiving or currently receiving treatment or therapy from a psychologist or mental health professional (37%). Adult Gen Zs were more likely to report being diagnosed with an anxiety disorder (18%) and/or depression (23%).[13] Of the Gen Zs who reported feeling stressed, only 50% felt they managed their stress, while 25% felt they did not do enough. Almost three-quarters of Gen Z adults (73%) felt they could have used more emotional support. In 2018, the reported stress level for Gen Z was 5.3 out

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[10] Ibid, 1104.
[11] Ibid.
[12] In 2018, Generation Z was divided into two groups: Gen Z teens, ages 15-17, and Gen Z adults, ages 18-21.
[13] American Psychological Association, *Stress in America: Generation Z*, Stress in America Survey (Washington D.C.: APA, 2018), https://www.apa.org/news/press/releases/stress/2018/stress-gen-z.pdf.

of 10, which was higher than the average stress level of 4.9 for all adults and only second to Millenials whose average was 5.7.[14] In 2019, Gen Z adults[15] reported the highest average stress level (5.8), surpassing Millennials (5.4), while the national average remained at 4.9.[16]

In October 2020, the APA revealed in its annual survey that the effects of the COVID-19 pandemic and stressors from previous years had a profound impact on the lives of Americans. This led to the APA announcing that the United States was facing a national mental health crisis. It was believed that the constant stress and trauma created by the pandemic would have serious consequences for Generation Z teens and adults.[17] The 2020 survey revealed that Gen Zs experienced elevated levels of stress and reported symptoms of depression. In September 2020, Gen Z adults reported the highest level of stress, averaging 6.1, significantly higher than all other generations, as well as the national average of 5.0. While the national average level of stress has remained consistent since 2018, the level of stress reported by Gen Z adults has risen from 5.6 in 2018 and 5.8 in 2019 to 6.1 in 2020. Gen Z adults in college (87%) cited education as a significant source of stress, while 82% said the uncertainty of what school in 2020–2021 would look like was causing stress. Approximately two-thirds of Gen Z adults in college (67%) felt that because of the pandemic, they could not plan for the future. Gen Z adults (34%) reported their mental health was worse than the previous year, and were more likely to report common symptoms of depression. Three-quarters of Gen Z adults felt so fatigued that they "sat around

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[14] Ibid, 6-7.
[15] In 2019, Gen Z adults were 18-22 years old.
[16] American Psychological Association, *Stress in America: Stress and Current Events*, Stress in America Survey (Washington D.C.: APA, 2019), https://www.apa.org/news/press/releases/stress/2019/stress-america-2019.pdf.
[17] In 2020, Gen Z teens were ages 13-17 and Gen Z adults were ages 18-23.

and did nothing," 74% felt restless, 73% experienced difficulty concentrating, 73% felt lonely, and 71% were miserable or unhappy. In addition to their mental health, 76% of Gen Z adults reported negative health impacts caused by the pandemic, including: disrupted sleep patterns (31%), eating unhealthy food more than normal (28%), and/or weight changes (28%). More than 8 in 10 Gen Z adults (82%) felt they could have used more emotional support.[18] By looking at the results the APA released regarding Generation Z, one can assume that these results apply to collegiate music students because the age range of Generation Z is 18–23, which is the general age range of young adults attending college. In 2019, Koops and Kuebel published the results of an online survey completed by 252 music majors from universities across the United States. The majority of music majors self-reported mild to extreme levels of depression, anxiety, and stress, citing emotional attachment to music-making and criticism, as well as the intensive workload and curricular requirements, as contributors to their difficulties.[19] In 2020, Payne et al. presented the results of a survey of 1,137 music education majors in the United States, which revealed elevated stress levels, with 57% exhibiting moderate to severe depression and over 70% exhibiting moderate to severe anxiety.[20]

Multiple countries, including the United States and Canada, have conducted research indicating that music students report stress levels that are comparable to or greater than those of

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[18] American Psychological Association, *Stress in America: A National Mental Health Crisis*, Stress in America Survey (Washington D.C.: APA, 2020), https://www.apa.org/news/press/releases/stress/2020/sia-mental-health-crisis.pdf.

[19] Lisa Huisman Koops and Christa R. Kuebel, "Self-reported Mental Health and Mental Illness Among University Music Students in the United States," *Research Studies in Music Education* 43, no. 2 (July 2021): 129, https://doi.org/10.1177/1321103X19863265.

[20] Phillip D. Payne, Wesley Lewis, and Frank McCaskill, "Looking Within: An Investigation of Music Education Majors and Mental Health," *Journal of Music Teacher Education*, 29, no. 3 (June 2020): 50, https://doi.org/10.1177/1057083720927748.

other majors. Studies conducted in Germany and Norway as far back as 2004 indicate that students majoring in music are more likely to experience stress and mental health issues than students majoring in other disciplines (Spahn et al., 2004; Ginsborg et al., 2009; Vagg et al., 2021).

In 2013, in their survey mentioned above, Hatheway and Chesky also presented their findings on the differences in mental health of music majors and non-music majors. Students responded to the following questions regarding performance anxiety:

> (1) How often this semester have you been stressed or anxious about marching band?
> (2) How intense is your stress or anxiety about marching band?
> (3) How often does this stress or anxiety interfere with your day-to-day activities?
> (4) What do you feel causes your stress or anxiety?[21]

There were no significant differences between music majors and non-music majors who played a woodwind or brass instrument. Woodwind non-music majors reported greater frequency and intensity of stress, as well as a greater impact on their daily lives. Brass music majors, on the other hand, reported experiencing stress more frequently and that it affected their daily lives. Results in the percussion section revealed significant differences between music majors and non-music majors, indicating that music majors experienced stress more frequently and with greater intensity, and that it affected their daily activities.[22]

In 2011, Schneider and Chesky presented the findings of a cross-sectional study on the social support and performance anxiety of music majors and non-music majors attending the University of North Texas. There were 609 students that completed a questionnaire that included demographics, the Multidimensional Scale of Perceived Social Support (MSPSS), and a visual

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[21] Hathaway and Chesky, 251e.
[22] Ibid, 245-246.

analog scale to measure performance anxiety.[23] Of the 609 students, approximately 40% were music majors. A greater percentage of music majors reported healthy eating habits. However, they reported fewer hours of sleep per day and fewer hours of exercise per week.[24] Significantly more time was spent alone by music majors than by non-music majors. Results indicated that music majors perceived significantly less social support from significant others than non-music majors. The results also suggested a correlation between performance anxiety control and perceived social support, as well as cognitive and physical symptoms.[25]

In 2021, Bruder, Ballenberger, Villas, et al. evaluated differences in mental health in addition to differences in physical health between music students and non-music students. To assess levels of stress, anxiety, and depression, students completed the Depression, Anxiety, and Stress Scale (DASS-21) short form, which consists of twenty-one questions, seven per area. The DASS-21 scores were lower among music students than non-music students in all three mental health areas; however, only the stress component was significantly lower. On the Kenny Music Performance Inventory-Revised (KMPAI-R), 63.6% of music students got a score above 84, indicating more severe symptoms of performance anxiety.[26] The survey revealed that music students experienced significantly higher levels of depression, anxiety, and stress than non-music majors.

In 2021, Gilbert presented the results of a study conducted at the University of Nebraska-Lincoln comparing anxiety and depression among music and non-music majors.

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[23] Erin Schneider and Kris Chesky, "Social Support and Performance Anxiety of College Music Students," *Medical Problems of Performing Artists* 26, no. 3 (September 2011): 157, https://doi.org/10.21091/mppa.2011.3025.
[24] Ibid, 158.
[25] Ibid, 161.
[26] Bruder, 2.

Twenty-five of thirty music majors and twenty-two of thirty non-music majors responded to the questionnaire. Participants completed the Burns Anxiety Inventory (BAI) and the Burns Depression Checklist (BDC), two widely accepted self-reporting instruments for detecting anxiety and depression.[27] Each item on the BAI was ranked on a scale from 0 to 3 and measured anxious feelings, anxious thoughts, and physical symptoms of anxiety. The BDC scale consisted of twenty-five items related to thoughts and feelings, activities and personal relationships, physical symptoms, and suicidal urges, and each item was ranked on a scale from 0 to 4. The study revealed that undergraduate music majors reported significantly higher levels of anxiety and depression than non-music majors. Music majors reported anxiety levels at a mean of 36.08 compared to 14.36 for non-music majors, and depression levels at a mean of 34.68 compared to 14.00 for non-music majors.[28]

Studies where Collegiate Saxophonists are Included

There have been several studies that have examined the prevalence of playing-related health concerns among collegiate music students that have identified incidences in saxophone students and have displayed their findings such that the reader can identify. Studies conducted in Australia and France have shown incidences of playing-related complications in saxophonists. In 1988, H J H Fry revealed that eleven university saxophonists experienced overuse syndrome at

[27] Gilbert, Danni, "A Comparison of Self-Reported Anxiety and Depression Among Undergraduate Music Majors and Nonmusic Majors," *Journal of Music Teacher Education* 30, no.3 (June 2021): 74, https://doi.org/10.1177/10570837211021048.
[28] Ibid, 76.

varying degrees of severity.[29] In 2010, Alvarado et al. studied the prevalence of dental and cervical-facial pain in wind instrumental students studying at a French conservatory. He found that all students, including saxophonists, mentioned dental instability.[30] In 2011, Evans et al. found that thirty of seventy-seven students attending an Australian school experienced velopharyngeal insufficiency (VPI), and that saxophonists, along with students that played clarinet, oboe, bassoon, horn, or trumpet, had the highest prevalence of reported VPI.[31] In addition to these studies, there have been several studies in the United States and Canada that have demonstrated playing-related health concerns among collegiate saxophonists.

In 1990, Hartsell and Tata published their findings investigating overuse injuries in undergraduate music students at the University of West Ontario. Of the 122 returned responses, 14 students primarily played saxophone, and of those 14, 2 students (1 male, 1 female) reported a playing-related injury. Affected regions were the face, neck, and shoulders. The saxophonists described their discomfort as "muscular (dull ache, pain, tenderness, and cramping in areas of muscle or tendon), other (cysts, ganglia, dryness, joints popping, rash), and a combination of the

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[29] H. J. H. Fry, "The Treatment of Overuse Syndrome in Musicians. Results in 175 patients," in *Journal of the Royal Society of Medicine* 81, no. 10 (October 1988): 573-574, http://doi.org/10.1177/014107688808101007.

[30] C. Alvarado et al., "Étude des douleurs dentaires et cervico-faciales chez les instrumentistes à vent," in *Médecine des arts: approaches médicale scientifique des pratiques artistiques,* no. 71 (March 2010): 11.

[31] A. Evans, T. Driscoll, and B. Ackermann, "Prevalence of Velopharyngeal Insufficiency in Woodwind and Brass Students," *Occupational Medicine* 61, no. 7 (October 2011): 481, http://doi.org/10.1093/occmed/kqr072.

previous two descriptors."[32] The two saxophonists felt that posture, fatigue, and technique were the primary causes of music-related injuries.[33]

In 1998, at a New York university, Danelle Cayea and Ralph Manchester published their results from data collected over fourteen academic years, examining the rate (number of injuries per 100 performance students) at which upper-extremity injuries occured in each instrument.[34] Injury rates were categorized into three levels: low, medium, and high. Instruments were divided according to the reported pain levels (low, 0-5.9; medium, 6.0-11.9; and high, 12.0-18.0). They found that injuries among saxophonists fell into the lower end of the medium-rate group. In this study, injuries among oboists and bassoonists had the lowest incidence rate; saxophonists fell in the middle; and flutists had the highest injury rate, followed by clarinetists.[35]

Also in 1998, Erin Cornick et al. presented their findings from a comparative study evaluating the prevalence of temporomandibular disorders in collegiate flutists and saxophonists compared to non-musicians. The study included 54 university students within a 60-mile radius of Chapman University, located in Orange, California. Participants included 14 flutists (10 music majors), 13 saxophonists (6 music majors), and 27 non-musicians.[36] The data collected was from a physical examination and a questionnaire. Saxophonists and flutists had higher incidences of

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[32] H. D. Hartsell and G. E. Tata, "A Retrospective Survey of Music-Related Musculoskeletal Problems Occurring in Undergraduate Music Students," in *Physiotherapy Canada* 43, no. 1 (January-February 1990): 15-16.
[33] Ibid, 17.
[34] Danelle Cayea and Ralph A. Manchester, "Instrument-Specific Rates of Upper-Extremity Injuries in Music Students," in *Medical Problems of Performing Artists* 13, no. 1 (March 1998): 20.
[35] Ibid, 21.
[36] Erin Cornick, Kendra Del Carlo, and Laural Didham, "The Incidence and Prevalence of Temporomandibular Disorder: Signs and Symptoms among College Music Majors Who Play the Flute or Saxophone," (master's thesis, Chapman University, Orange, CA, 1998), 4, ProQuest Dissertations & Theses Global.

temporomandibular disorder signs and symptoms than non-musicians. 51.9% of saxophonists and flutists had experienced pain upon palpation of masticatory muscles, while only 33.3% of non-musicians experienced pain. While playing, 71% of flutists experienced pain, while only 46% of saxophonists experienced pain.[37]

In 2015, Beckett et al. published the findings of a survey analyzing the prevalence of musculoskeletal injuries (MSI) among twenty-one college marching bands. There were 792 females and 587 males who answered the survey and provided information regarding their demographics, years of experience, footwear worn, instrument played, stretching habits, injury prevalence and kind, treatment, and time lost to injury. Of marching band and color guard participants, 25% reported musculoskeletal injuries. Females were 20% more likely to incur an MSI, and lower extremity injuries accounted for 87.7% of all MSIs.[38] A higher BMI was considered as a risk factor for injury. Of 147 saxophonists who participated in the poll, 32 (21.77%) reported a MSI, the third highest behind color guard members and trumpet players. The majority of saxophonists reported injuries to the lower extremities, followed by multiple injury sites, and then the upper extremities and the spine.[39]

Individual Cases of Playing-Related Health Problems in Saxophonists

There are a limited number of case studies pertaining to saxophonists presenting with playing-related health concerns, and even fewer pertaining to collegiate saxophonists. In 1991,

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[37] Ibid, 1.
[38] Sarah Beckett et al., "Prevalence of Musculoskeletal Injury Among Collegiate Marching Band and Color Guard Members," *Medical Problems of Performing Artists* 30, no. 2 (June 2015): 106, https://doi.org/10.21091/mppa.2015.2018.
[39] Ibid, 107.

Wegen-Keijser and Bruynzeel presented one of the earliest case studies, where a 21-year-old saxophonist nearing the end of his conservatory training in the Netherlands was presented with contact cheilitis (an inflammation of the lower lip), which lasted for a year and occurred directly after playing the saxophone.[40]

In 2002, at a physical therapy clinic in Flagstaff, Arizona, a 20-year-old male saxophone performance major at a university in a high-altitude area sought treatment for a repetitive stress injury in his right hand, wrist, and forearm, and chronic low back pain. While the student presented with several physical issues affecting his performance, his poor posture during saxophone practice seemed to cause the most stress on his body. One aspect of his treatment was to correct his posture and balance his body alignment. Changing his posture was one of the few aspects of the treatment plan the student consistently followed. It had an immediate effect on decreasing his symptoms and allowed him to practice at the level he desired.[41]

In 2004, Orman presented a case study exploring the physiological and psychological responses of performing musicians to computer-generated virtual reality graded exposure. Three upper division undergraduate saxophonists attending Louisiana State University, two females and one male, performed while immersed in four virtual environments, each meant to gradually

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[40] M. H. van der Wegen-Keijser and D. P. Bruynzeel, "Allergy to Cane Reed in a Saxophonist," in *Contact Dermatitis* 25, no.4 (October 1991): 268, http://doi.org/10.1111/j.1600-0536.1991.tb01868.x.

[41] Lynn E. Medoff and Kim Short, "Treatment of Repetitive Stress Injury in a High Altitude Saxophone Player with Pectus Excavatum and Scoliosis," in *Orthopaedic Practice* 14, no. 2 (2002): 13, https://www.orthopt.org/uploads/content_files/Treatment_of_Repetitive_Stress_Inujury_in_a_High_Altitude_Sax_Player.pdf.

increase the anticipated anxiety level of the performer.[42] All three performers had over one hundred performances as a member of a large ensemble and four to twenty performances as a soloist. Each saxophonist performed in two separate sessions. In the first session, the study and the equipment used were described, and subjects filled in a form documenting their age, sex, skill level, number of years learning all instruments, and number of public appearances as a group and as a soloist. Subjects then experienced a virtual forest, waterfall, and stream. To remove self-imposed spatial limits, subjects were invited to explore while immersed. In the second session, each player performed major scales in each scenario, staying there until they finished the major scales. A two-minute baseline heart rate and Subjective Units of Discomfort (SUD) were recorded in the forest, waterfall, and stream settings. A baseline reading and immersion were done before each performance. Immersion was conducted in the following order: empty practice room, studio class participants as an audience, three music professors as if listening to and maybe judging a performance, and the director of bands as if judging a seat audition for admittance and placement in a large performing group. After immersion in each setting, heart rate and SUDS were reported.[43] During the duration of the exposure, heart rates and subjective measures were obtained. According to this study, virtual reality graded exposure generated physiological and psychological symptoms of rising anxiety in musical performance environments built to prepare for a graded performance.

In 2014, in *Notes of Hope: Stories by Musicians Coping with Injuries*, saxophonist Dr. Allison Dromgold Adams wrote of her journey in developing embouchure dystonia and how she

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[42] Evelyn K. Orman, "Effect of Virtual Reality Graded Exposure on Anxiety Levels of Performing Musicians: A Case Study," *Journal of Music Therapy* 41, no. 1 (Spring 2004): 70, https://doi.org/10.1093/jmt/41.1.70.
[43] Ibid, 74.

overcame it. Having a medical problem that often ends the careers of musicians, Dr. Adams changed her lifestyle and perception of what it took to be a professional saxophonist. She states that she had "adopted an unhealthy and unsustainable lifestyle encased in negativity, criticism, and isolation."[44] She firmly believed her physical, emotional, and mental state played a significant role in her onset and persistence of embouchure dystonia. Through Alexander Technique, she learned better breathing techniques and ways to eliminate tension. She worked with a behavioral scientist who believed her attitude and perception could affect her performance. Once Dr. Adams changed this, she noticed her jaw stopped shaking, and she was gaining more control over her tonguing and air. When she incorporated yoga into her routine and saxophone career, she eliminated the tension in her body and finally gained full control of her embouchure. By changing her lifestyle and mindset, Dr. Adams overcame an otherwise career-ending condition.

Studies on PRMDs and Health Complaints in Saxophonists

There are only a few studies that identify playing-related injuries among saxophonists, and even fewer that discuss playing-related injuries among collegiate saxophonists. In 1999, Thrasher and Chesky examined the rate at which medical ailments were found in saxophonists regarding the primary music genre they performed. They selected 82 subjects from an accidental sample of over 4000 participants. The study included musicians whose primary instrument was saxophone, which narrowed the group to 29 classical and 53 non-classical saxophonists. Subjects

[44] Allison Dromgold Adams, "How Dystonia Brought Balance to My Life," in *Notes of Hope: Stories by Musicians Coping with Injuries*, comp. David Vining (Flagstaff, AZ: Mountain Peak Music, 2014), 60.

filled out a questionnaire, which revealed that both groups experienced pain predominantly in their neck, right upper back, right wrist, and both sets of fingers.[45] Classical saxophonists experienced musculoskeletal injuries more frequently and at higher levels of severity, as well as higher levels of depression, headaches, and fatigue. Regarding work-related stress and alcohol/cigarette consumption, the study revealed higher instances in non-classical saxophonists.[46]

In 2014, Stéphane Bihan presented a similar study targeting French-speaking saxophonists. Bihan conducted the study using a questionnaire accessible via the internet. The study group comprised 196 saxophonists and addressed gender, age, amateur vs. (semi-) professional[47] musicians, types of saxophones played, doubling, and hours practiced. Unlike the study completed by Thrasher, the incident rate of musculoskeletal disorders among non-classical and classical saxophonists was relatively the same, with non-classical saxophonists reporting slightly higher incidences. More than half of the major complaints were back and/or neck related.[48] Bihan discussed these findings in great detail, providing risk factors, prevention strategies, and the importance of proper equipment (model of horn, neck straps/harnesses, and thumb rest modifications). Bihan also discovered non-musculoskeletal injuries, such as dental/temporomandibular joint problems, hearing ailments (Tinnitus, Hyperacusis,

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[45] Michael Thrasher and Kris S. Chesky, "Medical Problems of Saxophonists: A Comparison of Physical and Psychosocial Dysfunction among Classical and Non-Classical Performers," in *The Saxophone Symposium* 24 (1999): 80.
[46] Ibid, 81.
[47] Bihan does not specify what qualifies a saxophonist as an amateur, semi-professional, or professional.
[48] Stéphane Bihan, "Problèmes de santé et facteurs de risqué chez les saxophonistes," in *Médecine des arts: approaches médicale scientifique des pratiques artistiques*, no. 77 (May 2014): 18.

