



GRADUATE SCHOOL
EAST TENNESSEE STATE UNIVERSITY

East Tennessee State University
**Digital Commons @ East
Tennessee State University**

Electronic Theses and Dissertations

Student Works

8-2021

Prevalence of Musculoskeletal Disorders in Third- and Fourth-Year Dental Students at the University of Tennessee Health Science Center College of Dentistry

Felisa Jackson
East Tennessee State University

Follow this and additional works at: <https://dc.etsu.edu/etd>



Part of the [Musculoskeletal Diseases Commons](#)

Recommended Citation

Jackson, Felisa, "Prevalence of Musculoskeletal Disorders in Third- and Fourth-Year Dental Students at the University of Tennessee Health Science Center College of Dentistry" (2021). *Electronic Theses and Dissertations*. Paper 3925. <https://dc.etsu.edu/etd/3925>

This Thesis - unrestricted is brought to you for free and open access by the Student Works at Digital Commons @ East Tennessee State University. It has been accepted for inclusion in Electronic Theses and Dissertations by an authorized administrator of Digital Commons @ East Tennessee State University. For more information, please contact digilib@etsu.edu.

Prevalence of Musculoskeletal Disorders in Third- and Fourth-Year Dental Students at the
University of Tennessee Health Science Center College of Dentistry

A thesis
Presented to
the faculty of the Allied Health Sciences Department
East Tennessee State University

In partial fulfillment
of the requirements of the degree
Master of Science in Allied Health

by
Felisa L. Jackson
August 2021

Dr. Deborah Dotson, Chair
Dr. Randy Byington
Dr. Tabitha Fair
Dr. Landon Shields

Keywords: musculoskeletal disorder, ergonomics, work-related musculoskeletal disorder,
sedentary, dentistry/ dental students and musculoskeletal disorder

ABSTRACT

Prevalence of Musculoskeletal Disorders in Third- and Fourth-Year Dental Students at the
University of Tennessee Health Science Center College of Dentistry

by

Felisa L. Jackson

The effects of pain suffered from musculoskeletal disorders by dental professionals may lead to reduced work hours, loss of production, and early retirement. Although third- and fourth-year dental students are provided lectures about musculoskeletal disorders, proper positioning and ergonomics, they are at an increased risk of developing MSD. This study was conducted to evaluate the prevalence on musculoskeletal disorders in third- and fourth-year dental students and to determine if third-year dental students experience more MSD pain than fourth-year dental students at the University of Tennessee Health Science Center College of Dentistry. A total of 50 third- and fourth- year dental students responded to the online questionnaire, 21 third-year dental students and 29 fourth-year dental students. Both third- and fourth-year dental students report experiencing MSD pain over the last twelve months. There was no statistically significant difference between MSD pain felt between third- or fourth-year dental students.

Copyright 2021 by Felisa L. Jackson

All Rights Reserved

DEDICATION

I dedicate this thesis to my family who has supported and encouraged me throughout this process. To my husband, Brandon, you have truly been my biggest cheerleader and the wind beneath my wings. I am so appreciative for you giving so much more than I ever deserved. To my children, Morgan, Braden, and Brooke, thank you for always pushing me to stay the course. I hope I am leading by example and showing you that you can always accomplish your goals if you just keep trying. And last, to my momma, Joyce Loyd, I can only imagine how proud you are of me. I wish you could be here to see this but God needed you more. I miss you still.

ACKNOWLEDGEMENTS

I must first thank God for keeping me throughout this program. When I doubted myself, He constantly reminded me that I was “good enough”. Even during a pandemic and the death of my beloved mother, God never left nor forsake me. He is so faithful and for that, I am eternally grateful.

I am so grateful for the support and guidance from my committee: Dr. Deborah Dotson, Dr. Randy Byington, Dr. Tabitha Fair, and Dr. Landon Shields. Dr. Byington, thanks for always challenging me to think outside of the box even when I just wanted to simply answer a discussion post. Dr. Dotson, your compassion and support has helped me throughout this process of obtaining my Master’s degree even when I did not think I could complete this process. Thank you for being a listening ear.

A special thanks to John Schuetz M Pharm. I am very grateful for your help and expertise. To my colleagues, I am so very grateful for your encouragement and knowledge throughout the program and allowing me to vent when needed. Lastly, a very special thanks to Jim Kimmelman DDS, MS, who constantly encouraged me to continue my pursuit of a higher degree.