Hypoacousia), allergies (asthma and lung), and tachycardia, appeared in these musicians. In response to these findings, Bihan discussed the importance of dental hygiene and protection and the responsibility of the teacher to instill "good" practice methods. Both the Thrasher/Chesky and Bihan articles helped provide a foundation for different types of medical problems one may encounter when playing the saxophone. Bihan additionally provided insight into risk factors, prevention methods, ergonomics, and the importance of pedagogues in teaching safe practice.

Most recently (2019), Chelsea Shanoff et al. conducted a study evaluating playing-related musculoskeletal disorders (PRMD) in relation to postural habits among professional[49] and collegiate-level saxophonists in North America. Of the three studies mentioned, this is the only study where collegiate saxophonists were part of the targeted audience. While the study does not directly identify how many collegiate saxophonists presented with PRMDs, the number of participants in the 18–20 (n = 14) and 21–25 (n = 38) age groups raises the assumption that a considerable number of saxophonists were students in a collegiate music program.[50] The objectives of the study were to examine the occurrence of playing-related disorders, determine the most problematic areas, and finally identify the main postural habits of saxophonists and find out if these habits correlated with the presence of pain. Shanoff found that 76.15% of the 109 saxophonists that responded had experienced a PRMD. 50% reported having experienced an injury in the past year, 27.52% in the past month, and 21.10% in the past week. The most

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[49] Shanoff describes a professional as defined by the Toronto Arts Council. A professional artist (musician) is someone who has developed their skills through training and/or practice, is recognized as such by artists working in the same artistic tradition, actively practices his or her art, seeks payment for their work, and has a history of public performance.

[50] Chelsea Shanoff et al., "Playing-Related Injuries and Posture Among Saxophonists," abstract, *Medical Problems of Performing Artists* 34, no. 4 (December 2019): 217, https://doi.org/10.21091/mppa.2019.4032.

problematic areas for saxophonists were the left and/or right wrists, neck, and mouth/jaw. The most common postural habits among saxophonists were a forward head position and a rounded upper back. Shanoff revealed that the rounded upper back and backward pelvic tilt correlated with higher pain ratings. The aforementioned positions and an excessive curve in the lower back had a significant correlation with PRMD issues in the right wrist.[51] The results from this survey, along with interviews covering treatments participants had sought and evidence-based treatments for musicians, were included in her doctoral thesis "Playing-Related Injuries and Posture among Saxophonists" completed by Shanoff in 2020.

As mentioned above, there have been surveys that presented findings on playing-related pain in saxophonists. These surveys included collegiate saxophonists among the subject population, but they were not the focus of the surveys. The primary purpose of the following survey is to identify what injuries collegiate saxophonists in Canada and the United States experience, if any, and to determine what factors might cause a higher chance of injury among this group of musicians.

[51]Ibid, 216.

Chapter 2: Methods and Materials

This research study (protocol #1705579333) was approved by the West Virginia University Office of Research Integrity and Compliance. Two questionnaires were distributed to collegiate-level saxophonists attending North American universities. Only the data collected from the second questionnaire was analyzed for this study. To distribute the second questionnaire, the North American Saxophone Alliance (NASA) was contacted and asked to circulate the survey to its current members. Before starting the questionnaire, participants read an online cover letter approved by the WVU ORIC. Qualtrics, an online form and data collection service, was used to create and collect the data from the questionnaire. Because of the method in which the survey was distributed, the response rate could not be determined. The completion rate for the responses received was 79.28%. The Chi-Square test and Fisher's Exact test were used to determine the differences between various variables and areas of playing-related health problems reported, along with the Spearman's test to identify correlations. Statistical analysis was performed using Qualtrics Stats iQ. The *p*-value was set at a 5% level of significance.

The questionnaire was developed under the supervision of a research advisor and a professor of physical therapy. The questions were based on a questionnaire by Michael Thrasher and Kris S. Chesky at the University of North Texas, which evaluated medical problems among classical and non-classical saxophonists.[52] Questions were modified and adjusted to reflect collegiate students studying saxophone in the United States and Canada. The questionnaire covered ten areas and posed questions regarding: 1) Qualifications to participate in the survey, 2)

[52] Thrasher and Chesky, 77-84.

Demographics, 3) Playing-Related Musculoskeletal Pain, 4) Orofacial Playing-Related Injuries, 5) Non-Musculoskeletal Problems, 6) Musical Background, 7) Practice Routine, 8) Ergonomic Adjustments, 9) Lifestyle, and 10) Feedback and Comments. The demographics section included questions about the participant: the degree and music program they were pursuing; their country of study; as well as their age, sex (which was listed as "gender"), weight, and height. The musculoskeletal section presented questions regarding seventeen bilateral body areas, while the craniofacial/orofacial section assessed pain reported in the jaw and embouchure. The non-musculoskeletal section consisted of questions concerning the occurrence and severity of medical problems that fall under dermatological, audiological, respiratory, and "other." Practicing habits included questions about the length at which students practiced, how many ensembles they participated in, which saxophones they played, and if they played a secondary instrument. The lifestyle section presented questions regarding levels of activity, school and work-related activities, and stress.

Chapter 3: Results

Participants

To qualify for the survey, the participant had to be at least 18 years or older, be actively pursuing a music degree at a university in Canada or the United States (recent graduates of Spring 2018 could participate), saxophone had to be their primary instrument, and they must have been studying saxophone for at least one semester/trimester. The participant could continue the survey if they met these requirements, regardless of age, race, ethnicity, sexuality, or gender. A total of 111 responses were received, and data was collected from 87 based on the completion and validity of the surveys. There were 23 surveys that were not completed, and the validity of one response was questioned, as the participant had only played saxophone for one year.

Demographics

Of the 87 surveys evaluated, there was a larger response from male students (n = 52, 59.77%) than females (n = 35, 40.23%).[53] This representation was similar to students who graduated with a music degree in 2018: male (54.5%) and female (45.5%).[54] The age range of the students was 18 to 32 years of age. The largest group ranged from 18 to 22 (n = 54, 62.07%),

[53] For the purpose of this study, male and female were used as biological terminology to frame physiological differences.
[54] DataUSA, 2018, *Sex Imbalance for Common Institutions: 2018*, Distributed by the Integrated Postsecondary Education Data System, 2016, https://datausa.io/profile/cip/music#institutions.

with the average age being 22.1 years. Eighty-three students (95.40%) attended a university in the United States, while four students (4.60%) attended a university in Canada. The majority of students pursued an undergraduate degree (n = 67, 77.01%), while the remaining students pursued a master's (n = 10, 11.49%) or doctoral (n = 10, 11.49%) degree. Nearly all students were full-time students (n = 84, 96.55%). More than half of the students lived off-campus (n = 52, 59.77%), while 27 students (31.03%) lived on-campus, and the remaining students (n = 8, 9.20%) lived off-campus with their families. The majority of the students (n = 75, 86.21%) primarily studied classical/contemporary music, while only 12 students (13.79%) studied jazz. There were 42 students (48.28%) pursuing a performance major and 45 students (51.72%) pursuing a non-performance major. This study represented students who self-reported as Asian (n=6, 6.90%), Black or African American (n=1, 1.15%), Indigenous (n = 1, 1.15%), Latino or Hispanic (n = 6, 6.90%), Lebanese (n = 1, 1.15%), multiracial (n = 4, 4.60%), and White (n=68, 78.16%). With the exception of the higher percentage of students who self-reported as White, the diversity of students represented in this study is similar to that of students who earned a degree in music in 2018.[55] Students were asked to describe their current weight and height, and from that, their Body Mass Index (BMI) was calculated. The majority of students fell within what the CDC considered a normal weight range (n = 39, 44.83%). Students considered overweight or obese were nearly equal in response (overweight: n = 22, 25.29%; obese: n = 21, 24.14%), while

[55] In 2018, DataUSA reported the percentage of degrees awarded for Music by race and ethnicity, which included Asian (5.06%), Black or African American (6.28%), Indigenous (0.258%), Latino or Hispanic (11%), multiracial (4.14%), Native Hawaiin or Other Pacific Islanders (.118%), unknown (4.01%), and White (55.2%). Data USA also reported Non-resident students graduates at (14%).
DataUSA, 2018, *Race & Ethnicity by Degrees Awarded: 2018*, Distributed by the Integrated Postsecondary Education Data System, 2016, https://datausa.io/profile/cip/music#institutions.

students underweight formed the smallest group (n = 4, 4.60%). The average BMI was 25.5, the lowest BMI was 16.3, and the highest was 42.5. The height of students was divided into four ranges: 5′1″-5′4″ (n = 14, 16.09%), 5′5″-5′8″ (n = 31, 35.63%), 5′9″-6′ (n = 35, 40.23%), and 6′1″-6′4″ (n = 7, 8.05%). The average height was 5′8,″ the shortest 5′1,″ and the tallest 6′4″ (Table 1).

Table 1. Demographics of Saxophonists (n = 87)

	% of Participants (n)		% of Participants (n)		% of Participants (n)
Sex		**Student Status**		**Race**	
Male	59.77% (52)	Full-time	96.55% (84)	Asian	6.90% (6)
Female	40.23% (35)	Part-time	3.45% (3)	Black or African Am.	1.15% (1)
Age		**Living Status**		Indigenous	1.15% (1)
18-22	62.07% (54)	Off-Campus	59.77% (52)	Latino or Hispanic	6.90% (6)
23-27	27.59% (24)	On-Campus	31.03% (27)	Lebanese	1.15% (1)
28-32	10.34% (9)	Off-Campus with family	9.20% (8)	Multiracial	4.60% (4)
Location of University		**Genre Studied**		White	78.16% (68)
United States	95.40% (83)	Classical	86.21% (75)	**Body Mass Index**	
Canada	4.60% (4)	Jazz	13.79% (12)	Underweight (< 18.5)	4.60% (4)
Degree		**Major Area**		Normal (18.5-24.9)	44.83% (39)
Bachelor	77.01% (67)	Performance	48.28% (42)	Overweight (25.0-29.9)	25.29% (22)
Master	11.49% (10)	Non-Performance	51.72% (45)	Obesity (≥ 30.0)	24.14% (21)
Doctorate	11.49% (10)			No Response	1.15% (1)
				Height	
				5′1″-5′4″	16.09% (14)
				5′5″-5′8″	35.63% (31)
				5′9″-6′	40.23% (35)
				6′1″-6′4″	8.05% (7)

Playing-Related Musculoskeletal Pain

In the next section of the survey, students were asked to identify the musculoskeletal areas in which they were experiencing pain, which included the upper extremity region (thumbs, fingers, hands, wrists, forearms, elbows, and shoulders), the spinal region (neck, upper back, middle back, and lower back), and the lower extremity region (hips, knees, calves, ankles, feet, and toes). Most of the 87 students (n = 79, 90.80%) reported playing-related musculoskeletal pain in at least one of the anatomical areas listed in Table 2, while only 8 students (9.20%) had

not reported any musculoskeletal play-related pain. Of the 52 male students, 45 (86.54%) experienced pain from playing the saxophone, while 34 (97.14%) of the 35 female students reported playing-related pain. The percentage of female students who reported playing-related pain was higher than male students (p = .136). Playing-related pain was found in 50 students (92.59%) ages 18-22, 21 students (87.50%) 23-27 years old, and 8 students (88.89%) 28-32 years old. Of the 8 students who did not report playing-related pain, 1 student (12.50%) identified as Latino or Hispanic, and 7 students (87.5%) identified as White. In regards to race and ethnicity, particularly the effects of racism on health disparities and inequity, no significant conclusions could be drawn due to the small number of saxophonists that did not identify as White.[56]

There were 3 students (75%) who had an underweight BMI who reported playing-related pain, 36 students (92.31%) with a normal BMI, 18 students (81.82%) who were overweight, and 21 students (100%) who were considered obese. Higher incidences of playing-related pain were reported in students with an obese BMI compared to students with an underweight BMI (p = .019) or an overweight BMI (p = .04). The 8 students who did not report playing-related pain had a BMI that ranged from underweight, normal, or overweight. Playing-related pain was reported by 13 students (92.86%) 5′1″-5′4″, 28 students (90.32%) 5′5″-5′8″, and 31 students (88.57%) 5′9″-6′. All students (n = 7) 6′1″ or taller reported playing-related pain.

Among the 67 undergraduate students, 63 (94.03%) had experienced playing-related pain. There were 7 students (70%) pursuing a master's degree, and 9 students (90%) working towards

[56] Both the Center for Disease Control and the American Medical Association have identified racism as the primary cause for health disparities and inequities among racial and ethnic minority groups.

a doctorate who reported pain from playing the saxophone. A higher number of undergraduate students reported playing-related pain compared to students pursuing a master's degree (p = .042) and students pursuing a doctorate degree (p = .511). Of the students who experienced playing-related pain, 49 students (94.23%) lived off-campus, 25 students (92.59%) lived on-campus, and 5 students (62.50%) lived off-campus with family. The occurrence of playing-related pain was significantly lower in students who lived off-campus with family (n = 5, 62.50%, p = .014) compared to students who lived off-campus (n = 49, 94.23%) and students who lived on-campus (n = 25, 92.59%). Of the 75 students who studied primarily classical/contemporary music, 69 students (92%) experienced playing-related pain, while 10 students (83.33%) of the 12 students studying jazz reported pain. Playing-related pain was nearly equal among performance students (n = 38, 90.48%) and non-performance students (n = 41, 91.11%).

Table 2. Demographics of Saxophonists and Prevalence of Playing-Related Musculoskeletal Pain (n = 87)

	% of Participants (n)
Playing-Related Pain (n = 87)	
Pain Reported	90.80% (79)
No Pain Reported	9.20% (8)

Sex	**Reported Pain**	**No Pain Reported**
Male (n = 52)	86.54% (45)	13.46% (7)
Female (n = 35)	97.14% (34)	2.86% (1)
Age		
18-22 (n = 54)	92.59% (50)	7.41% (4)
23-27 (n = 24)	87.50% (21)	12.50% (3)
28-32 (n = 9)	88.89% (8)	11.11% (1)
Race		
Asian (n = 6)	100% (6)	0% (0)
Black, African Am. (n = 1)	100% (1)	0% (0)
Indigenous (n = 1)	100% (1)	0% (0)
Latino or Hispanic (n = 6)	83.33% (5)	16.67% (1)
Lebanese (n = 1)	100% (1)	0% (0)
Multiracial (n = 4)	100% (4)	0% (0)
White (n = 68)	89.71% (61)	10.29% (7)
Body Mass Index		
Underweight (n = 4)	75% (3)	25% (1)
Normal Weight (n = 39)	92.31% (36)	7.69% (3)
Overweight (n = 22)	81.82% (18)	18.18% (4)
Obesity (n = 21)	100% (21)	0% (0)
No Response (n = 1)	100% (1)	0% (0)

	% of Participants (n)	
Degree	**Reported Pain**	**No Pain Reported**
Bachelor (n = 67)	94.03% (63)	5.97% (4)
Master (n = 10)	70% (7)	30% (3)
Doctorate (n = 10)	90% (9)	10% (1)
Student Status		
Full-time (n = 84)	90.48% (76)	9.52% (8)
Part-time (n = 3)	100% (3)	0% (0)
Living Status		
Off-Campus (n = 52)	94.23% (49)	5.77% (3)
On-Campus (n = 27)	92.59% (25)	7.41% (2)
Off-Campus w/family (n = 8)	62.50% (5)	37.50% (3)
Genre Studied		
Classical (n = 75)	92% (69)	8% (6)
Jazz (n = 12)	83.33% (10)	16.67% (2)
Major Area		
Non-Performance (n = 45)	91.11% (41)	8.89% (4)
Non-Performance (n = 42)	90.48% (38)	9.52% (4)
Height		
5′1″-5′4″ (n=14)	92.86% (13)	7.14% (1)
5′5″-5′8″ (n=31)	90.32% (28)	9.68% (3)
5′9″-6′ (n=35)	88.57% (31)	11.43% (4)
6′1″-6′4″ (n=7)	100% (7)	0% (0)

The regions with the highest reported incidence rates were the upper extremities and the spinal region. Of the students who experienced playing-related pain, 73 (92.41%) reported pain in the upper extremity region. This was higher than 64 students (81.01%) that reported pain in the spinal region (p = .049). Injuries reported in the upper extremity region correlated with reported spinal region injuries (r_s = .305, p = .004). There were significantly more cases of playing-related pain in the upper extremities and the spinal region than in the lower extremities (n = 10, 12.66%, p.001). Injuries reported in the lower extremity region also correlated with reported spinal injuries (r_2 = .216, p = .045). There were 58 students (73.42%) who reported playing-related pain in more than one region.

Reports of playing-related pain in the spinal region appeared to have been affected by sex, age, degree, and major, whereas reports of playing-related pain in the upper extremities appeared to have been affected by living status. Playing-related pain in the spinal region had a higher incident rate in female students (n = 30, 85.71%, p = .047) than male students (n = 34, 65.38%). Students ages 18-22 (n = 45, 83.33%, p = .008) reported playing-related pain in the spinal region more than students 23-27 (n = 12, 50%) and 28-32 (n = 7, 77.78%). A pairwise comparison revealed the incident rate of playing-related pain in the spinal region among undergraduate students (n = 53, 79.10%) was higher than students pursuing a master's degree (n = 4, 40%, p = .009) and doctoral students (n = 7, 70%, p = .517). Non-performance students (n = 38, 84.44%, p = .028) reported playing-related pain in the spinal region more than performance students (n = 26, 61.90%). Students who lived off-campus with their families (n = 4, 50%, p = .022) reported fewer incidences of playing-related pain in the upper extremity region than students who lived off-campus (n = 46, 88.46%), and those who lived on-campus (n = 23,

85.19%). There were no significant demographic differences for reported playing-related pain in the lower extremities.

The areas of the body where students reported experiencing pain the most were the neck (n = 58, 66.67%), thumbs (n = 46, 52.87%), and wrists (n = 46, 52.87%). The incidence rate of playing-related pain in the neck was higher than the thumbs ($p = .033$) and wrists ($p = .390$), and the remaining areas of the body ($p < .001$). Students reported playing-related pain in the thumbs and wrists more than the shoulders ($p = .026$) and upper back ($p = .045$), the lower back ($p = .002$) and middle back ($p = .002$), and the remaining areas ($p < .001$). There was no difference in reported incidents between the thumbs and wrists ($p = 1$).

The areas least reported were the ankles (n = 1, 1.15%), calves (n = 2, 2.30%), hips (n = 3, 3.80%), and knees (n = 3, 3.45%). There were zero reported incidences of playing-related pain in the toes, so data could not be collected to determine significance. The incidence rate of playing-related pain in the ankles was less than the feet ($p = .025$), elbows ($p = .003$), and remaining anatomical areas ($p < .001$), except for the calves, hips, and knees ($p = .567$, $p = .320$, $p = .320$) where there were no significant differences. Students reported playing-related pain in the calves less than the feet ($p = .045$), elbows ($p = .006$), and the remaining anatomical areas ($p < .001$), except for the hips, knees, and ankles ($p = .567$, $p = .657$, $p = .567$) where no significant differences occurred. Hips and knees were reported at the same incidence rate ($p = 1$), and there were no significant differences between the calves, ankles, or feet ($p = .657$, $p = .320$, $p = .259$). Hips and knees were reported less frequently than the spinal region and upper extremities ($p < .001$).

The survey data revealed some demographic differences and correlations. There was evidence that age, height, and living status could affect the presence of playing-related pain in various upper extremity areas. More students ages 28-32 (n = 5, 55.56%) reported playing-related pain in their fingers than students ages 18-22 (n = 15, 27.78%), and students 23-27 years old (n = 1, 4.15%), and more students ages 18-22 reported pain than students 23-27 years (p = .005). Both off-campus students (n = 29, 55.77%, p = .023) and on-campus students (n = 16, 59.26%, p = .02) had higher incidences of playing-related pain in the wrists than students who lived off-campus with their families (n = 1, 12.50%). The incident rate for playing-related pain in the wrists for students 5′9″-6′ tall (n = 23, 65.71%) was higher compared to incidences reported by students 5′5″-5′8″ tall (n = 12, 38.71%, p = .028), and students 5′-5′4″ tall and 6′1″-6′4″ tall (p =.574, p = .256). Shoulder pain occurred more frequently in students ages 28–32 (n = 6, 66.67%) than in students ages 23–27 (n = 6, 25%, p = .028) and students 18–22 years old (n = 20, 37.04%, p =.095). There were more students who lived off-campus (n = 25, 48.08%, p = .012) who reported playing-related pain in the shoulders compared to students who lived off-campus with family (n = 0, 0%) and students who lived on-campus (n = 7, 25.93%).

The spinal region was found to be potentially affected by age, BMI, musical genre, and living status. There was a higher incidence of playing-related pain in the neck in students ages 18-22 (n = 40, 74.07%) compared to students 23-27 years old (n = 11, 45.83%, p = .016). Non-performance majors (n = 23, 51.11%) reported upper back playing-related pain significantly more than performance majors (n = 11, 26.19%, p = .027). There was a higher incident rate of playing-related pain in the upper back among classical/contemporary students (n = 33, 44%) than jazz students (n = 1, 8.33%, p = .024). More students who lived on-campus (n = 11, 40.74%)

reported playing-related pain in the lower back compared to students who lived off-campus with family (n = 0, 0%, p = .029). The incident rate of playing-related pain in the lower back correlated with BMI (r_s = .242, p = .0239). There was not enough data available to determine statistical differences in demographics for the hips, knees, calves, ankles, feet, and toes.

In addition, students were asked if they experienced pain on the left and/or right side of each body region (Table 3). Age, sex, height, BMI, major, and living situation appeared to influence particular sides of the upper extremities. The incident rate for left thumb pain was higher for female students (n = 13, 37.14%) than male students (n = 8, 15.38%, p = .024). More non-performance majors (n = 14, 31.11%) reported playing-related pain in the left fingers than performance majors (n = 4, 9.52%, p = .017). Right side finger pain was reported more in students ages 28-32 (n = 5, 55.56%, p = .003) than students 23-27 (n = 1, 4.17%) and 18-22 (n = 10, 18.52%). More female students (n = 12, 34.29%) complained of playing-related pain in their right hand than male students (n = 8, 15.38%, p = .04). There was a correlation between students who reported playing-related pain in their left shoulder and their height (r_s = .279, p = .009). The incident rate for right shoulder pain in students ages 28-32 (n = 6, 66.67%, p = .042) was higher than ages 18-22 (n = 17, 31.48%) and 23-27 (n = 5, 28.83%). Students who lived off-campus (n = 22, 42.31%) complained of playing-related pain in the right shoulder at a higher incident rate than students who lived on-campus (n = 6, 22.22%) and students who lived off-campus with family (n = 0, 0%, p = .024).

External factors such as age, major, genre of music played, and BMI were associated with higher incidence rates on particular sides of the spinal region. Incidences of right side neck pain was reported more in students ages 18-22 (n = 34, 62.96%) than in students 23-27 years old (n =

8, 33.33%, p = .04). Right side upper back pain was reported more in students ages 18-22 years old (n = 22, 40.74%) than students 23-27 years old (n = 4, 16.67%, p = .037). Non-performance majors reported playing-related pain in the left upper back (n = 21, 46.67%, p = .043) and right upper back (n = 20, 44.44%, p = .026) more than non-performance majors (left: n = 10, 23.81%; right: n = 9, 21.43%). This was the same for classical/contemporary students, who reported left upper back (n = 30, 40%, p = .049) and right upper back (n = 28, 37.33%, p = .0545) pain more than jazz students (left: n = 1, 8.33%; right: n = 1, 8.33%). There was a correlation between students with right middle back pain and BMI (r_s = .227, p =.034). Playing-related pain in the left and right sides of the lower back correlated with BMI range (left: r_s = .221, p =.04; r_s = .227, p =.034). The incidence rate of playing-related pain in the left lower back correlated with age (r_s = -.226, p =.036). The significance of demographic differences pertaining to the left and right sides of the lower extremities was not analyzed due to the low incident rate of occurrences.

The majority of the responses were evenly matched left to right, except for responses regarding the left and right thumbs. Of the 46 students who experienced thumb pain, 41 students (89.14%) experienced playing-related pain in their right thumb, nearly double of those who reported pain in their left thumb (n=21, 45.65%, p < .001). There were no leading factors demographically that could explain this occurrence.

Of the 79 students who experienced musculoskeletal playing-related pain, most students (65.82%, n = 52) noticed increased soreness or pain as they increased their practice times before a performance (Table 3). As practice time increased, female students and non-performance majors were more likely to report increased musculoskeletal pain. Female students (n = 30, 90.91%) reported increased soreness with increased practice time at a higher incident rate than

male students (n = 22, 48.89%, $p < .001$). Non-performance majors (n = 32, 80%) reported increased soreness and pain, as they increased their practicing, significantly more than performance majors (n = 20, 52.63%, $p = .016$).

Table 3. Areas of the Body Where Playing-Related Pain was Reported (n = 87)

	% of Participants (n)
Pain Reported by Anatomical Region (n = 87)	
Upper Extremities	83.91% (73)
Spinal Region	73.56% (64)
Lower Extremities	11.49% (10)

The percentage of each body area (Thumb, Fingers, etc.) was calculated by using the number of total participants as the divisor. The left and right percentages were calculated using the number of participants who reported pain in each area as the divisor.

Upper Extremities	% of Participants (n)
Thumbs	**52.87% (46)**
Left	45.65% (21)
Right	89.13% (41)
Fingers	**24.14% (21)**
Left	85.71% (18)
Right	76.19% (16)
Hands	**27.59% (24)**
Left	79.17% (19)
Right	83.33% (20)
Wrists	**52.87% (46)**
Left	63.04% (29)
Right	71.74% (33)
Forearms	**26.44% (23)**
Left	86.96% (20)
Right	91.30% (21)
Elbows	**12.64% (11)**
Left	54.55% (6)
Right	63.64% (7)
Shoulders	**36.78% (32)**
Left	87.50% (28)
Right	87.50% (28)

Spinal Region	% of Participants (n)
Neck	**66.67% (58)**
Left	89.66% (52)
Right	82.76% (48)
Upper Back	**39.08% (34)**
Left	91.18% (31)
Right	85.29% (29)
Middle Back	**29.89% (26)**
Left	92.31% (24)
Right	96.15% (25)
Lower Back	**31.03% (27)**
Left	88.89% (24)
Right	92.59% (25)
I have not experienced any pai	**9.20% (n = 8)**
in any of these areas.	
Increased Practice=Increased Pain (n = 79)	
Yes	65.82% (52)
No	32.91% (26)
No Response	1.27% (1)

Lower Extremities	% of Participants (n)
Hips	**3.45% (3)**
Left	100% (3)
Right	66.67% (2)
Knees	**3.45% (3)**
Left	66.67% (2)
Right	100% (3)
Calves	**2.30% (2)**
Left	50% (1)
Right	50% (1)
Ankles	**1.15% (1)**
Left	100% (1)
Right	100% (1)
Feet	**6.90% (6)**
Left	83.33% (5)
Right	100% (6)
Toes	**0% (0)**
Left	N/A
Right	N/A

Students who reported experiencing playing-related pain were then asked a series of questions regarding their approach to resolving the pain they experienced: 1) Did they seek help from a medical professional? If so, were they given a diagnosis? If not, why? 2) Did they speak with their instructor about the pain they were experiencing? If so, did their instructor offer advice? If not, did they feel comfortable speaking with their instructor? There were 30 students (37.97%) who saw a physician or visited student health services on campus, while 49 students (62.03%) had not sought medical help (Table 4). Of the students who sought medical advice, 15 students (50%) had not received a diagnosis of why they may have experienced pain, while 2

students (6.67%) were only given a possible diagnosis. Students who received a diagnosis (n = 13, 43.33%) revealed they had conditions such as tendonitis, carpal tunnel, tension-related injuries, pulled ligaments, ulnar neuropathy, winged scapula, focal dystonia, and de Quervain's tenosynovitis. Most treatments students received for tendonitis and carpal tunnel included physical therapy, anti-inflammatory medication, corticosteroid injections, braces, or compression bandages. One student found chiropractic care helpful regarding tendonitis of the shoulder. The student with focal dystonia found that physical therapy and Botox injections helped, and another student found that a mild dosage of steroids helped with ulnar neuropathy. It should also be noted that while two students received treatment advice for their playing-related pain, their physicians also recommended that they quit playing the saxophone.

Students who chose not to seek medical help were asked to provide a reason. Thirty-four students (69.39%) stated the pain was not severe enough to seek professional help or felt it was a normal occurrence, "no pain, no gain." Six students (12.24%) stated they could not afford care or had the time to seek help. There were two students (4.08%) who believed medical professionals would not know what to do or tell them to stop playing. Seven students (14.29%) did not provide a reason why they did not seek medical help.

Students were asked if they discussed their playing-related pain with their professor. There were 44 students (55.70%) who stated yes, 34 students (43.04%) who said no, and 1 student (1.27%) who did not respond (Table 4). Of the students that spoke with their professor, there were 34 students (77.27%) who received sufficient advice on how to deal with their playing-related pain. Three students (6.82%) felt the advice they received was the bare minimum or lacking. There were 6 students (13.64%) who stated they did not receive any advice, and 1

student (2.27%) did not respond. Most students (n=24, 70.59%) received advice on stretching, practicing habits, equipment modifications, and technique/posture changes. Nearly half of the students (n=15, 44.12%) were told to seek help from a physician or student services, as well as eat healthier, exercise, and sleep more. Of the suggestions given to students, the advice that was not well-received was being told to relax, especially when the professor did not provide guidance on how to relax. Students who had not spoken with their professor were asked if they felt comfortable speaking with them about the topic. Only 1 student (2.94%) stated they were not comfortable speaking with their professor, and their reasoning was that the professor would say they were fine. Students who sought medical help were more likely to discuss their playing-related pain with their professors than students who did not seek medical help ($r_s = .429$, $p < .001$). In fact, only 5 of the 30 students (16.67%) who sought medical help did not seek advice from their professor, while 29 of the 48 students (60.42%) did not seek medical help or talk to their professor.

Table 4. Actions of Students Following Playing-Related Pain (n = 87*)*

	% of Participants (n)		% of Participants (n)
Sought Medical Help (n = 79)		**Sought Advice from Professor (n = 79)**	
Yes	37.97% (30)	Yes	55.70% (44)
No	62.03% (49)	No	43.04% (34)
Received Diagnoses (n = 30)		No Response	1.27% (1)
Yes	43.33% (13)	**Received Advice from Professor (n = 44)**	
No	50% (15)	Yes	77.27% (34)
Possible Diagnosis	6.67% (2)	Bare Minimum Advice	6.82% (3)
Did Not Seek Medical Help (n = 49)		No	13.64% (6)
Not severe, “normal,”	69.39% (34)	No Response	2.27% (1)
Financial/Time	12.24% (6)	**Comfortable Speaking with Professor (n = 34)**	
Dr. will not know or say quit	4.08% (2)	Yes	94.12% (32)
No Reason Given	14.29% (7)	No	2.94% (1)
		No Response	2.94% (1)

Orofacial Playing-Related Injuries

The orofacial structures employed to play the saxophone consist of the lips, muscles of the face, the oral cavity, teeth, and jaw. Students were asked to answer various questions regarding jaw pain, tooth movement, embouchure control, and air leaking through the soft palate/nose while playing. Of the 87 students who completed the survey, 43 students (49.43%) reported experiencing playing-related pain in their jaw (Table 5). Incidences of playing-related pain in the jaw correlated with age (r_s = -.264, p = .014). There were 32 students ages 18-22 (59.26%, p = .047) who reported playing-related pain in the jaw, which was higher than students 23-27 (n = 7, 29.17%) and 28-32 (n = 4, 44.44%). The incident rate of playing-related jaw pain was higher in students who lived on-campus (n = 19, 70.37%, p = .027) compared to students who lived off-campus (n = 20, 38.46%). Of those complaining of jaw pain, 27 students (60%, p = .041) were non-performance majors, which was higher than the 16 students (38.10%) who were performance majors. The majority of the students who reported jaw pain experienced it in both sides of their jaw (n = 32, 74.42%), which was higher than the 6 students (13.95%, p < .001) who reported left-side jaw pain and the 5 students (11.63%, p < .001) who reported having right-side jaw pain. There were only 10 students (11.49%) who slept with a night guard, and of those 10 students, 6 students (60%) experienced playing-related jaw pain, while 4 students (40%) did not.

There were 38 students (43.68%) who reported experiencing tooth movement while playing the saxophone or just after (Table 5). Students who reported jaw pain had higher incidences of tooth movement than those without jaw pain (p = .01). Of the 38 students that experienced tooth movement, only 8 students (21.05%) had a dental appliance (6 wore a

permanent bar retainer, 1 had braces, and 1 wore a denture appliance specifically to support their teeth when playing). Of the remaining 49 students (56.32%) who had not experienced tooth movement, 14 students (28.57%) wore a dental appliance (13 wore a permanent bar retainer and 1 had braces).

There were 46 students (52.87%) who had trouble maintaining their embouchure (loss of seal or lip pain) after practicing for a short period, while 40 students (45.98%) had not (Table 5). Age, level of education, living situation, and the presence of jaw pain appeared to influence whether or not a student reported difficulty maintaining their embouchure. Loss of embouchure correlated with the age of the student ($r2$ = -.307, p = .004) and the degree they were pursuing ($r2$ = -.232, p = .032). There was a higher incident rate of loss of embouchure in students ages 18-22 (n = 34, 64.15%, p = .036) than in students 23-27 years old (n = 8, 33.33%) and students 28-32 (n = 4, 44.44%). There were 40 undergraduates (60.61%, p = .011) who had trouble maintaining their embouchure, which was higher than students pursuing a master's degree (n = 1, 10%) and doctoral students (n = 5, 50%). Students who lived on-campus (n = 20, 76.92%, p = .003) had a higher incident rate of embouchure loss compared to students who lived off-campus (n = 20, 38.46%). Reported incidences of loss of embouchure correlated with incidences of jaw pain (r_s =-.258, p = .016)

Of the 46 students who had trouble maintaining their embouchure, 22 students (47.83%) wore lip protection over their bottom teeth, while the remaining 24 students (52.17%) did not. Incidences of loss of embouchure decreased with lip protection (r_s =-.224, p = .038). Of the students who reported loss of embouchure or lip pain, there were more students (n = 24, 52.17%) who did not wear lip protection compared to those without loss of embouchure who had more

students (n = 28, 70%) who wore lip protection (p = .049). The teeth coverings saxophonists used included medical/athletic tape, paper (plain, wax, or parchment), denture cushion, plastic/molded retainers, and teeth cushions branded specifically for reed players (Table 5).

Lastly, students were asked if they had ever experienced air leaking from their nasal passage while playing the saxophone, known as stress velopharyngeal insufficiency (SVPI). SPVI "is a particular form of velopharyngeal insufficiency/incompetence (VPI) in which there is an escape of air from the oral cavity to the nasal cavity while playing brass or woodwind instruments."[57] There were 27 students (31.03%) who reported experiencing air leaking from their nose while playing the saxophone, while 60 students (68.97%) had not (Table 5). A higher proportion of jazz students (n = 8, 66.67%) reported SVPI than classical/contemporary students (n = 19, 25.33%, p = .007). Of the 27 students that experienced SVPI, 20 students (74.07%) noticed the phenomenon when they drastically increased their practice time, while 7 students (25.93%) did not.

[57] Mausumi N. Syamal, "Injection Pharyngoplasty with Autologous Fat as Treatment for Stress Velopharyngeal Insufficiency in Brass and Woodwinds Musicians," in *JAMA Otolaryngology-Head & Neck Surgery* 143, no. 2 (February 2017): 142, http://doi.org/10.1001/jamaoto.2016.1920.

Table 5. Playing-Related Orofacial Injuries (n = 87)

		% of Participants (n)
Jaw Pain (n = 87)	**Pain Reported**	**No Pain Reported**
Pain Reported	49.43% (43)	50.58% (44)
Jaw Pain (n = 43)	**Reported Pain**	
Left Side Only	13.95% (6)	
Right Side Only	11.63% (5)	
Both Sides	74.42% (32)	
Nightguard (n = 87)	**Pain Reported**	**No Pain Reported**
Wears a Nightguard (n = 10)	60% (6)	40% (4)
No Nightguard (n = 77)	48.05% (37)	51.95% (40)
Teeth Shifting (n = 87)	**Tooth Movement Reported**	**No Tooth Movement**
Movement Reported	43.68% (38)	56.32% (49)
Dental Appliance (n = 87)	**Tooth Movement**	**No Tooth Movement**
Wears an Appliance (n = 22)	36.36% (8)	63.64% (14)
Does Not Wear an Appliance (n = 65)	46.15% (30)	53.85% (35)
Loss of Embouchure and/or Painful Lip (n = 87)	**Loss/Pain Reported**	**No Loss/Pain Reported**
Loss/Pain Reported	52.87% (46)	45.98% (40)
Teeth Cover (n = 87)	**Loss/Pain**	**No Loss/Pain**
Wears Covering (n = 51)	43.14% (22)	54.90% (28)
No Cover (n = 36)	66.67% (24)	33.33% (12)
Presence of Velopharyngeal Insufficiency (n = 87)	**Air Leaking Reported**	**No Air Leaking Reported**
Air Leaking Reported	31.03% (27)	68.97% (60)
More Noticeable with Drastic Increase in Practice (n = 27)	**Yes**	**No**
More noticeable	74.07% (20)	25.93% (7)

Non-Musculoskeletal Problems

In the non-musculoskeletal section of the survey, students answered questions regarding medical issues such as asthma, dizziness/blackouts, chest discomfort, stage fright, stress, hearing loss and tinnitus, skin allergies, hernias, and any medical problems not addressed in the survey. Of the 87 students, 14 (16.09%) were diagnosed with asthma. From those 14 students, 11 students (78.57%) were diagnosed with asthma prior to playing saxophone, while 3 students (21.43%) were diagnosed since playing saxophone (Table 6).

Students were asked if they had experienced dizziness or blackouts while playing. If yes, they then indicated what they experienced: dizziness, blackouts, or both. They were also asked to describe how often they experienced these symptoms while playing. There were 27 students

(31.03%) who reported having experienced one of these symptoms, or both. Twenty-four students (88.89%) had experienced dizziness while playing, while the remaining three students (11.11%) had experienced both dizziness and blackouts (Table 6). Three students stated that the dizziness seemed to only happen when another factor was present (dehydration, anemia, or concussion). For 10 of the students (37.07%), experiencing dizziness was rare, while 16 students (59.26%) experienced dizziness sometimes, and 1 student (3.70%) experienced dizziness every time they played saxophone. The 3 students who reported experiencing blackouts stated they were rare. The presence of dizziness and blackouts correlated with age (r_s -.370, $p < .001$), which was also true regarding the frequency at which dizziness occurred (r_s -.396, $p < .001$). Reports of dizziness/blackouts were lower among students who lived off-campus (n = 10, 19.23%) compared to students who lived on-campus (n = 13, 48.14%, $p = .01$) and students who lived off-campus with family (n = 4, 50%, $p = .077$).

Students reported incidences of chest discomfort while playing saxophone, with sex and height as possible contributing factors. Symptoms could include tightness, pain, and/or difficulty breathing. There were 12 students (13.79%) who experienced chest discomfort while playing saxophone (Table 6). Some descriptors students used for their chest discomfort included: their chest felt heavy, they had chest pains, they had a rapid heartbeat, their chest felt tight, or they felt short of breath. There were more female students (n = 9, 25.71%) who experienced chest discomfort while playing compared to male students (n = 3, 5.77%, $p = .012$). Chest discomfort negatively correlated with height, with students standing 5′1″-5′4″ having the highest incidence rate, and students 6′1″ and taller not reporting any chest discomfort ($r_s = -.271$, $p = .011$).

Reported incidences of chest discomfort correlated with incidences of dizziness/blackouts (r_s =.380, $p < .001$).

There were 74 students (83.06%) who reported experiencing stage fright before performing, while 13 students (14.94%) had not (Table 6). Students were then asked how often they experienced stage fright: rarely-14 students (18.92%); sometimes-29 students (39.19%); most of the time-20 students (27.03%); and every time-11 students (14.86%). The rate at which female students reported stage fright increased as the frequency of stage fright occurred (r_s = .319, p = .006), while the opposite happened in male students.

When asked about the level of stress students experienced as a music student, the 1-5 grading scale was unclear in what number represented little to no stress and what number represented constantly stressed. Because of this error, the data collected was not analyzed. Students, however, did state if they did any activities to help prevent or ease stress. There were 68 students (78.16%) who responded yes. Those students described what activities they did to relieve stress, including breathing exercises, stretching, exercise (yoga, running, swimming, etc.), outdoor activities, socialization (hanging with friends or church activities), video games, watching TV or reading, counseling, and taking prescribed medication. Some students also admitted to turning to drinking and substance abuse for stress relief.

There were 28 students (32.18%) who experienced hearing loss since they started playing saxophone (Table 6). Those who experienced hearing loss were asked to describe the severity of their hearing loss: mild- 22 students (78.57%); moderate- 4 students (14.29%); severe- 2 students (7.14%); and no students described their hearing loss as profound. There were more male

students (n = 21, 40.38%) who reported hearing loss compared to female students (n = 7, 20%, p = .046).

There were 25 students (28.74%) who experienced ringing in their ears or were diagnosed with tinnitus (Table 6). Non-performance majors (n = 18, 40%) were more likely to report tinnitus compared to performance majors (n = 7, 16.67%, p = .019). Of those 25 students, 10 students (40%) experienced ringing prior to starting the saxophone, while 15 students (60%) experienced ringing since starting the saxophone. The occurrence of tinnitus positively correlated with hearing loss (r_s = .215, p = .046), meaning students with hearing loss had a higher incident rate of tinnitus than those without hearing loss.

Only one student (1.15%) responded with an allergy to a specific part of the saxophone. This student was allergic to multiple metals, and their arms would break out into a rash, which they solved by playing in long sleeves. There were two students (2.30%) who played saxophone with a hernia (Table 6).

Table 6. Non-Musculoskeletal Problems (n = 87)

	% of Participants (n)
Asthma (n = 87)	
Asthma Reported	16.09% (14)
No Asthma Reported	83.91% (73)
Asthma Time of Diagnosis (n = 14)	
Prior to Saxophone	78.57% (11)
After Saxophone	21.43% (3)
Dizziness/Blackouts (n = 87)	
Dizziness/Blackouts	31.03% (27)
No Dizziness/Blackouts	68.97% (60)
Dizziness, Blackouts, Both (n = 27)	
Dizziness only	88.89% (24)
Blackouts only	0% (0)
Both	11.11% (3)
Frequency Dizz./Blackouts (n = 27)	
Dizziness-Rarely	37.04% (10)
Dizziness-Sometimes	59.26% (16)
Dizziness-Most of the time	0% (0)
Dizziness-Every time	3.70% (1)
Blackouts-Rarely	11.11% (3)

	% of Participants (n)
Chest Discomfort (n = 87)	
Chest Discomfort	13.79% (12)
No Chest Discomfort	86.21% (75)
Stage Fright (n = 87)	
Stage Fright Reported	85.06% (74)
No Stage Fright	14.94% (13)
Frequency of Stage Fright (n = 74)	
Rarely	18.92% (14)
Sometimes	39.19% (29)
Most of the time	27.03% (20)
Every time	14.86% (11)
Activities to Alleviate Stress (n = 87)	
Activities for Stress	78.16% (68)
No Activities for Stress	21.84% (19)
Allergy (n = 87)	
Allergy Reported	1.15% (1)
No Allergies Reported	98.85% (86)

	% of Participants (n)
Hearing loss since playing (n = 87)	
Hearing Loss Reported	32.18% (28)
No Hearing Loss	67.82% (59)
Severity of Hearing Loss (n = 28)	
Mild	78.57% (22)
Moderate	14.29% (4)
Severe	7.14% (2)
Ringing/Tinnitus (n = 87)	
Ringing/Tinnitus	28.74% (25)
No Ringing/Tinnitus	71.26% (62)
Time of Occurrence (n = 25)	
Prior to Saxophone	40% (10)
After Saxophone	60% (15)
Tinnitus and Hearing Loss (n = 87)	
Tinnitus (HL n = 28)	42.86% (12)
Tinnitus (No HL n = 59)	22.03% (13)
Hernia Present (n = 87)	
Hernia Reported	2.30% (2)
No Hernia Reported	97.70% (85)

Students were asked if there were any other medical issues not addressed by the survey that they wanted to mention. Students brought up new playing-related problems and expanded on some covered earlier in the survey (Table 7). Topics brought up by students included anxiety and mental health, headaches and earaches, canker sores, split lips/tongue, and focal dystonia. There were two students with focal dystonia who responded to the survey. The first student was mentioned earlier, as he had also experienced musculoskeletal pain in addition to focal dystonia and had received a medical diagnosis along with treatment. The second student reported his dystonia in the additional health problems portion of the survey. "Focal dystonia in musicians, also known as musician's dystonia or musician's cramp, is a task-specific movement disorder that presents itself as muscular incoordination or loss of voluntary motor control of extensively trained movements while a musician plays the instrument."[58] Focal dystonia can be seen as a repetitive stress injury, and some musicians have noticed that tension and stress trigger the phenomenon.

[58] Eckart Altenmüller and Hans-Chirstian Jabusch, "Focal Dystonia in Musicians: Phenomenolgoy, Pathophysiology, Triggering Factors, and Treatment," in *Medical Problems for the Performing Artist* 25, no. 1 (March 2010): 3, https://doi.org/10.21091/mppa.2010.1002.

Table 7. Student Responses for Additional Health Problems

Student 1: I mentioned earlier, I developed some type of anxiety/obsessive mental health disorder.	Student 2: With the high stress level of being a music student, I struggle with mental health issues, such as anxiety and depression. I am on several medications to help, and I attend counseling regularly.
Student 3: One major thing is the aching pain on my lower lip, from over-practicing without necessary rest.	Student 4: I've split my lip open several times while practicing.
Student 5: I have gotten multiple canker sores on my bottom lip from cane reeds. It seems to have improved since switching to Légère synthetic reeds.	Student 6: I have had issues with pain in my throat. I have also sliced/split my tongue on reeds before.
Student 7: I had an extensive issue with soft palate leakage, which led to my palate not sealing at all. This was during my undergraduate degree.	Student 8: I have had TMJ for ~1 month
Student 9: Headaches and earaches from a jaw problem. I slouch a little.	Student 10: Jaw soreness after playing for a short to moderate length of time. It makes it difficult to keep playing comfortably.
Student 11: As I just started experiencing real pain in my jaw after playing. Normally, I would just feel sore, which I thought was normal. About a month ago, I started to experience pain and symptoms of TMD after playing, so much so that I took a full week off from playing, trying to remedy my situation. The next time I played, I took it easy, but the pain/symptoms still returned. If I kind of push my jaw to the right, it fixes itself, but obviously that isn't a real fix.	
Student 12: After practicing a lot of altissimo, I need to give my ears a break from the high/loud pitches. I wear earplugs, but that only helps lengthen the time I can practice altissimo by so much.	
Student 13: I experienced focal dystonia in my right hand. It didn't apply to any of the previous questions, because there wasn't any pain. I went to practice one day and noticed my middle finger was not pressing down the key, and instead my pointer finger was doing the work of both fingers. Focal dystonia is usually categorized as a repetitive stress injury, so I retrained my body through super slow practice and body mapping techniques. This helped reduce tension and allowed my body, including my fingers, to do what came naturally.	
Student 14: This is not only about only playing the saxophone, but I march saxophone in marching band. Over the years, due to marching with a heavy instrument hanging off my neck, I believe I have experienced some back damage.	

Musical Background, Practice Routines, Ergonomic Adjustments, and Lifestyle

Musical Background

Students answered questions on the length of time they had been playing saxophone, whether they had taken lessons prior to entering college, which saxophones they played, if they played any secondary instruments, and if they participated in any ensembles. Of 87 students, 30 students (34.48%) had been playing the saxophone for 5-9 years, 43 students (49.43%) had been playing for 10-14 years, and 14 students (16.09%) had been playing for 15-22 years (Table 8). The average time students reported playing saxophone was 11 years, with the shortest time being

5 years and the longest time being 22 years. Prior to starting college, 66 students (75.86%) had taken lessons, while 20 students (22.99%) had not. The majority of students played 2 or more saxophones (n = 80, 91.95%), while only 7 students (8.05%) played 1 saxophone. The most common saxophone played was the alto saxophone (n = 84, 96.55%), followed by tenor (n = 64, 73.56%), baritone (n = 48, 55.17%), and soprano (n = 46, 52.87%). There were 11 students (12.64%) who reported playing bass (n = 7) or sopranino (n = 4).

In addition to playing the saxophone, 50 students (57.47%) reported playing a secondary instrument. Of those 50 students, 20 students (40%) played 1 secondary instrument, while 18 students (36%) played 2 secondary instruments, and 12 students (24%) played 3 or more instruments. When asked about participation in ensembles, 41 students (47.13%) played in 3-4 ensembles, 25 students (28.74%) played in 1-2 ensembles, and 19 students (21.84%) played in 7-9 ensembles. Of the students that played in an ensemble, only 23 students (26.43%) played in a marching band (Table 8).

Table 8. Playing Background of Saxophonists (n = 87)

	% of Participants (n)		% of Participants (n)		% of Participants (n)
Years Playing Saxophone		**Types of Saxophones Played**		**# of Ensembles Played In**	
5-9 years	34.48% (30)	Sopranino	4.60% (4)	0 Ensembles	2.30% (2)
10-14 years	49.43% (43)	Soprano	52.87% (46)	1-2 Ensembles	28.74% (25)
15-22 years	16.09% (14)	Alto	96.55% (84)	3-4 Ensembles	47.13% (41)
Lessons Prior to University		Tenor	73.56% (64)	5-7 Ensembles	21.84% (19)
Yes	75.86% (66)	Baritone	55.17% (48)	**Participation in Marching Band (n = 87)**	
No	22.99% (20)	Bass	8.05% (7)	Yes	26.44% (23)
No Response	1.15% (1)	**Secondary Instrument Played**		No	72.41% (63)
# of Saxophones Played		Yes	57.47% (50)	No Response	1.15% (1)
1 Saxophone	8.05% (7)	No	42.53% (37)		
2 Saxophones	27.59% (24)	**# of Secondary Instruments Played (n = 50)**			
3 Saxophones	33.33% (29)	1 Instrument	40% (20)		
4 Saxophones	26.44% (23)	2 Instruments	36% (18)		
5 Saxophones	4.60% (4)	3+ Instruments	24% (12)		

Looking at the playing backgrounds of the students, there were several correlations regarding reported playing-related pain or health problems. The data revealed that certain

saxophones played by the student could have influenced the type of medical problems reported. There was a positive correlation between students who played sopranino and the occurrence of tinnitus (r_2 = .215, p = .046). Three of the four students (75%) who played sopranino indicated they had tinnitus, all of which reported the ringing occurred after starting the saxophone. The alto saxophone was the most selected saxophone, but there were no positive correlations with playing-related pain or illnesses. However, there were negative correlations for playing-related pain in the left and right fingers, upper back (left and right), knees (left and right), feet (left and right), the upper extremity region, and the right jaw (Table 9).

Table 9. Alto Saxophone Correlations (n=84)

Area	**n**	**%**	r_s	p
Left Fingers	16	19.05	-.214	= .046
Right Fingers	14	16.67	-.235	= .028
Upper Back	31	36.90	-.236	= .028
L-Upper Back	28	33.33	-.254	= .018
R-Upper Back	26	30.95	-.267	= .012
Knees	2	2.38	-.310	= .004
L-Knee	1	1.19	-.391	< .001
R-Knee	2	2.38	-.310	= .004
Feet	4	4.76	-.446	< .001
L-Foot	3	3.57	-.495	< .001
R-Foot	4	4.76	-.446	< .001
Lower Extremity Region	8	9.52	-.327	= .002
Right Jaw	4	4.76	-.224	< .037

The lower three voices tended to have higher incident rates of playing-related health conditions, with the bass saxophone having a major impact on musculoskeletal health. There was a positive correlation between students who played tenor saxophone and reported incidences of playing-related pain in the thumbs (n = 38, 59.38%, r_s =.217, p = .043), as well as a correlation between those who reported tooth movement during or after playing (n = 33, 51.56%, r_s =.265, p = .013). Like those who played tenor saxophone, students who played baritone saxophone also showed a positive correlation in reporting playing-related pain in their thumbs (n = 30, 62.50%, r_s =.214, p = .047). There were seven students who played bass saxophone, all of whom reported

playing-related pain. All seven students reported pain in their thumbs (r_s =.279, p = .009), and six of the seven reported pain specifically in their right thumb (r_s =.229, p = .033). There were positive correlations for playing-related pain in the shoulders (right), upper back (left and right), middle back, and lower back (right). See Table 10.

Table 10. Bass Saxophone Correlations (n=7)

Area	**n**	**%**	***r*$_s$**	***p***
Shoulders	5	71.43	.213	= .048
R-Shoulder	5	71.43	.248	= .02
Upper Back	6	87.71	.283	= .008
L-Upper Back	5	71.43	.221	= .04
R-Upper Back	5	71.43	.239	= .026
Middle Back	5	71.43	.268	= .012
Lower Back	5	71.43	.258	= .016
R-Lower Back	5	71.43	.279	= .009

The number of saxophones a student played seemed to have little significance in whether playing-related pain or illness was reported. The thumbs were the only area of the body that had a significant positive correlation with the number of saxophones students played (r_s = .263, p =.014). There were four individuals who played five saxophones, and all four reported incidences of playing-related pain in one area or more. They all reported pain in the neck and upper back, and were the only group to do so. All four students also indicated they noticed their teeth shifting during or directly after playing saxophone. All the students who only played one saxophone also experienced playing-related pain, which leads to the possibility that playing-related pain may not be due to the number of saxophones one plays.

There were no significant correlations between the number of secondary instruments students played and the incidences of playing-related injuries or illnesses. The data did reveal that all 20 students who played a single secondary instrument experienced playing-related pain, which was a higher incident rate than those who did not play a secondary instrument (p = .290).

However, it also revealed a higher incidence rate than those who played three or more instruments (p = .059) and those who played two secondary instruments (p = .026).

The data regarding the number of ensembles students played and reported incidences of playing-related pain and health issues was minimal. Incidences of playing-related pain in the right hand increased as the number of ensembles one participated in increased (r_s = .290, p = .007). The incident rate of playing-related pain in the left thumb was higher among students who played in 5-7 ensembles (n = 6, 31.57%, p = .045) and 3-4 ensembles (n = 12, 29.27%, p = .04) compared to students who played in 1-2 ensembles (n = 2, 8%). However, students who played in 1-2 ensembles (n = 8, 32%) had more incidences of playing-related pain in their left forearm than students who played in 5-7 ensembles (n = 1, 5.26%, p = .029). Incidences of playing-related pain in the left thumb and the left fingers correlated with participation in marching band (r_s = .290, p = .007; r_s = .270, p = .012). There was a positive correlation between playing-related pain in the right hip and participation in marching band (n=2, 100%, r_s = .255, p = .018).

Practice Routines

To gain a better understanding of the factors that influence the prevalence of playing-related health concerns and injuries, students were asked to report the number of hours per day they practice saxophone, the number of hours per week they practice their secondary instrument and/or participate in ensembles, and the structure of their individual practice sessions. Most students reported practicing saxophone 1-2 hours a day (n = 38, 43.68%), closely followed by students who practiced 3-4 hours a day (n = 34, 39.08%). The remaining 15 students

(17.24%) practiced 5-7 hours a day (Table 11). The average number of hours per day practiced was 3.1, with the minimum hours practiced being 1 hour and the maximum being 7 hours. There were more on-campus students (n = 17, 62.96%) who practiced 1-2 hours a day than off-campus students (n = 16, 30.77%), and more off-campus students (n = 27, 51.92%) than on-campus students (n = 5, 18.52%) who practiced 3-4 hours a day (p = .032). The hours practiced a day correlated with the degree students were pursuing at the time (r_s = .227, p = .034), as well as their age (r_s = .259, p = .015). There was also a correlation between the number of hours practiced and the major a student pursued, with non-performance majors tending to practice fewer hours a day than performance majors (r_s = .246, p = .022).

The number of hours students practiced a day did not seem to have a significant impact on health problems reported. The data showed a correlation in the number of hours practiced and reported incidences of playing-related pain in the elbows (r_s = .281, p = .008), specifically the left elbow (r_s = .284, p = .008). Unexpectedly, reported incidences of loss of embouchure decreased as students reported more hours of practice (r_s = -.317, p = .003). Students who practiced 1-2 hours a day (n = 27, 71.05%, p = .007) reported a higher rate of embouchure loss and lip pain than those who practiced 5-7 hours a day (n = 4, 26.67%) and those who played 3-4 hours a day (n = 15, 45.45%).

First-year undergraduates were asked if their practice time had increased considerably compared to when they were in high school. There were 13 students (72.22%) of the 18 first-years who responded “yes” (Table 11). There was a correlation between the first-years who stated that the hours they practiced increased significantly from high school and those who

reported playing-related pain in the neck (r_s = .523, p = .026), especially the left side (r_s = .614, p = .007).

Of the 50 students that played a secondary instrument, 25 students (50%) reported practicing between 1 and 5 hours a week, while the second largest group of students (n = 14, 28%) played 11-20 hours on their secondary instrument (Table 11). The average number of hours students practiced a secondary instrument was 6.8 hours, with the minimum being 0 and the maximum being 30 hours. For all saxophones and secondary instruments they played, students were asked to provide a total number of hours they practiced each week in the ensembles they participated in. Of the 85 students that participated in an ensemble, nearly half of the students (n = 41, 48.24%) played 1 to 10 hours a week, followed closely by students (n = 36, 42.35%) who practiced 11–20 hours a week (Table 11). The average number of hours played in their ensembles a week was 11.8 hours, with the minimum being 0 and the maximum being 54 hours. Because there were multiple ranges for hours practiced regarding ensembles and secondary instruments, some groups had statistical differences but had too few data points to determine if those differences were significant.

In the survey, students described their individual saxophone practice routine. Almost all students (n = 79, 90.80%) stated they warmed up with musical exercises, such as long tones, scales, and other technique exercises (Table 11). Reports of playing-related pain in the right elbow decreased among students who employed a musical warm-up (r_s = -.222, p = .04), whereas reports of playing-related pain in the left upper back increased (r_s = .223, p = .039). All 31 students reported having playing-related pain in their upper left back.

Just over half of the students (n = 50, 57.47%) practiced in multiple smaller sessions versus a single large session, with several students stating that practice sessions varied day to day based on their school schedule. Of the 87 students, 78 students (89.66%) stated they took small breaks during their practice sessions (Table 11). Students who responded "other" took breaks based on how much time they had to practice or how they were feeling mentally. While there were several statistical differences, some groups did not have enough data points to determine if the results were significant.

Most students had what could be considered good practice habits, which included gradually speeding up technical passages; practicing without the saxophone (listening to music or score study); and keeping a regular practice schedule throughout the semester, only increasing in frequency and length of sessions slightly as deadlines approached (Table 11). Students who practiced slowly and then gradually sped up reported a lower incident rate of chest discomfort (n = 8, 10.26%, $p = .019$) and dizziness/blackouts (n = 21, 36.84%, $p = .023$) compared to students who played faster than what they could play. A similar result was seen in students who experienced loss of embouchure or painful lip. Students who gradually sped up (n = 38, 49.35%) reported a lower incident rate than those who played faster than capable (n = 8, 88.89%, $p = .023$). Considering these results, it is possible that students who practice music too fast may create tension, leading to chest discomfort, dizziness, and loss of embouchure or lip pain.

When asked if they practiced when their muscles or embouchure were fatigued, nearly all students responded with "yes" or "maybe" (n = 78, 89.66%). Practicing when fatigued correlated with incidences of playing-related pain in the forearms ($r_s = .326$, $p = .002$) and shoulders ($r_s = .308$, $p = .004$), as well as embouchure loss ($r_s = .215$, $p = .047$). Approximately half of the

students (n = 47, 54.02%) responded “yes” or “maybe”to practicing through pain, to the point where it affected their practice the next day. In both the upper and lower back, playing-related pain incidences positively correlated with students who played through the pain (r_s = .311, p = .003; r_s = .267, p = .012). Only 33 students (37.93%) stated they stretched before, during, or after their practice sessions (Table 11).

Table 11. Practicing Habits of Participants (n = 87)

	% of Participants (n)		% of Participants (n)		% of Participants (n)
Saxophone Practice Hours/Day		**Secondary Hours/Week (n = 50)**		**Breaks during Practice**	
1-2 hours	43.68% (38)	0 hours	6% (3)	Breaks	89.66% (78)
3-4 hours	39.08% (34)	1-5 hours	50% (25)	Straight through	6.90% (6)
5-7 hours	17.24% (15)	6-10 hours	28% (14)	Other	2.30% (2)
First-Year’s Practice Increased Significantly in College (n = 18)		11-20 hours	10% (5)	No Response	1.15% (1)
		21+ hours	6% (3)	**Slow Practice with Gradual Speed Up**	
Yes	72.22% (13)	**Music Warm-Up**		Slowly, gradual speed up	89.66% (78)
No	27.78% (5)	Yes	90.80% (79)	Faster than capable	10.34% (9)
Ensemble Hours/Week (n=85)		No	8.05% (7)	**Practice Regularly throughout Semester**	
1-10 hours	48.24% (41)	No Response	1.15% (1)	Practice Regularly	72.41% (63)
11-20 hours	42.35% (36)	**Type of Practice Sessions**		Little practice, drastic increase	27.59% (24)
21-30 hours	8.24% (7)	Multiple Sessions	57.47% (50)	**Practice without Saxophone**	
40+ hours	1.18% (1)	1 Large Session	31.03% (27)	Yes	87.36% (76)
		Other	11.49% (10)	No	12.64% (11)
Playing with Fatigued Muscles or Embouchure		**Playing through Pain, Affecting Practice the Next Day**		**Stretching Habits**	
Yes	37.93% (33)	Yes	24.14% (21)	Stretch	37.93% (33)
Maybe	51.72% (45)	Maybe	29.89% (26)	Does Not Stretch	62.07% (54)
No	10.34% (9)	No	45.98% (40)	-Before (n = 33)	57.58% (19)
				-During (n = 33)	63.64% (21)
				-After (n = 33)	63.64% (21)

Ergonomic Adjustments

To help with musculoskeletal injuries or ease the playing of the saxophone, many saxophonists have changed their equipment or made modifications to their saxophone to create a more ergonomic setup. Students were asked what type of neck strap or harness they used, if they used any assistive devices to play, and if they had made any modifications to the saxophone (different thumb rests, key risers, etc.).

The saxophone's weight is supported by a neck strap or harness. The design is crucial because it can affect the saxophonist's practice quality, duration, and performance. Traditional

saxophone neck straps are 1-2 inches wide and place the instrument's weight on 1-2 vertebrae. Some saxophonists may find the strap to be comfortable, while others may experience neck discomfort. A harness rests on both shoulders and allows for the distribution of weight. Constantly, new saxophone straps are developed in an effort to make the instrument's weight more comfortable to carry. Of 87 students, 69 students (79.31%) wore 1 type of strap regardless of the saxophone being played, while 17 students (19.54%) used more than 1 type of strap depending on which saxophone they were playing (Table 13). The majority of the students used a standard neck strap (padded and non-padded) which had no adjustments to ease neck pressure.

There were 50 students (58.14%) who played saxophone using a standard neck strap, with 38 (76%) only using the standard strap. Sixteen students (18.60%) used the Breathtaking Premium Saxophone Strap, with thirteen (81.25%) wearing this strap only. Sixteen students (18.60%) wore a harness; however, only four (25%) used just the harness. Fifteen students (17.44%) used the Jazzlab Saxholder, and eight students (53.33%) wore only the holder. There were 7 students (8.14%) who used a neck strap adapted to relieve pressure on the neck, 5 (71.43%) of whom used only an adapted neck strap. One (1.16%) student played with only a single shoulder strap (Table 13).

When looking at who wore a standard neck strap, another strap, or a combination of both, there was a significant relationship between performance majors and non-performance majors and the straps they used. There were more non-performance majors that reported using only a standard neck strap (n = 26, 57.78%), and there were more performance majors that reported utilizing another strap (n = 25, 59.52%, $p = .008$). The use of a standard neck strap negatively correlated with the degree a student was pursuing ($r_s = -.262$, $p = .015$) and their age ($r_s = -.330$,

p = .002). None of the analyses reported statistically significant results in relation to playing-related pain and the use of a standard neck strap. Playing-related pain incidences positively correlated with the use of a harness in multiple areas of the body (Table 12).

Table 12. Positive Correlations of Playing-Related Problems and the Harness (n=16)

Area	**n**	**%**	r_s	p	**Area**	**n**	**%**	r_s	p
Thumbs	13	81.25	.266	= .013	L-Neck	13	81.25	.214	= .048
L-Thumb	7	43.75	.215	= .047	Upper Back	10	62.5	.225	= .038
R-Finger	6	37.5	.232	= .032	L-Upper Back	10	62.5	.263	= .014
Hands	9	56.25	.302	= .005	R-Upper Back	9	56.25	.228	= .035
L-Hand	7	43.75	.250	= .021	Middle Back	8	50	.220	= .042
R-Hand	9	56.25	.373	< .001	Lower Back	9	56.25	.256	= .017
Wrists	12	75	.217	= .045	L-Lower Back	8	50	.235	= .029
R-Wrist	11	68.75	.312	= .003	R-Lower Back	9	56.25	.286	=.008
Shoulders	11	68.75	.312	= .003	Knees	2	12.5	.235	= .03
L-Shoulder	11	68.75	.369	< .001	R-Knee	2	12.5	.235	= .03
R-Shoulder	9	56.25	.242	= .025	Spinal Region	15	93.75	.221	= .041
Neck	14	87.5	.215	= .047					

It is unclear if the harness is the possible cause of playing-related pain in the areas above or if the students switched to the harness to relieve pain. Incidences of pain in the lower extremity region (n = 4, 40%) and right fingers (n = 4, 40%) correlated with the use of the JazzLab (r_2 = -.216, p = .046; r_2 = .331, p = .002). Students with an adaptive neck strap did not report any pain in the upper back (r_2 = -.245, p = .024) or its left and right sides (r_2 = -.227, p = .037; r_2 = -.216, p = .048), making it the only strap to have no pain reported in these areas. The use of the Breathtaking Saxophone Strap was associated with fewer incidences of playing-related pain in the thumbs (n = 4, 25%) and left fingers (n = 0, 0%) (r2 = -.273, p =.011; r2 = -.237, p =.028). Like the adapted strap, which had zero incidences of upper back pain, the Breathtaking Saxophone Strap was the only strap to have zero reports of pain in the left fingers.

Specific devices have been created to remove the weight of the saxophone from the performer, such as stands to remove the weight from the shoulders and neck of the performer or extensions to remove the weight from the thumb when playing soprano saxophone. When asked

if students used an assistive device (saxophone stand/peg, Pittel-Hand Eze, etc.) while playing the saxophone, 8 (9.20%) of the 87 students responded yes. Only in 4 (4.60%) of those responses did students use what was considered an assistive device for the saxophone (Table 13). Three students used a saxophone stand while playing, while one student used the Pittel-Hand Eze. The responses that did not qualify as assistive devices consisted of two saxophone modifications, a protective covering for the bottom lip, and a saxophone stand used by the student when they were not playing.

For some, the saxophone directly from the manufacturer does not always fit the saxophonist; therefore, modifications may be necessary to make it the most ergonomic for each player. Modifications of the saxophone can include changing the thumb rests, adding key risers, changing the height, position, or tension of keys, and extreme modifications, including the saxophone being played one-handed. Students were asked if they had any modifications done to their saxophones, and if so, they were asked to describe the adaptations they implemented. There were 34 students (39.08%) who modified their saxophones, while 52 students (59.77%) made no changes (Table 13). The most common modification students made to the saxophone was the addition of key risers to either the palm keys, the right-side keys, or both. In total, there were 27 students (79.42%) who added key risers. Of those 27 students, 16 students (59.26%) added key risers to their palm keys, 5 students (18.52%) added key risers to both their right-side keys and palm keys, and 1 student (3.70%) added risers to only their right-side keys (Table 13).

The second most common modification reported was an adjustment of the right thumb rest. There were nine students (26.47%) total that modified the thumb rest. Of those nine students, three students (33.33%) completely removed the thumb rest, three students (33.33%)

replaced the thumb rest with a different model, two students (22.22%) adjusted the position of their thumb rest, and one student (11.11%) added a cushion to their thumb rest. There was a significant correlation between the rate of playing-related incidents reported in the right wrist and students who had their thumb rests modified. Students who modified the thumb rest reported higher incidences of playing-related pain in the right wrist compared to students who did not modify their saxophone and students who performed other modifications (p = .024). Other modifications to the saxophone included changing the tension of the keys (n = 2, 5.88%) and changing the positioning of the keys (n = 1, 2.94%).[59]

Table 13. Equipment and Saxophone Modifications (n = 87)

	% of Participants (n)			% of Participants (n)			% of Participants (n)
# of Saxophone Straps (n = 87)			**Type of Straps Implemented (n = 86)**			**Saxophone Modifications(n = 87)**	
One Strap Only	79.31% (69)		**Standard Neck Strap**	**58.14% (50)**		Yes	39.08% (34)
Multiple Straps	19.54% (17)		Only Standard Neck Strap	76% (38)		No	59.77% (52)
No Response	1.15% (1)		In combo w/others	24% (12)		No Response	1.15% (1)
Saxophone Strap (n = 86)			**Breathtaking Saxophone Strap**	**18.60% (16)**		**Types of Modifications (n = 34)**	
Standard Strap	58.14% (50)		Only Breathtaking Strap	81.25% (13)		**Key Risers**	**79.42% (27)**
Breathtaking	18.60% (16)		In combo w/others	18.75% (3)		Both Key Risers	18.52% (5)
Harness	18.60% (16)		**Harness**	**18.60% (16)**		Palm Keys	59.26% (16)
JazzLab	17.44% (15)		Only Harness	25% (4)		Right-Side Keys	3.70% (1)
Adapted Strap	8.14% (7)		In combo w/others	75% (12)		Unknown Keys	18.52% (5)
Shoulder Strap	1.16% (1)		**JazzLab Saxholder**	**17.44% (15)**		**Thumb Rests**	**26.47% (9)**
Assistive Device (n = 87)			Only JazzLab Saxholder	53.33% (8)		Removal	33.33% (3)
Yes	4.60% (4)		In combo w/others	46.67% (7)		Replaced with New	33.33% (3)
No	94.25% (82)		**Adapted Neck Strap**	**8.14% (7)**		Adjusted Thumb Rest	22.22% (2)
No Response	1.15% (1)		Only Modified Neck Strap	71.43% (5)		Modified Rest	11.11% (1)
			In combo w/others	28.57% (2)		**Tension Adjustment**	**5.88% (2)**
			Shoulder Strap	**1.16% (1)**		**Positioning of Keys**	**2.94% (1)**
			Only Shoulder Strap	100% (1)		**Unknown Modification**	**5.88% (2)**

Lifestyle

Students answered a series of questions about their lifestyle while in school and their overall health. There were 26 students (30.23%) who were not working at the time of the survey, while 59 students (68.60%) either worked part-time, full-time, had an assistantship, or had a work-study (Table 14). Of those 59 students that worked, there were 36 students (61.02%) that

[59] This student glued dimes to their ring finger keys to extend them.

worked part-time, 4 students (6.78%) with full-time jobs, 10 students (16.94%) completing work study, 3 students (5.08%) with assistantships, and 6 students (6.98%) that worked more than one job.[60] The incident rate of playing-related pain in the left forearm was lower in students who worked (n = 10, 16.98%) compared to those who did not (n = 10, 38.46%, $p = .031$). When asked how many hours of homework per week they had, just over two-thirds of the students reported having 10 hours or fewer: 33 students (37.93%) reported 0-5 hours of homework, while 30 students (34.48%) reported 6-10 hours. Incidences of playing-related pain in the left upper back ($r_2 = .258$, $p = .016$) and right upper back ($r_2 = .286$, $p = .007$) increased with the number of hours of homework students reported. Playing-related pain in the right elbow was higher in students with 11-15 hours of homework a week (n = 5, 31.25%, $p = .002$), compared to students with 0-5 hours of homework (n = 1, 3.03%) and 6-10 hours of homework (n = 1, 3.33%). There were 83 students (95.40%) who reported using a cell phone for texting, games, and surfing the web. Eighty-two students (94.25%) used a laptop, thirty-five students (40.23%) played video games, and twenty students (22.99%) used a tablet (Table 14).

The majority of students (n = 66, 75.86%) exercised at least once a week for at least 30 minutes, while only 21 (24.14%) did not exercise. Playing-related pain in the fingers was the only area where significant statistical results were present. The incident rate of playing-related pain in the left fingers was lower among students who exercised at least once a week for 30 minutes (n = 10, 15.15%) compared to those who did not exercise (n = 8, 38.10%, $p = .033$). The National Institute of Health divides exercise into four basic categories: endurance, strength,

[60] One student was not included because they selected contradictory choices of “full time” and “I currently do not work” along with answering they worked 7 hours a week.

balance, and flexibility.[61] Endurance exercises raise both your breathing and heart rate. Examples include running, swimming, dancing, and bicycling. Any exercise that uses resistance and contracts the muscles of the body is classified as strength training. This includes lifting weights, resistance bands, and using your own body weight (push-ups, squats, etc.). Yoga, Pilates, and Tai Chi are exercises that fall within the categories of balance and flexibility.

The most common form of exercise students executed was combined endurance and strength training (n = 28, 42.42%), closely followed by students who only performed endurance-type exercises (n = 26, 39.39%). There were nine students (13.64%) who performed endurance exercises in combination with balance/flexibility exercises, while the remaining three students (4.55%) focused on strength exercises (Table 14). Students who combined endurance and balance/flexibility exercises (n = 8, 88.89%) had a higher incident rate of playing-related pain in the upper back than those students who used endurance and strength exercises (n = 9, 32.14%, p = 003.), specifically on the left side (endurance/balance: n = 7, 77.78; endurance/strength: n= 7. 25%, p = .005). In contrast, students who used endurance and strength exercises reported a higher incident rate of playing-related pain in the forearms (endurance/strength: n = 10, 35.71%; endurance/balance: n = 0, 0%, p = .036); which was the same for the left and right forearms. Students who only used endurance exercises reported playing-related pain in the left fingers (n = 1, 3.85%) less than those who did not exercise (n = 8, 38.10%, p = .003) and those who performed endurance and balance exercises (n = 3, 33.33%, p = .017). Students who only used endurance exercises reported fewer incidences of playing-related

[61] "Four Types of Exercise Can Improve Your Health and Physical Ability," Health Information, National Institute on Aging, accessed March 27, 2022, https://www.nia.nih.gov/health/four-types-exercise-can-improve-your-health-and-physical-ability.

pain in the left hand (n = 1, 3.85%) than those who did not exercise (n = 7, 33.33%, p = .007) and those who performed endurance and balance exercises (n = 3, 33.33%, p = .017). Students who used endurance and strength exercises (n = 20, 71.43%) reported a higher rate of playing-related pain in the jaw than students who only performed endurance exercises (n = 8, 30.77%, p = .006) and those who did not exercise (n = 8, 38.10% p = .04). Only three students (3.45%) participated in an intramural or collegiate sport (Table 14).

Students were asked how many hours of sleep they got a night. The least amount of time recorded was three hours, while the most recorded was over ten hours. Most students (n = 35, 40.23%) reported seven hours of sleep per night, followed by six hours of sleep (n = 32, 36.78%). Incidences of playing-related pain in the jaw increased as the number of hours students reported increased (r_s = .232, p = .031). The eight students who did not report musculoskeletal playing-related pain reported an average of six to eight hours of sleep.

Of the 87 students, 47 (54.02%) considered their sleep restful, while the remaining 40 students (45.98%) described their sleep as turbulent, delayed, or restless (Table 14). Several students commented that their sleep would vary depending on how stressed they were. Students who reported playing-related pain in their feet (n = 6, 100%, p = .008), including the left foot (n = 5, 100%, p = .018) and right foot (n = 6, 100%, p = .008), all reported their sleep was "other" than restful. Of the 10 students who reported playing-related pain in the lower extremity region, there were 8 who reported less than restful sleep (n = 8, 80%, p = .039).

When ranking their health, 35 students (40.23%) believed their health was "good," while 29 students (33.33%) ranked their health as "very good," and 17 students (19.54%) felt their health was "fair." There were 6 students (6.90%) who ranked their health as "excellent," and

there were no students who ranked their health as “poor” (Table 14). Lastly, students were asked if they took part in any activities that helped them maintain a healthy saxophone career. There were 23 responses that included eating healthy, observing their own practice techniques, doing nonmusical activities, and hanging out with friends (Responses in Table 15).

Table 14. Lifestyle and Health of Participants (n = 87)

	% of Participants (n)		% of Participants (n)		% of Participants (n)
Working Status (n = 86)		**Exercises (n = 87)**		**Sleep Hours/Night**	
Does Not Work	30.23% (26)	Yes	75.86% (66)	3 hours	1.15% (1)
Part-Time	41.86% (36)	No	24.14% (21)	4 hours	2.30% (2)
Work Study	11.63% (10)	**Exercise Times/Wk for 30 min (n = 66)**		5 hours	11.49% (10)
2 Jobs or More	6.98% (6)	1-2 Times	56.06% (37)	6 hours	36.78% (32)
Full-Time	4.65% (4)	3-7 Times	43.94% (29)	7 hours	40.23% (35)
Assistantship	3.49% (3)	**Types of Exercise (n = 66)**		8 hours	6.90% (6)
No Response	1.16% (1)	Endurance/Strength	42.42% (28)	9 hours	0% (0)
Homework Hours/Week		Endurance	39.39% (26)	10+ hours	1.15% (1)
0-5 Hours	37.93% (33)	Endurance & Bal./Flex.	13.64% (9)	**Restful Sleep? (n = 87)**	
6-10 Hours	34.48% (30)	Strength	4.55% (3)	Restful	54.02% (47)
11-15 Hours	18.39% (16)	**Sport Participation-Intramural/College**		Other	45.98% (40)
16+ Hours	9.20% (8)	Yes	3.45% (3)	**Overall Health (n = 87)**	
Electronic Use		No	96.55% (84)	Excellent	6.90% (6)
Cell Phone	95.40% (83)			Very Good	33.33% (29)
Computer	94.25% (82)			Good	40.23% (35)
Video Game	40.23% (35)			Fair	19.54% (17)
Tablet	22.99% (20)				

Table 15. Activities for a Healthy Saxophone Career (n = 23)

<table>
<tr><td rowspan="2">Eating healthy! I try to stay away from junk food, and I feel like I have a better practice session when I eat healthy, because I am more focused and less stressed.</td><td>Drinking up to 2L of water daily</td><td>I drink a gallon of water a day.</td><td>I try to eat healthy.</td><td>Staying hydrated, eating healthy.</td><td rowspan="2">I have been a vegetarian for 10 years. While that doesn't mean anything for a saxophone standpoint, I feel it has helped me maintain decent health through diet.</td></tr>
<tr><td>Massages seem to help, though I don't get them often enough.</td><td colspan="3">Swimming and lifting weights have helped me develop upper body strength, which helps take pressure off my hands and forearms. I feel this has helped with my tendinitis and back problems.</td><td>I have been doing hand specific exercises in physical therapy and following a return to play schedule.</td></tr>
<tr><td>Slow practice, long tones, wearing ear plugs.</td><td>Practicing good posture, Alexander Technique study</td><td colspan="3">Practicing in front of a mirror, always checking for jaw movements that can cause TMJ. Taking videos of yourself while you practice, checking for extra finger/wrist motion.</td><td>The Art of Practicing by Madeline Bruser</td><td>Mindfulness exercises and vocal training.</td></tr>
<tr><td>Taking a break from practicing occasionally.</td><td>Listening to the saxophone & classical genre (in general) repertoire.</td><td>Jazz jams, free jazz attempts, jamming in general</td><td>I read a lot of books to wind down for the night. I feel that it helps me focus and perform better.</td><td>Dealing with studio competition by crying myself to sleep, lol.</td><td>Volunteering for community service for two hours every two weeks was beneficial in relieving me of stress.</td></tr>
<tr><td>Having friends to talk to and commiserate with.</td><td colspan="4">Keeping in touch with friends and going out for coffee for breaks has been a huge help in my career. Listening to music during my breaks from practicing has also been a huge help.</td><td>Talking to others to share ideas has greatly helped me.</td></tr>
</table>

Chapter 5: Discussion and Limitations

In comparison to the three studies conducted by Thrasher and Chesky, Bihan, and Shanoff, the current study reported higher incidences of playing-related musculoskeletal pain, with an incident rate of 90.80%, whereas Bihan reported 56.12%[62] and Shanoff reported 76.15%.[63] The study by Thrasher and Chesky did not display the injury rate of musculoskeletal injuries as a whole; however, the incident rates of various anatomical regions were reported. Similar to the aforementioned three studies, the current study discovered higher incidences of pain or discomfort in the neck, and similar to the Thrasher and Shanoff studies, the incidence rate was also higher in the right wrist. The small difference between the rates of musculoskeletal pain reported by classical and jazz saxophonists in this study (92% and 83.33%, respectively) was supported by similar findings in studies by Thrasher and Chesky and Bihan.

Case Study: Playing-Related Pain in the Right Thumb

One aspect of the data collected that seemed unusual and calls for further discussion was the results collected for playing-related pain reported in the thumbs. As stated earlier, 46 students complained of pain in their thumbs; 21 reported pain in their left thumb and 41 reported pain in their right thumb. Except for the thumbs, every musculoskeletal body area was reported nearly equal left to right, whereas the right thumb was nearly double that of the left.

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[62] Bihan, 17.
[63] Shanoff, 217.

Generally, when playing the saxophone, the right thumb should have minimal weight from the instrument on it, unless one is playing the soprano and/or sopranino saxophone or is participating in a marching band. There were only 2 students that played the sopranino and 22 students that played the soprano that reported playing-related pain in their right thumb, which represented less than half of the students that played those saxophones. As for students who participated in the marching band, only 14 of the 23 students reported playing-related pain in their right thumb. Neither of these factors were statistically significant, which still leaves the question of why the incidence rate of pain in the right thumb is double that of the left thumb.

One possible reason for this occurrence is the position or angle of the thumb rest, which causes the thumb to sit out of alignment with the fingers, creating undue tension and leading to pain over time. In fact, there were eight students who either adjusted the position of the thumb rest, switched out the thumb rest, or removed the thumb rest. There have been several thumb rest designs created to relieve tension and support the right thumb. MusicMedic Comfort Thumb Hook (Figure 1) and the Ishimori Wood Stone Thumb Hook Type II (Figure 2) are two thumb rests with a similar design. The MusicMedic hook was designed to provide comfort to players by allowing them to achieve the exact angle for their hand shape and playing position, as well as provide extra support for the thumb via the side extension.[64] The Ishimori hook is similar, consisting of a round-chamber finger hook that offers various angles for the hand to rest; however, volume control and tone variation are the primary purposes of the thumb rest.[65] Both

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[64] "MusicMedic Comfort Thumb Hook," Saxophone Accessories, MusicMedic, 2000-2021, https://www.musicmedic.com/catalog/product/view/id/339/s/musicmedic-comfort-thumb-hook/category/28/.

[65] "Wood Stone Thumb Hook Type II," Thumb Hook, Ishimori Wind Instruments Special Co. LTD., 2020, https://www.wood-stone.jp/product/64.

hooks prevent the saxophonist from wrapping their thumb around the saxophone, thus reducing tension that can arise in players with larger hands.

Figure 1. MusicMedic Comfort Thumb Hook[66]
Used with Permission.

Figure 2. Ishimori Wood Stone Thumb Hook Type Two[67]
Used with Permission.

The Kooiman Forza Thumb Rest (Figure 3), another alternative to the traditional thumb rest, was designed in response to saxophonists who had developed playing-related pain in the thumb, fingers, wrist, and hand. The traditional thumb rest design, for some, forces the thumb under a hook, which turns the joint that connects the thumb and hand downward, limiting movement of the fingers and sometimes adding unnecessary pressure on the thumb. The Forza allows the performer to place their thumb in a more natural position by allowing it to point slightly downward, while still providing enough room for the thumb to move in the most optimal position and giving the thumb a resting location.[68]

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[66] "MusicMedic Comfort Thumb Hook," Saxophone Accessories, MusicMedic, 2000-2021, https://www.musicmedic.com/media/catalog/product/cache/eaa1e91660665b874dd4d0098aac4310/t/h/thumbhooks4_2.jpg.

[67] "Wood Stone Thumb Hook Type II," Thumb Hook, Ishimori Wind Instruments Special Co. LTD., 2020, https://www.wood-stone.jp/data/wood-stone/product/5ee9666f6c.jpg.

[68] "The Kooiman FORZA Thumb Rest." Publications, Ton Kooiman, 2002-2015, https://www.tonkooiman.com/index.php/publications/12-the-kooiman-forza-thumb-rest.

Figure 3. Kooiman Forza Sax Thumb Rest[69]
Used with Permission.

As mentioned above in the results from the survey, there was a relationship between students that modified their thumb rest and the reported incidences of playing-related pain in the right wrist. Students who modified the thumb rest had higher incidences of playing-related pain in the right wrist (n = 7, 77.78%) than students who did not modify their saxophone (n = 19, 36.58%, $p = .021$), and higher incidences compared to other modifications (n = 6, 35.29%, $p = .007$). The incidences of playing-related pain in the right wrist correlated with playing-related pain in the right thumb ($r_s = .259$, $p = .016$), right fingers ($r_s = .363$, $p < .001$), and the right hand ($r_s = .643$, $p < .001$). These correlations in the different areas of the right upper extremity make a case for the positioning of the thumb rest as the possible cause of why playing-related pain in the right thumb was nearly double that of the left thumb.

The Lagan Wrist Saver (Figure 4) addresses the issue of the thumb position with respect to the fingers. Designed to alleviate discomfort and pain in the right hand and improve the

[69] "Kooiman Forza Sax Thumb Rest," Thumbrest, Reeds Direct Cambridge, 2021, https://www.reeds-direct.co.uk/kooiman-forza-ergonomic-saxophone-thumbrest-akf.html.

ergonomics of the thumb rest of the right hand, especially the soprano, the Lagan Wrist Saver allows the thumb rest to be positioned higher on the saxophone, straightening out the wrist. There is a 1.5″ area where the thumb rest can be positioned, with the additional ability to open the hand to feel more like an alto or tenor. It is designed to be used with the preferred thumb rest of the saxophonist, along with being designed to fit specific models and saxophones.[70]

Figure 4. Lagan Wrist Saver[71]
Used with Permission.

Ideally, the right thumb rest is to only act as a guide or point of reference for the rest of the hand, especially when using the right side keys. Generally, there should be no weight on the thumb rest, but for those who play soprano saxophone or participate in marching band, weight on the thumb is almost inevitable. For some saxophonists, having to support the weight of the saxophone in either situation can lead to discomfort and eventually playing-related pain.

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[70] "Lagan Wrist Saver," Lagan Music, Brennan Lagan, 2020, https://www.lagan-music.com/product-page/lagan-wrist-saver.
More information can be found on Lagan's YouTube video "Lagan Wrist Saver," https://youtu.be/0hxrlgRSfMQ.
[71] Ibid.

Although there were no significant statistical findings among these two groups regarding right thumb pain, it is still a problem that some saxophonists seek to resolve.

Harvey Pittel was one of the first saxophonists to come up with a device that supports the weight of the saxophone, especially the soprano. The Pittel Hand-Eze (Figures 5 and 6) was designed to respond to Mr. Pittel developing severe pain in his right thumb and hand, known as "overuse syndrome" or "English horn thumb," caused by extended playing time during a tour. The only way he could play the saxophone and clarinet was to make a device that completely removed the weight of the instruments. Over three decades later, the Hand-Eze was created, completely removing the weight of the instrument, freeing up the right hand and thumb, and removing nearly all tension in the thumb.[72]

The ERGOsax support also acts as an additional support, taking the weight completely off the right hand. Unlike the Hand-Eze, the ERGOsax (Figure 7) is only designed to work with the soprano saxophone. The device allows the soprano to be held out for the player by attaching it to a belt when standing or a chair when sitting. One of the main differences between the two designs, besides only being designed for the soprano saxophone, is that the ERGOsax does not require the thumb rest to be changed, as it attaches to the neck strap hook, whereas the Hand-Eze replaces the existing thumb rest.[73]

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[72] "Pittel Hand Eze" Pittel Hand EZE, 2019, https://pittelhandeze.net.
More information can be found on Pittel's YouTube video "Saxophone Pittel Hand Eze," https://youtu.be/0hxrlgRSfMQ.
[73] "ERGOsax Saxophone Support System," ERGObrass Support System, 2020, https://www.ergobrass.com/saxophone/.

Figure 5. The Pittel Hand-Eze

Figure 6. The Pittel Hand-Eze[74]

Figure 7. The ErgoSax support[75]
Used with Permission.

With the weight of the instrument being a possible factor for playing-related pain in the right thumb, another possible reason for the significant difference in thumb pain left to right is that some responding students may have been holding the weight of their saxophone on their right thumb, even if they were not playing soprano saxophone or participating in marching band. This could be because their neck strap is not sufficiently pulled taut to bring the saxophone directly into their mouth. Therefore, the thumb must hold the saxophone for the correct

[74] "Pittel Hand Eze" Pittel Hand EZE, 2019, https://pittelhandeze.net.
[75] "ERGOsax Saxophone Support System," ERGObrass Support System, 2020, https://www.ergobrass.com/saxophone/.

mouthpiece placement. The other possibility is that they are holding the instrument away from their bodies rather than allowing the saxophone to rest against them.

A further investigation into playing-related pain found in the right thumb is warranted. Is it the weight of the horn that causes playing-related pain, or is it the position of the thumb rest? Are certain individuals at a higher risk of developing discomfort or pain than others? Does the size of the hand play a part? Do certain thumb rest designs relieve pressure and pain, or even prevent it? Or are students playing with unnecessary weight on their right thumb?

Case Study: Students without Playing-Related Injuries and Illnesses

Of the eight students who did not experience playing-related pain, six had experienced orofacial pain or problems, and five had reported other non-musculoskeletal problems (Table 13). Only one student had not experienced any playing-related issues, except for occasional stage fright. When comparing the group of students who experienced playing-related musculoskeletal pain to these eight students, it is evident that the two groups are similar in demographics, musical activities, and lifestyle.

Table 16. Orofacial and Non-Musculoskeletal Problems of Students without Musculoskeletal Injuries

	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7	Student 8
Jaw Pain	X	X	X		X			
Teeth Movement	X	X	X			X		
Loss of Embouchure		X						X
Velopharyngeal Insufficiency			X		X			
Asthma								
Dizziness	X					X		
Blackouts								
Chest Discomfort								
Stage Fright	X	X	X	X	X	X		X
Hearing Loss					X			
Tinnitus	X-Before	X-Before			X-After			
Hernia							X	
Focal Dystonia							X	

There were two portions of the survey that stood out among the eight students; their saxophone background and practicing habits. All eight students played at least two saxophones, but not more than four. They did not report playing bass saxophone or using a harness or shoulder strap. All eight students had a warmup routine that included long tones, scales (slow to goal tempo), and technique exercises. Seven of the students practiced repertoire slowly, gradually speeding up the material to tempo, rather than practicing faster than what they could play. Seven of the eight students practiced regularly, increasing time and frequency gradually as deadlines for juries and recitals approached. Each of the students practiced without their horn by listening to recordings, studying scores, and/or singing through their pieces. They took brief breaks throughout their practice sessions and did not play straight through. Six of the eight students practiced in multiple sessions rather than in one large period of time. It should be noted that most students with playing-related musculoskeletal pain in this study also had similar practicing habits. Had more students without musculoskeletal playing-related pain completed the survey, it is possible the results would also show instances of practicing habits that are not ideal. The results from the survey may be skewed due to the disproportional sizes of the two groups.

The small percentage of students without playing-related pain or ailments may not be an accurate representation of the collegiate saxophonist population. It seems more plausible that there would be fewer students with playing-related injuries or health conditions than without. Even when focusing on individual areas of the body and specific ailments, some of the statistically significant results cannot be guaranteed due to a lack of data points.

The results of the questionnaire could have revealed more insight into what may lead to play-related health problems, had there been more responses. While there was a substantial

number of responses from those experiencing playing-related ailments, interpretations are limited by a lack of responses from those without. A larger number of responses would have resulted in more accurate analyses, especially pertaining to demographics, saxophone background, and playing routines, where a variety of answers could be selected. It is possible that the language of the questionnaire title deterred students without medical problems, and that a different title could have resulted in a larger pool of subjects. Even though the subject pool was small, the survey ascertained that collegiate saxophonists are experiencing playing-related pain and that it may be more common than what was originally believed.

Responses to the Design of the Survey

At the end of the survey, students were asked three questions pertaining to the design and readability of the questionnaire. [76]

> Q67: Did you feel the survey was easy to navigate? If no, please indicate why.
> Q68: Were all of the questions and answers easy to comprehend?
> Q69: Do you have additional comments regarding the survey?

There were three students who felt the survey was not easy to navigate, and two felt the survey was less mobile-friendly. Qualtrics did offer the opportunity to check the visual component of the survey on a mobile device, which was utilized. The survey, however, was more visually pleasing and accessible on a computer than on a mobile device. The third student found an error in the survey regarding one of the questions. There were three students who felt that not all the questions were easy to comprehend, particularly the questions regarding the level of stress

[76] The following questions are directly from the questionnaire.

on a 1-5 scale (indication of what numbers represented least to worst was absent), the use of electronics (indication of minutes or hours was absent), and how long a student had been experiencing pain in a particular area. This was removed from the analysis due to the open-ended nature of the question, which made it difficult to analyze.

Some students felt there could have been more questions about how a person was coping with their injury, or if they recovered from the injury, and if yes, how so. This survey primarily focused on physical pain. A student suggested that a section pertaining to mental health in musicians would have been a good component of the survey.[77] Some responses suggested that the length of the survey was excessive and that some questions could have benefited from covering more information so that students did not feel as though they were repeating themselves.

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[77] Since the distribution of this survey, the COVID-19 pandemic has altered our way of life, and its effects on the mental health of students are becoming increasingly evident. During the height of the pandemic, students, including music students, were limited to virtual instruction and separated from their peers. Private lessons were conducted through a computer screen, and the quality of the lesson was heavily dependent on internet access. Early research observing the impact of the pandemic on mental health of college students revealed that while some students thrived, others struggled. There is a significant need for further research on the effects of the COVID-19 pandemic and lockdown on the mental health of music students. How did students react to switching to virtual learning and gaining more time, and how did it affect their self-reported stress, depression, and anxiety levels? How well did students who increased their practice time manage the COVID-19 pandemic? Were they using practice as a coping mechanism and exhibiting the same symptoms as those who fell behind in practice and their studies, or even those who left the degree entirely? How has virtual instruction impacted students socially, and how has this impacted their musical interactions? How has pandemic and their mental state affected their physical health? Is there a correlation between increased or decreased practice time and an increase in physical injuries? Did virtual instruction lead to an increase in injuries as a result of poor practice habits as instructors were unable to fully visualize their students? Because of their mental health, are students more tense, resulting in more physical complaints?

Overall Design of the Survey

The design of the survey was constrained by the university's preferred survey platform, Qualtrics. A more concise survey layout could have eliminated unnecessary questions, shortened survey completion time, and possibly increased response rates. All complaints would be presented on a single page, as opposed to having distinct sections for various types of medical complications. Students would select "I have not experienced any of the above complications" if they had not experienced any of the listed playing-related injuries or health conditions. If the survey platform allowed it, it would be ideal if students could answer descriptive questions for each chosen area of the body on the same page.

This page would also include options for orofacial injuries, respiratory conditions, dermatological issues, and mental health, along with their respective descriptors. Again, the respondent would select "I have not experienced any of the above complications" if they had not experienced any of the ailments listed. If the survey did not address a condition experienced by the student, an open-ended question would be available.

1. I have pain (discomfort) in this area.
    a. Is this a past or current issue?
    b. What descriptors would you use to describe the pain? Examples may include aching, sharp, stabbing, throbbing, etc…
    c. How would you rank the severity of the pain on a scale 1-10? 1- the least, and 10-the greatest.
    d. How long have you been experiencing this (>1 mo., b/w 1-6 mos., 6 mos-1 yr., 1 yr. or more, etc.)
    e. Is the pain constant or does it come and go?
    f. How often does it occur?
    g. How long does it last?
    h. Does anything worsen it?
    i. Does anything make it better?
    j. Did you experience this prior to starting college or after?
    k. Did you seek help from a medical professional?
    l. If you have received a medical diagnosis, please describe.
    m. Did you seek advice from your saxophone instructor? If so, was any advice provided?
2. I have not experienced any pain or discomfort in these areas.

All students would be asked questions about protection or appliances they are currently using, such as current or previous dental appliances, hearing protection (which was neglected in the current survey), lip protection, night guard, etc. Students would be asked if their university provided any information on playing-related medical problems and the increased risk of developing them.

1. Did the university make it clear that one should not experience pain or discomfort?
2. Does the university provide any resources for students to use if they need them?
    a. Student health services
    b. Performance medicine clinic, access to various therapies
3. Do they offer any classes associated with musician health and prevention? Topics addressed may include Alexander Technique, Body Mapping, or an overview of health problems and prevention.

Questions addressing musical background, playing routine, saxophone equipment, and lifestyle habits would be displayed similarly. Most answers would be selection-based rather than open-ended, which would provide more uniform responses and limit possible misunderstandings from the participant. Should a participant feel that any selection-based questions do not offer a choice that satisfies the participant, an open-ended comment section would be available at the end of each section.

Clarity and Design of Questions

As respondents pointed out, several questions lacked clarity, leading to parts or all of the questions to be eliminated from the analysis. These questions are listed below. [78]

[78] The following questions are directly from the questionnaire.

Q18b: Please describe how long have you experienced pain in the areas you selected on the LEFT SIDE. (Thumb: 2 weeks; Fingers: 3 months; Hand: 1 year; etc...)
Q18c: Please describe how long have you experienced pain in the areas you selected on the RIGHT SIDE. (Thumb: 2 weeks; Fingers: 3 months; Hand: 1 year; etc...)

- For both questions, some students were not sure what to write. This question would have been better suited in a multiple-choice format.

Q32a: How often do you experience chest discomfort while playing saxophone?

- Instead of listing chest discomfort, blackouts and dizziness were listed.

Q33: On a scale 1 to 5, how would you rate your level of stress as a music student? If you are concerned about the level of stress you are experiencing, please know that you can seek help from your student health center or physician.

- There was no indication of how the scale was ranked.

Q43a: Please name the ensembles in which you are participating on all instruments you currently play. If you played in marching band in the previous fall semester, please indicate that as well.

- This question could have been a multiple-choice question. Participation in marching band should have been a separate question, and should have covered if the students currently played in marching band or ever participated.

Q54: In addition to school, do you work? Please select all that apply and indicate how many hours a week.

- Each form of work should have had a clear definition of what it entails, and students should have had a drop-down menu to select hours to prevent confusion.

Q62: On average, how many times a week do you exercise for at least 30 minutes per week?

- Do not exercise
- 1-2 times per week
- 3-5 times per week
- 5-7 times per week
    - The selections should have been “Do not exercise,” “1-2 times per week,” “3-4 times per week,” and “5-7 times per week.” This question should have been designed to allow the participant to input a number, rather than be limited to the choices above, as some may exercise more than once a day.

Q65a: Please indicate how frequently you use these devices each day.

Q65b: Please indicate how frequently you do each activity on your computer/laptop each day.

- The scale for each question did not indicate if it was hours or minutes.

In addition to clarity issues, some question designs led to multiple types of answers, which required new variables to be created and the responses of students organized so it could be properly analyzed. The following questions would have benefited from multiple choice and/or selection questions.

Q9: How much do you weigh in pounds?

- A drop-down menu would have allowed an equation to be designed to use height and weight to create a new variable for calculating BMI Range.

Q14: Please indicate your major area (composition, education, performance, etc....)

- Instead of an open-ended question, students would select either performance major (which includes dual programs with performance) or non-performance major, with an additional option to identify the major they are pursuing.

Q18e: Were you diagnosed with a specific disorder, such as carpal tunnel syndrome, bursitis, tendonitis, etc...? If yes, please indicate what you were diagnosed with, what type of treatment was recommended, and if it was successful. (If no diagnosis was made, please answer "no.")

- Make a yes or no selection, with a description option when selecting yes.

Q18f: Is there a particular reason why you have not sought help from a physician or student health? Please describe below.

- Make a yes or no selection, with a description option when selecting yes.

Q18h: Has your professor given you any suggestions on how to cope with the pain, evaluated your playing, suggested going to the doctor, or given any other advice? Please explain.

- Make a yes or no selection, with a description option when selecting yes.

Q20: What type of strap do you use to hold the saxophone (harness, neck strap, sax holder, shoulder strap, etc.)? If you know the brand or type, please indicate that as well.

- Make a multiple selection question, any straps not listed in choices would be described under “other.”

Q22: Have you modified the saxophone in any way to make it easier to play (different thumb rests, key risers, changing key positions/heights etc.) If yes, please describe.

- Make a multiple selection question, any modifications not listed in choices would be described under “other.”

Q28: Do you have any dental appliances in your mouth, such as a permanent bar retainer or braces? If yes, please describe.

- A second question should have been created to ask about the history of dental appliances.

Q29: Do you use anything to protect your lower lip while playing (mouth guard, denture pad, wax paper, etc...) If yes, please describe.

- Make a multiple selection question, any lip protection not listed in the choices would be described under “other.”

Q56: How would you describe your sleep (restful, constantly waking up, etc.)?

- Have the option to choose “restful” or “other.” Examples of restful sleep would be provided, and respondents would have the choice to describe their sleep under “other.”

Q62a: Which types of exercises do you perform? (weight training, cardio, yoga, etc...)

- Make a multiple selection question. List the four categories of exercises with examples of each.

In the demographics section of the survey, clarity was not regarded as an issue by any of the participants. However, Question 5, "Gender. Please specify," and Question 6, "Choose one or more races that you consider yourself to be," both standard stock questions, have terminology that has been conflated with other terms in a large number of studies.[79] [80] Question 5 should have read as "Sex assigned at birth" and allowed for the participant to select "male," "female,"

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[79] Gender, sex, and gender identity are often conflated and used interchangeably. According to the organization Gender Spectrum, the "gender" of an individual is the combination of three distinct but interrelated aspects: body, identity, and social gender (how one presents their gender and how a community perceives, interacts, or shapes the gender of that individual). The term "sex" often refers to the external and internal reproductive organs of a person, which can be classified as male, female, or intersex. "Gender identity" is the innate sense that one identifies as being male or female, a blend of both, neither, or something else. The gender identity of an individual can correspond with or deviate from their sex assigned at birth.
Gender Spectrum, *The Language of Gender*, Gender Spectrum, 2019, https://genderspectrum.org/articles/language-of-gender.

[80] Race and ethnicity have frequently been used synonymously in various fields of study, but they are two distinct concepts in the social sciences. Race and ethnicity are both social constructs that are used to identify and divide people into groups based on actual or perceived differences. The term "race" generally refers to shared physical and/or biological characteristics, such as hair texture, or skin color. "Ethnicity" is based on shared cultural traits such as language, religion, holidays, attire, and dietary traditions. People can choose to adopt or reject ethnic identities, but not racial identities. For example, a child born in China, adopted by French parents and raised in France, grows up identifying as French because they speak the language, eat the food, and value their cultural traditions. While that person sees themselves as "French," in the United States, society will see them as "Asian" based on their physical traits. Race and ethnicity are both concepts that have been defined and changed over time by human societies, and they are both ongoing and in constant flux. With the expansion of genome research, the American Medical Association has recognized race as a social, not biological, construct and has stated the effects of racism and oppression, rather than race, are to blame for health disparities.
American Medical Association, "New AMA Policies Recognize Race as a Social, Not Biological Construct," *Press Releases*, American Medical Association, November 16, 2020, https://www.ama-assn.org/press-center/press-releases/new-ama-policies-recognize-race-social-not-biological-construct.
Erin Blakemore, "Race and Ethnicity: How are They Different?" *National Geographic*, National Geographic Partners, LLC., February 22, 2019, https://www.nationalgeographic.com/culture/article/race-ethnicity.
Justin García, "Ethnicity," *Salem Press Encyclopedia*, Salem Press, January 1, 2022, https://discovery.ebsco.com/linkprocessor/plink?id=624af079-965a-3ad8-aad6-b66635a5edec.

“intersex,” or “prefer not to disclose.” In addition, an explanation regarding the purpose of identifying the sex of the participant should have been provided. This question should have been followed by an open-ended question to allow the participant to express their gender identity if they so desired. Question 6 was a standard stock question that addressed the race of a participant and used identifiers that were observed in both the 2010 and 2020 US Census. However, one participant felt some of the nomenclature was outdated. The following changes occurred in the presentation of the results: “American Indian or Alaskan Native” was changed to "Indigenous," and students that self-reported as multiple races were represented as “multiracial.” While answering this question was not required, there should have been an option for the participant to select “prefer not to answer.” This should have been a two-part question, where students could self-report their race and the ethnicity/ies with which they identify.

The original intention of this document was to present the results and findings of the questionnaire in conjunction with a resource that identified the playing-related injuries and health complications in various areas of the body a saxophonist could encounter, their background, prevention, management, and/or treatment. The resource would have also included information about lifestyle behaviors that could optimize injury prevention and wellness, as well as what outside factors might negatively impact the performance ability of a saxophonist. It would have included a guide to ideal practice habits, posture and breathing, and performance preparation, as well as a collection of ergonomic devices developed to aid performers. The vastness of the proposed resource was limited by the time available to complete the research and present it. The resource could have been reduced to focus on a specific anatomical area, providing background on the various ailments that could arise, how to prevent, manage, and/or treat them, what

lifestyle factors could reduce their risks and what factors can increase their risks, and the ergonomic aids that could assist the performer. With the questionnaire already distributed, the focus of the research was on the results and findings of this survey.

Chapter 7: Conclusion

While the results from this survey could not entirely determine what factors may lead to a saxophonist being injured, they revealed that playing-related injuries and health conditions occur among collegiate saxophonists. The low response rate of those without playing-related injuries or illnesses possibly skews the results, but that does not make them any less valid. One of the main reasons for the distribution of this survey was to show that there are injuries among university saxophonists, as well as to bring awareness to educators and help students realize they are not alone. The mental health of collegiate saxophonists should be investigated further. How has the COVID-19 pandemic affected them both mentally and physically? There should be additional research comparing the playing-related injuries and health concerns of students who have taken lessons from a young age to those who have not or who began lessons later, which raises the issue of socioeconomic status and how it has impacted the saxophonist.

It was predicted to have collegiate saxophonists report playing-related pain or a health condition. However, it was not expected that 90.80% of the 87 students would report a complaint while only 8 would be free of musculoskeletal pain. Then, when other health conditions were considered, except for experiencing occasional stage fright, only one student was not affected. The wording of the survey and the introductory letter may have contributed to the low response rate of those without playing-related complaints. However, it is also possible that students did not respond because the topic of playing-related pain and health conditions did not interest them as it did not affect them personally. Participation in a study that is mandated by the institution

may elicit more responses from students who have no complaints, thereby yielding more data for analysis.

In previous studies, students pursuing a degree in performance have reported higher incidences of playing-related pain and health conditions. This study revealed the opposite to be true. Non-performance majors were more likely to report playing-related complications in the majority of the musculoskeletal areas and health concerns discussed. This may be partially attributable to the fact that the majority of non-performance majors were undergraduates, whose workload differs from that of graduate students. Depending on the type of institution, undergraduates may be required to take courses in general studies, which can result in additional stressors that graduate students do not experience. Non-performance majors may not be concerned with performing frequently. Therefore, they might not consistently practice. Some students may delay practicing until juries are near, resulting in injuries from overpracticing in a short period. Moreover, performance majors may be more aware of their bodies and willing to seek out ways to make their instruments more ergonomically compatible. A serious injury could end their careers, so their health may take precedence. These hypotheses could be confirmed by a future study investigating the perspectives of non-performance majors and performance majors on the subject of playing-related injuries and health conditions with reported incidences.

The right thumb and embouchure were the two areas of the body that produced unexpected results. There were more than twice as many cases in the right thumb as in the left.There were no correlations between the right thumb and the soprano saxophone or marching band participation, both of which would be expected to increase the risk of injuries. As discomfort in the right wrist correlates with the right thumb, it is possible that the position of the

thumb rest is the cause. There is a need for additional research on the specific models of saxophones, the location of the thumb rests, and correlations with reported incidents. A study would benefit from being conducted in person, which would allow the researcher to take measurements of the saxophonist and their instrument, as well as examine their posture. The study could also investigate the various ergonomic thumb rests and determine which ones work best for each player and the saxophone being played. In terms of embouchure, we observed that those who practiced for 1-2 hours per day had higher rates of embouchure loss and lip pain than those who practiced for longer periods of time. Further investigation into the frequency with which students practice could help explain why shorter practice times led to a higher incidence rate than longer practice times. Do students who practice for longer periods of time practice daily, which is why they experience less embouchure fatigue and pain? Do students who practice fewer hours per day also play less frequently throughout the week, requiring them to constantly rebuild their embouchure?

The results revealed that any saxophonist can develop a playing-related injury regardless of their physical attributes, practice habits, or lifestyle. Some students in the survey did not seek help or advice, stating the pain was not severe enough or citing the proverb "no pain, no gain." The performing arts medical community is making efforts to inform educators and students of the detrimental effects "no pain, no gain" has on the health of a musician, that any discomfort is not normal, and that students should not feel stigmatized should they reach out for help. Indirectly, the way in which a university or its applied faculty handles playing-related medical issues influences how open a student is about their pain or discomfort. Institutions and saxophone teachers can help create a supportive environment by talking to students about

injuries when they begin college, making it clear that pain isn't normal and that it's okay to ask for help without fear of being shamed, and by providing classes on the health issues musicians can face and the methods to prevent them.

Appendix 1

Dear Participant:

I am a doctoral candidate in the School of Music at West Virginia University, and I am conducting a research study evaluating the occurrence of injuries in collegiate saxophonists currently enrolled in a post-secondary institution in the United States and Canada. This study is being conducted as part of a doctoral dissertation, under the supervision of Dr. Michael Ibrahim, the Primary Investigator. An anonymous survey link is included below for which you may participate in a survey that will assist my research.

In order to participate in this survey, you must be a student pursuing an undergraduate or graduate degree in music in one of the countries mentioned above; saxophone must be your primary instrument; you must have studied saxophone for at least one semester; and, you must be at least 18 years of age. If you recently graduated in Spring 2018 you may still participate. The survey will be posing questions pertaining to your most recent semester. Participants do not have to have an injury to participate. Responses from both those that are injured or not injured are equally important in this survey.

In this survey, you will be asked to identify any possible health issues related to playing the saxophone. You will also be asked questions about your practicing habits and daily activities. The survey is in English and will take approximately 20-30 minutes to complete. Only the first four qualification questions will require you to provide a response; you may choose to skip any of the remaining questions thereafter. Participation in this survey is voluntary and anonymous. Survey questions do not include identifying questions, and the results of the data will be reported in an aggregate. This study has been approved by the West Virginia University Institutional Review Board. Your participation in this survey is very much appreciated. I hope that you will participate, as your response will provide valuable data in researching common injuries found in saxophonists and their prevention, management, and/or treatment.

To participate in the survey, please use this link: Survey-Injuries in Collegiate Saxophonists Thank you very much for your time and assistance. Should you wish to receive the results of the survey, please feel welcome to contact me at matolan@mix.wvu.edu.

Sincerely,

Michael Anne Tolan-Coinvestigator DMA Candidate

Michael Ibrahim-Primary Investigator, Associate Professor of Saxophone, Interim Director of School of Music at West Virginia University

Appendix 2

Injuries Found in North American Collegiate Saxophonists Questionnaire

Start of Block: Introduction Qualification Questions

The purpose of this survey is to conduct research to determine the frequency at which injuries in collegiate saxophonists may occur. Your response is still encouraged even if you have not experienced any injuries playing the saxophone. Your involvement in this survey is completely voluntary and anonymous. The link provided will not release any personal details such as email or location. The survey has been designed to remove Internet Protocol (IP) addresses from each response. I will not be asking any identifying questions and all results will be reported as an aggregate. You may skip any question except for the opening questions that determine if a participant meets the requirements. You may choose to discontinue the survey at any time. By participating in this survey, you are giving your consent that your responses will be recorded and used in the study.

Q1 What is your age?

▼ 15 ... 50

Q2 Are you currently enrolled in a university in the United States or Canada and pursuing a degree in music? (If you graduated Spring 2018, select yes)

- o Yes
- o No

Q3 Is saxophone your primary instrument?

- o Yes
- o No

Q4 Have you studied saxophone for at least one semester or trimester?

- o Yes
- o No

End of Block: Introduction Qualification Questions

Start of Block: Demographics

Q5 Gender. Please specify.

- o Male
- o Female
- o Prefer not to respond

Q6 Choose one or more races that you consider yourself to be:
- o White
- o Black or African American
- o American Indian or Alaska Native (Changed to Indigenous in Results)
- o Asian
- o Native Hawaiian or Pacific Islander
- o Latino or Hispanic
- o Other _____

Q7 In which country is your place of birth?

▼ Afghanistan... Zimbabwe

Q8 What is your height?

▼ 4'... 7'11"

Q9 How much do you weigh in pounds?

_____

Q10 In which country is your current university located?
- o United States
- o Canada
- o Prefer not to Answer

Q11 Please indicate your student status for Spring 2018.
- o Part-time
- o Full-time

Q12 Please indicate where you live while enrolled.
- o On-campus
- o Off-campus
- o Off-campus with family

Q13 What was your year in university in Spring 2018?

Degree
Year

▼ Undergraduate... DMA or PhD ~ ABD

Q14 Please indicate your major area (composition, education, performance, etc....)

_____

Q15 For how many years have you been playing saxophone?

▼ 1... 30

Q16 Did you take saxophone lessons prior to attending university?
- o Yes
- o No

Q17 What genre of music do you primarily study on saxophone?
- o Classical/Contemporary
- o Jazz
- o Other, please indicate. _____

End of Block: Demographics

Start of Block: Musculoskeletal Problems

Q18 Please select the following areas where you have experience pain as a result of playing the saxophone. DO NOT select "I have not experienced any pain in these areas," if you have selected any of the locations on the body below.
- o Thumbs
- o Fingers
- o Hands
- o Wrist
- o Forearms
- o Elbows
- o Shoulders
- o Neck
- o Upper back
- o Middle back
- o Lower back
- o Hips
- o Knees
- o Calves
- o Ankles
- o Feet
- o Toes
- o I have not experienced any pain in these areas

Skip To: Q20 If Q18 = I have not experienced any pain in these areas

Carry Forward Selected Choices from "Q18"

Q18a Please select which side you experience pain, you may choose both if it applies.

	Left Side	Right Side
Thumbs	o	o
Fingers	o	o
Hands	o	o
Wrists	o	o
Forearms	o	o
Elbows	o	o
Shoulders	o	o
Neck	o	o
Upper back	o	o
Middle back	o	o
Lower back	o	o
Hips	o	o
Knees	o	o
Calves	o	o
Ankles	o	o
Feet	o	o
Toes	o	o
I have not experienced any pain in these areas	o	o

Display This Question:
If Q18a = Left Side

Q18b Please describe how long have you experienced pain in the areas you selected on the LEFT SIDE. (Thumb: 2 weeks; Fingers: 3 months; Hand: 1 year; etc...)

_____
_____

Display This Question:
If Q18a = Right Side

Q18c Please describe how long have you experienced pain in the areas you selected on the RIGHT SIDE. (Thumb: 2 weeks; Fingers: 3 months; Hand: 1 year; etc...)

_____
_____

Q18d Have you seen a physician or student health regarding the pain you have experienced?
o Yes
o No

Display This Question:
If Q18d = Yes

Q18e Were you diagnosed with a specific disorder, such as carpal tunnel syndrome, bursitis, tendonitis, etc...? If yes, please indicate what you were diagnosed with, and what type of treatment was recommended, and if it was successful. (If no diagnosis was made, please answer "no.")

_____
_____

Display This Question:
If Q18d = No

Q18f Is there a particular reason why you have not sought help from a physician or student health? Please describe below.

_____
_____

Q18g Have you spoken with your professor about the pain you have experienced?
o Yes
o No

Display This Question:
If Q18g = Yes

Q18h Has your professor given you any suggestions on how to cope with the pain, evaluated your playing, suggested going to the doctor, or given any other advice? Please explain.

_____
_____

Display This Question:
If Q18g = No

Q18i Do you feel comfortable speaking with your professor about the topic? If not, please explain.
- o Yes
- o No _____

Q19 Have you noticed increased soreness or pain as you increased your practicing, especially before performances?
- o Yes
- o No

Q20 What type of strap do you use to hold the saxophone (harness, neck strap, sax holder, shoulder strap, etc.)? If you know the brand or type, please indicate that as well.

_____
_____

Q21 Do you use any assistive devices while playing such as The Pittel Hand-Eze, saxophone stand/peg, etc...? If yes, please explain.
- o Yes_____
- o No

Q22 Have you modified the saxophone in any way to make it easier to play (different thumb rests, key risers, changing key positions/heights etc.) If yes, please to describe.
- o Yes_____
- o No

End of Block: Musculoskeletal Problems

Start of Block: Craniofacial/Orofacial Problems

Q23 Have you experienced any pain in your jaw? If yes please indicated which side: left, right, or both.
- o Yes_____
- o No

Q24 Have you noticed any movement or shifting with your teeth while playing or just after?
- o Yes
- o No

Q25 Do you wear a night guard when you sleep?
- o Yes
- o No

Q26 Have you experienced any difficulties maintaining your embouchure after a short period of playing (loss of seal or painful lip)?
o Yes
o No

Q27 Have you ever experienced air leaking out of your nose, while playing saxophone?
o Yes
o No

Display This Question:
If Q27 = Yes

Q27a Have you noticed the air leak more when you have increased your practice drastically?
o Yes
o No

Q28 Do you have any dental appliances in your mouth, such as a permanent bar retainer or braces? If yes, please describe.
o Yes_____
o No

Q29 Do you use anything to protect your lower lip while playing (mouth guard, denture pad, wax paper, etc...) If yes, please describe.
o Yes _____
o No

End of Block: Craniofacial/Orofacial Problems

Start of Block: Non-Musculoskeletal Problems

Q30 Have you been diagnosed with asthma?
o Yes
o No

Display This Question:
If Q30 = Yes

Q30a Were you diagnosed prior to playing saxophone or since you have been playing saxophone?
o Prior to playing saxophone
o Since I've been playing saxophone

Q31 Have you experienced dizziness or blackouts while playing? Please indicate blackouts, dizziness, or both.

- o Yes_____
- o No

Display This Question:
If Q31 = Yes

Q31a How often do you experience blackouts or dizziness while playing saxophone?

	Rarely	Sometimes	Most of the time	Every time I play
Dizziness	o	o	o	o
Blackouts	o	o	o	o

Q32 Do you experience chest discomfort while playing saxophone (tightness, pain, hard to breath)? If yes, try to describe what you are feeling when playing?

- o Yes_____
- o No

Display This Question:
If Q32 = Yes

Q32a How often do you experience chest discomfort while playing saxophone?

	Rarely	Sometimes	Most of the time	Every time I play
Blackouts	o	o	o	o
Dizziness	o	o	o	o

Q33 On a scale 1 to 5, how would you rate your level of stress as a music student? If you are concerned about the level of stress you are experiencing, please know that you can seek help from your student health center or physician.

	1	2	3	4	5	NA
Stress level	o	o	o	o	o	o

Display This Question:
If Q33 != NA

Q33a Do you do any activities to prevent or alleviate stress, such as exercise, meditation, socialization, breathing exercises, or seek medical attention? If yes, please describe what you do.
o Yes _____
o No

Q34 Have you ever experienced stage fright before performing?
o Yes
o No

Display This Question:
If Q34 = Yes

Q34a How often do you experience stage fright?

	Rarely	Sometimes	Most of the time	Every time
Stage fright	o	o	o	o

Q35 Have you experience hearing loss since you started playing saxophone?
o Yes
o No

Display This Question:
If Q35 = Yes

Q35a How would you describe your hearing loss?
o Mild
o Moderate
o Severe
o Profound

Q36 Do you experience any ringing in your ears or have been diagnosed with tinnitus?
o Yes
o No

Display This Question:
If Q36 = Yes

Q36a Did the ringing start before or after you started playing saxophone?
o Before
o After

Q37 Have you an experienced a skin allergy to any part of the saxophone (i.e. rash after playing with a cane reed)? If so, please describe the allergy and what what you do to compensate for the allergy.
o Yes_____
o No

Q38 Have you ever experienced a hernia or currently have a hernia since playing the saxophone? If yes, and you are comfortable with describing what type of hernia, please do so.
o Yes_____
o No

Q39 If you have any further comments about health problems you have encountered while playing the saxophone that were not covered in this survey please describe here.
_____
_____

End of Block: Non-Musculoskeletal Problems

Start of Block: Practicing Habits

For the following set of questions please answer each one as if you were still currently in the Spring 2018 semester.

Q40 Hours a DAY you practice saxophone (any and all).
▼ 0... 10

Display This Question:
If Q13 = Undergraduate ~ Freshman

Q40a Is the amount of hours you practice now a significant increase from the amount you in high school? If yes, please indicate how much you practiced a day in high school.

o Yes_____
o No

Q41 Which saxophone(s) do you play? Please check all that apply

- o Sopranino
- o Soprano
- o Alto
- o Tenor
- o Baritone
- o Bass

Carry Forward Selected Choices from "Q41"

Q41a From the saxophones that you selected from the previous question, how many hours a WEEK do you play each instrument? This includes the hours you playing these saxophones in an ensemble.

Hours
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

Sopranino	
Soprano	
Alto	
Tenor	
Baritone	
Bass	

Q42 Do you play a secondary or tertiary instrument?

o Yes
o No

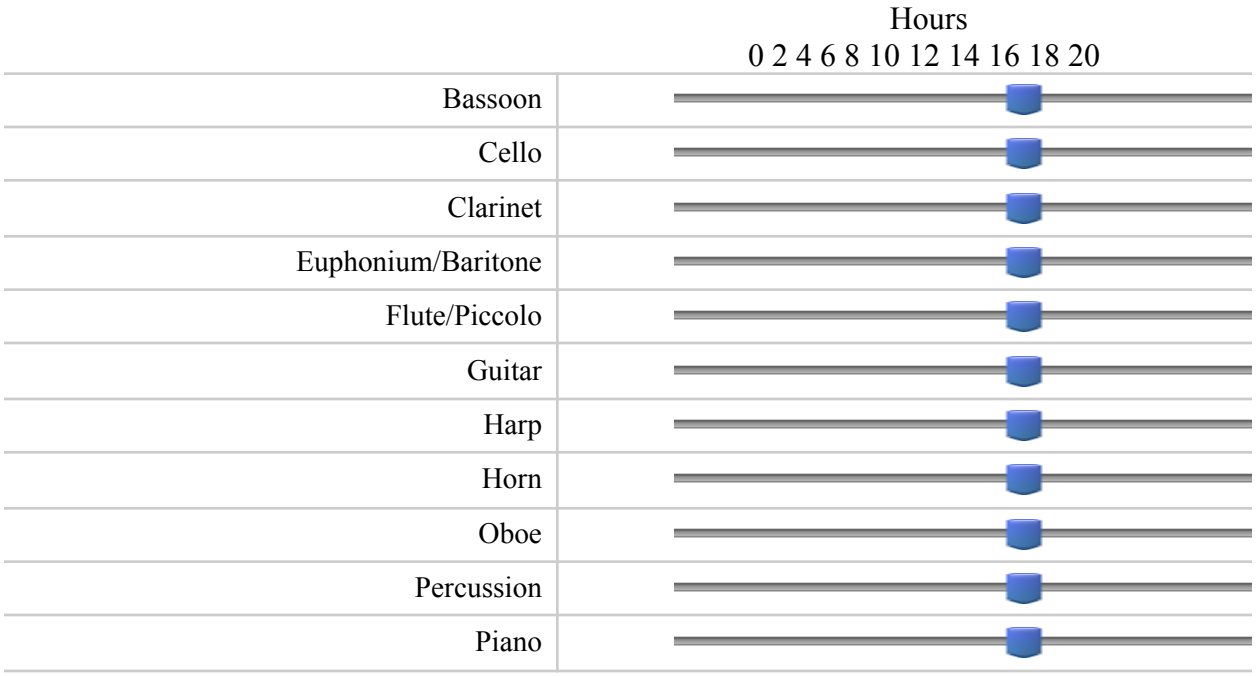
Skip To: Q43 If Q42 = No

Q42a In the previous question, you indicated that you play a secondary or tertiary instrument. To select more than one instrument please hold down the CTRL or command⌘ key.

- o Bassoon
- o Cello
- o Clarinet
- o Euphonium/Baritone
- o Flute/Piccolo
- o Guitar
- o Harp
- o Horn
- o Oboe
- o Percussion
- o Piano
- o String Bass
- o Trombone
- o Trumpet
- o Tuba
- o Viola
- o Violin

Carry Forward Selected Choices from "Q42a"

Q42b How many hours a week do you approximately play each instrument? This includes any ensembles you play on these instruments.



String Bass	
Trombone	
Trumpet	
Tuba	
Viola	
Violin	

Q43 Approximately how many ensembles do you currently participate in total (on all instruments that you play)? If you played in marching band in the previous fall semester, please include it in your count.

▼ 0 ... 10

Display This Question:
If Q43 != 0

Q43a Please name the ensembles in which you are participating on all instruments you currently play. If you played in marching band in the previous fall semester please indicate that as well.

_____

_____

Q43b How many hours a WEEK do you practice or rehearse in your ensembles? If you played in marching band in the previous fall semester please indicate the hours of practice for that as well.

	Hours 0 2 4 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
Ensembles Total MINUS Marching Band	
Marching Band	

Q44 Do you have a warm up when you practice [long tones, scales (slow-->goal speed), and technique exercises]?

o Yes
o No

Q45 Do you practice exercises, repertoire, scales, etc. slowly and then speed up or do you try to play faster than what you can ACTUALLY play?
- o Slowly then speed up
- o Faster than what I can do
- o I do not practice

Q46 Do you practice regularly and increase practice length slightly as performances or tests draw near, or do you tend to wait till the last minute and increase your practice drastically as these events get closer?
- o I practice regularly with a small increase as deadlines approach
- o I tend to practice less than I should and increase my practice time drastically as deadlines approach

Q47 Do you practice without your horn? Do you listen to your pieces, score study, or even sing through your pieces?
- o Yes
- o No

Q48 Do you continue to practice even when your muscles and embouchure are tired or fatigued?
- o Yes
- o Maybe
- o No

Q49 Are you practicing through pain to a point where it affects your practice the next day?
- o Yes
- o Maybe
- o No

Q50 Do you have you practice sessions broken up (i.e. 1.5 hour in the a.m. and 1.5 hour in the p.m.) or do you do all of your practicing for the day at once?
- o Multiple practice sessions
- o One large session
- o Other_____

Q51 Do you take breaks throughout your practice sessions or do you just play straight through?
- o Breaks
- o Straight through
- o Other_____

Q52 Do you stretch before, during, or after your practice sessions?

- o Before
- o During
- o After
- o I do not stretch

End of Block: Practicing Habits

Start of Block: Lifestyle

Q53 Please indicate how many hours a WEEK you spend on homework.

▼ 0 ... More than 15 hours a week

Q54 In addition to school, do you work? Please select all that apply and indicate how many hours a week.

- o Work-Study_____
- o Assistantship_____
- o Part-time_____
- o Full-time_____
- o I am currently not working.

Q55 How many hours of sleep do you get a night on average?

▼ 0... more than 10 hours a night

Q56 How would you describe your sleep (restful, constantly waking up, etc.)?

_____
_____

Q62 On average, how many times a week do you exercise for at least 30 minutes per week?

- o Do not exercise
- o 1-2 times per week
- o 3-5 times per week
- o 5-7 times per week

Skip To: Q63 If Q62 = Do not exercise

Q62a Which types of exercises do you perform? (weight training, cardio, yoga, etc...)

_____
_____

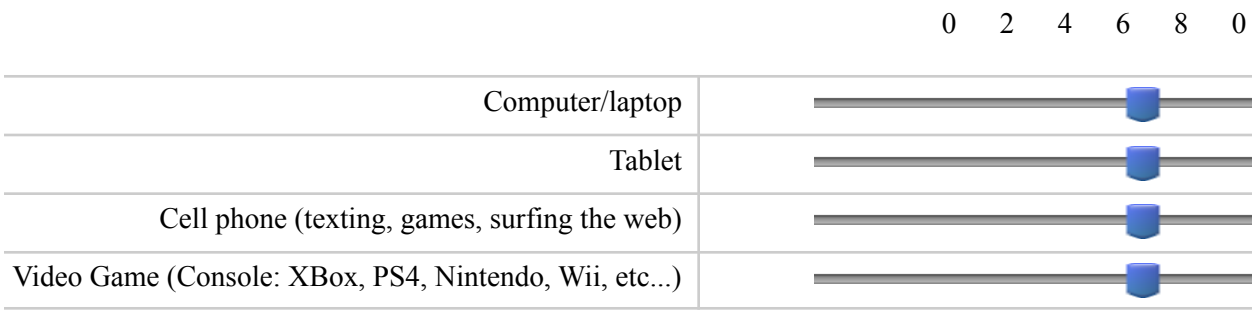
Q63 Do you participate in any sports (collegiate or intramural)? If yes, please describe.
- o Yes_____
- o No

Q64 How would you describe your overall health?
- o Excellent
- o Very Good
- o Good
- o Fair
- o Poor

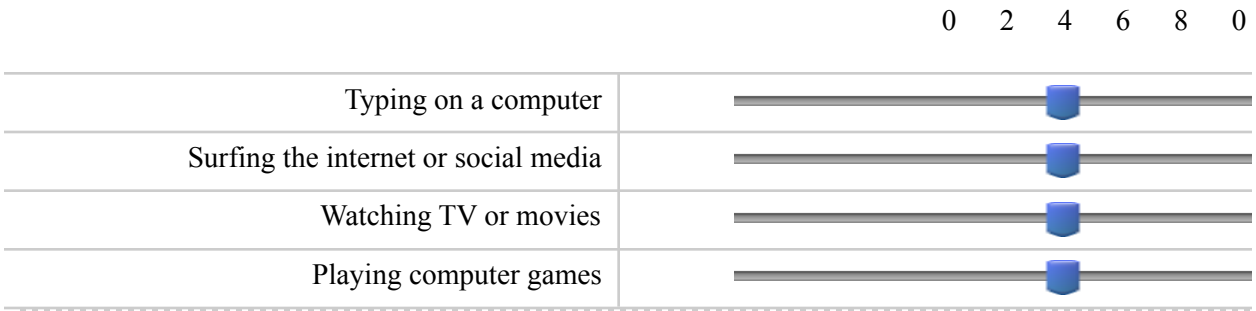
Q65 Please select the electronic devices that you currently use.
- o Computer/laptop
- o Tablet
- o Cell phone (texting, games, surfing the web)
- o Video Game (Console: XBox, PS4, Nintendo, Wii, etc...)

Carry Forward Selected Choices from "Q65"

Q65a Please indicate how frequently you use these devices each day.



Q65b Please indicate how frequently you do each activity on your computer/laptop each day.



Q66 You may also describe any activities or habits that you feel have helped you maintain a healthy saxophone career thus far, that were not were not mentioned above.

_____

_____

End of Block: Lifestyle

Start of Block: Survey Evaluation

Q67 Did you feel the survey was easy to navigate? If no, please indicate why.

o Yes
o No_____

Q68 Were all of the questions and answers easy to comprehend?

o Yes
o No

Q69 Do you have additional comments regarding the survey?

_____

_____

End of Block: Survey Evaluation

Bibliography

Adams, Allison Dromgold. “How Dystonia Brought Balance to My Life.” In *Notes of Hope: Stories by Musicians Coping with Injuries*, compiled by David Vining, 52-61. Flagstaff, AZ: Mountain Peak Music, 2014.

Altenmüller, Eckart, and Hans-Christian. “Focal Dystonia in Musicians: Phenomenology, Pathophysiology, Triggering Factors, and Treatment.” *Medical Problems of Performing Artists* 25, no. 1 (March 2010): 3-9. https://doi.org/10.21091/mppa.2010.1002.

Alvarado, C., Bréton, C. Lefebvre, L. Derfouri, and P. Goudot. “Études des douleurs dentaires et cervico-faciales chez les instrumentistes à vent.” *Médecine des arts: approaches médicale scientifique des pratiques artistiques,* no. 71 (March 2010): 11-14.

American Medical Association. “New AMA Policies Recognize Race as a Social, Not Biolgical Construct.” *Press Releases*. American Medical Association. November 16, 2020. https://www.ama-assn.org/press-center/press-releases/new-ama-policies-recognize-race-social-not-biological-construct.

Beckett, Sarah, et al. “Prevalence of Musculoskeletal Injury Among Collegiate Marching Band and Color Guard Members.” *Medical Problems of Performing Artists* 30 no.2 (June 2015): 106-110. https://doi.org/10.21091/mppa.2015.2018.

Bihan, Stéphane. “Problèmes de santé et facteurs de risqué chez les saxophonists.” *Médecine des arts: approaches médicale scientifique des pratiques artistiques*, no. 77 (May 2014):16-25.

Blakemore, Erin. “Race and Ethnicity: How are They Different?” *National Geographic*. National Geographic Partners, LLC., February 22, 2019, https://www.nationalgeographic.com/culture/article/race-ethnicity.

Bruder, Julius, Nikolaus Ballenberger, Bethany Villas, et al. “MusicCohort: Pilot feasibility of a protocol to assess students’ physical and mental health in a Canadian post-secondary school of music.” *BMC Research Notes* 14, no. 441 (2021): 1-7. https://doi.org/10.1186/s13104-021-05829-9

Cayea, Danelle, and Ralph A. Manchester. 1998. “Instrument-Specific Rates of Upper-Extremity Injuries in Music Students.” *Medical Problems of Performing Artists* 13, no. 1 (March 1998): 19-25.

Chang, Allen Ying-Lun, Hannah Boone, and Phil Gold. “Physical Health Status of Music STudents in a Post-Secondary Institution: A Cross-sectional Study.” *Work: a Journal of Prevention, Assessment, and Rehabilitation* 70, no. 4 (January 2021): 1101-1110.

Cornick, Erin, Kendra Del Carlo, and Laural Didham. “The Incidence and Prevalence of Temporomandibular Disorder: Signs and Symptoms among College Music Majors Who Play the Flute or Saxophone.” master’s thesis. Chapman University, Orange, CA, 1998. Proquest Dissertations & Theses Global.

ERGObrass Support System. “ERGOsax Saxophone Support System.” 2020. https://www.ergobrass.com/saxophone/.

Evans, A., T. Driscoll, and B. Ackermann. “Prevalence of Velopharyngeal Insufficiency in Woodwind and Brass Students.” *Occupational Medicine* 61, no. 7 (October 2011): 480–82. http://doi.org/10.1093/occmed/kqr072.

Fry, H. J. H. “Prevalence of Overuse (Injury) Syndrome in Australian Music Schools.” *British Journal of Industrial Medicine* 44, no. 1 (January 1987): 35–40. http://doi.org/10.1136/oem.44.1.35.

___. “The Treatment of Overuse Syndrome in Musicians. Results in 175 Patients.” *Journal of the Royal Society of Medicine* 81, no. 10 (October 1988): 572–575. http://doi.org/10.1177/014107688808101007.

García, Justin D. “Ethnicity.” *Salem Press Encyclopedia*. Salem Press. January 1, 2022. https://discovery.ebsco.com/linkprocessor/plink?id=624af079-965a-3ad8-aad6-b66635a5edec.

Gilbert, Danni, “A Comparison of Self-Reported Anxiety and Depression Among Undergraduate Music Majors and Nonmusic Majors.” *Journal of Music Teacher Education* 30, no.3 (June 2021): 69-83. https://doi.org/10.1177/10570837211021048.

Ginsborg, Jane, Gunter Kreutz, Mike Thomas, and Aaron Williamon. “Healthy Behaviours in Music and Non-Music Performance Students.” *Health Education* 109, no. 3 (June 2009): 242–58. http://doi.org/10.1108/09654280910955575.

Hatheway, Melissa, and Kriss Chesky. “Epidemiology of Health Concerns Among Collegiate Student Musicians Participating in Marching Band.” *Medical Problems of Performing Artists* 24, no. 4 (December 2013): 242-251. https://doi.org/10.21091/mppa.2013.4046.

Hartsell, H.D., and G.E. Tata. “A Retrospective Survey of Music-Related Musculoskeletal Problems Occurring.” *Physiotherapy Canada* 43, no. 1 (January-February 1990): 13-18.

Ishimori Wind Instruments Special Co. LTD. “Wood Stone Thumb Hook Type II.” Thumb Hook. 2020. https://www.wood-stone.jp/data/wood-stone/product/5ee9666f6c.jpg.

___. “Wood Stone Thumb Hook Type II.” Thumb Hook. 2020. https://www.wood-stone.jp/product/64.

Kok, Laura M, Theodora P. M. Vliet Vlieland, Marta Fiocco, and Rob G. H. H. Nelissen. “A Comparative Study on the Prevalence of Musculoskeletal Complaints among Musicians and Non-Musicians.” *BMC Musculoskeletal Disorders* 14, no. 9 (January 2013): 1-7. Http://doi.org/10.1186/1471-2474-14-9.

Kok, Laura M., Rob G.H.H. Nelissen, and Bionka M.A. Huisstede. “Prevalence and Consequences of Arm, Neck, and/or Shoulder Complaints Among Music Academy Students.” *Medical Problems of Performing Artists* 30, no. 3 (September 2015): 163–68. http://doi.org/10.21091/mppa.2015.3031.

Koops, Lisa Huisman, and Christa R. Kuebel. “Self-reported Mental Health and Mental Illness Among University Music Students in the United States.” *Research Studies in Music Education* 43, no. 2 (July 2021): 129-143. https://doi.org/10.1177/1321103X19863265.

Lagan Brennan. “Lagan Wrist Saver.” Lagan Music. 2020. https://www.lagan-music.com/product-page/lagan-wrist-saver.

Medoff, Lynn E., and Kim Short. “Treatment of Repetitive Stress Injury in a High Altitude Saxophone Player with Pectus Excavatum and Scoliosis.” *Orthopaedic Physical Therapy Practice* 14, no. 2 (2002): 11-18. https://www.orthopt.org/uploads/content_files/Treatment_of_Repetitive_Stress_Inujury_in_a_High_Altitude_Sax_Player.pdf.

MusicMedic. “MusicMedic Comfort Thumb Hook.” Saxophone Accessories. 2000-2021. https://www.musicmedic.com/catalog/product/view/id/339/s/musicmedic-comfort-thumb-hook/category/28/.

___. “MusicMedic Comfort Thumb Hook.” Saxophone Accessories. 2000-2021. https://www.musicmedic.com/media/catalog/product/cache/eaa1e91660665b874dd4d0098aac4310/t/h/thumbhooks4_2.jpg.

National Institute on Aging. “Four Types of Exercise Can Improve Your Health and Physical Ability,” Health Information. Last Modified January 29, 2021. https://www.nia.nih.gov/health/four-types-exercise-can-improve-your-health-and-physical-ability.

Orman, Evelyn K. “Effect of Virtual Reality Graded Exposure on Anxiety Levels of Performing Musicians: A Case Study.” *Journal of Music Therapy* 41, no. 1 (Spring 2004): 70-78. https://doi.org/10.1093/jmt/41.1.70.

Payne, Phillip D., Wesley Lewis, and Frank McCaskill. “Looking Within: An Investigation of Music Education Majors and Mental Health.” *Journal of Music Teacher Education* 29, no. 3 (June 2020): 50-61, https://doi.org/10.1177/1057083720927748

Pittel Hand EZE. “Pittel Hand Eze.” 2019. https://pittelhandeze.net.

Reeds Direct Cambridge. “Kooiman Forza Ergonomic Saxophone Thumbrest.” Thumbrest. 2021. https://www.reeds-direct.co.uk/kooiman-forza-ergonomic-saxophone-thumbrest-akf.html.

Shanoff, Chelsea, Kyurim Kang, Christine Guptill, and Michael Thaut. “Playing-Related Injuries and Posture Among Saxophonists.” *Medical Problems of Performing Artists* 34, no. 4 (December 2019): 215–21. http://doi.org/10.21091/mppa.2019.4032.

Schneider, Erin, and Kris Chesky. “Social Support and Performance Anxiety of College Music Students.” *Medical Problems of Performing Artists* 26, no. 3 (September 2011): 157-163.

Spahn, Claudia, Sandra Strukely, and Andreas Lehmann. “Health Conditions, Attitudes Toward Study, and Attitudes Toward Health at the Beginning of University Study: Music Students in Comparison with Other Student Populations.” *Medical Problems of Performing Artists* 19, no. 1 (March 2004): 26–33. http://doi.org/10.21091/mppa.2004.1005.

Steinmetz, A., H. Möller, W. Seidel, and T. Rigotti. “Playing-Related Musculoskeletal Disorders in Music Students-Associated Musculoskeletal Signs.” *European Journal of Physical, and Rehabilitation Medicine* 48, no. 4 (December 2012): 1-9.

Syamal, Mausumi N, and Paul C. Bryson. “Injection Pharyngoplasty With Autologous Fat as Treatment for Stress Velopharyngeal Insufficiency in Brass and Woodwind Musicians.” *JAMA Otolaryngology-- Head & Neck Surgery* 143, no. 2 (February 1, 2017): 142–46. http://doi.org/10.1001/jamaoto.2016.1920.

Thrasher, Michael, and Kris S. Chesky. “Medical Problems of Saxophonists: A Comparison of Physical and Psychosocial Dysfunction among Classical and Non-Classical Performers.” *The Saxophone Symposium* 24 (1999): 77-84.

Ton Kooiman, Woodwind Ergonomics. “The Kooiman FORZA Thumb Rest.” Publications. 2002-2015. https://www.tonkooiman.com/index.php/publications/12-the-kooiman-forza-thumb-rest.

van der Wegen-Keijser, M H, and D P Bruynzeel. “Allergy to Cane Reed in a Saxophonist.” *Contact Dermatitis* 25, no. 4 (October 1991): 268–69. http://doi.org/10.1111/j.1600-0536.1991.tb01868.x.