TABLE OF CONTENTS

ABSTRACT.....	2
DEDICATION.....	4
ACKNOWLEDGEMENTS.....	5
TABLE OF CONTENTS.....	6
LIST OF TABLES.....	8
LIST OF FIGURES.....	9
Chapter 1. Introduction.....	10
Statement of the Problem.....	10
Significance of the Study.....	10
Research Questions.....	11
Limitations and Delimitations.....	11
Assumptions.....	11
Definition of Terms.....	12
Chapter 2. Literature Review.....	13
Musculoskeletal Disorder.....	13
Work-related Musculoskeletal Disorders.....	13
Musculoskeletal Disorders in Dental Professionals.....	13
Spine.....	14
Posture.....	15
Static Posture.....	15
Technology.....	16
Most Common Musculoskeletal Disorders.....	16
Carpal Tunnel Syndrome.....	17
Neck and Lower Back Pain.....	18
Musculoskeletal Disorders in Dental Students.....	18
Prevention of Musculoskeletal Disorders in Dental Professionals.....	19
Pinch Force.....	20
Loupes.....	21
Chairs.....	21
Exercise.....	23
Dental Light.....	24
Ergonomics.....	24
Chapter 3. Methods.....	26

Overview	26
Research Design.....	26
Study Sample	27
Informed Consent Consideration	27
Data Collection Procedures.....	27
Instrument	28
Research Questions	28
Data Analysis Procedures	28
Chapter 4. Results: Presentation and Analysis of the Data.....	29
Introduction.....	29
Response Rate	29
Respondents	29
Descriptive Results	30
Summary	46
Do third- and fourth-year dental students experience pain associated with musculoskeletal disorders?	46
Do third-year dental students experience more pain associated with musculoskeletal disorders than fourth-year dental students at the University of Tennessee Health Science Center, College of Dentistry?	47
Conclusions.....	47
Recommendations.....	48
References	49
APPENDICES	56
Appendix A: Questionnaire	56
Appendix B: Copyright Permission	59
VITA.....	68

LIST OF TABLES

Table 1. Sitting vs. Standing Dental Procedures.....	31
Table 2. Educational History of Third- and Fourth-Year Dental Students.....	32
Table 3. MSD Pain Responses by Site During the Last 12 months.....	32
Table 4. MSD Pain responses by Site During the Last 7 days	33
Table 5. MSD Pain responses by Site Currently Experiencing	34
Table 6. MSD Pain Responses by Site Before Entering Dental School	34
Table 7. MSD Pain Responses by Site While in Dental School.....	35
Table 8. MSD Pain responses by Site Development of Symptoms during Third Year of Dental School.....	35
Table 9. MSD Pain responses by Site Development of Symptoms during Fourth Year of Dental School.....	35

LIST OF FIGURES

Figure 1. Year in Dental School.....	30
Figure 2. Number of Dental Students Using Magnifying Loupes During Patient Care	31
Figure 3. Percentage of MSD Pain by Site by Year in Dental School.....	37
Figure 4. Treatment Modification due to MSD Symptoms	38
Figure 5. Respondents Who Sought Treatment for MSD pain	38
Figure 6. Respondents' Occurrence of MSD pain	39
Figure 7. Likelihood of Respondents to Adjust Posture	40
Figure 8. Number of Respondents Who Exercise.....	41
Figure 9. Frequency of Exercise of Respondents	41
Figure 10. Frequency of Technology Devices	42
Figure 11. Hypothesis Test Summary for MSD pain site for Third- and Fourth-Year Dental Students During Last Twelve Months.....	43
Figure 12. Hypothesis Test Summary for MSD pain site for Third- and Fourth-Year Dental Students During Last Seven Days	44
Figure 13. Hypothesis Test Summary for MSD pain site for Third and Fourth Year Dental Students Currently Experiencing.....	45
Figure 14. Hypothesis Test Summary for MSD pain site Development during Third year of Dental School.....	45

Chapter 1. Introduction

Musculoskeletal disorders are listed among the top five occupational hazards in dentistry (Ayatollahi et al., 2012; Singh et al., 2012). Because of the prolonged sitting during procedures, poor posture, and constant twisting of the trunk to access instruments, dentists are constantly at risk for musculoskeletal disorders (Ayatollahi et al., 2012; Singh et al., 2012). The effects of musculoskeletal disorders can become a financial burden to many dentists. Dentists are faced with decreased production when suffering with musculoskeletal disorders due to missed work (Valachi, B. & Valachi, K., 2003).

Statement of the Problem

Musculoskeletal disorders are one of the top occupational hazards among dental workers (Babaji et al., 2011). The importance of proper ergonomics is often not stressed in didactic courses during dental school. Because of this, many dental students do not practice proper ergonomics when performing dental procedures. There is a risk of lowered recruitment of students to the dental profession due to the increased risk of the prevalence of MSDs (Barry et al., 2017). Little is known about the knowledge of third- and fourth-year dental students regarding musculoskeletal disorders and prevention methods at the University of Tennessee Health Science Center College of Dentistry.

Significance of the Study

There have been few studies on the prevalence of musculoskeletal disorders among third- and fourth-year dental students. Due to the significance of the effects of musculoskeletal disorders, this research aims to report the prevalence of musculoskeletal disorders among third- and fourth-year dental students at the University of Tennessee Health Science Center College of Dentistry (UTHSC COD). Also, this study aims to determine if third-year dental students

experience more pain associated with musculoskeletal pain than fourth-year dental students at UTHSC COD.

Research Questions

The following questions guide this project:

Do third- and fourth-year dental students experience pain associated with musculoskeletal disorders?

Do third-year dental students experience more pain associated with musculoskeletal disorders than fourth-year dental students at the University of Tennessee Health Science Center College of Dentistry?

Limitations and Delimitations

This study was delimited to dental students at the University of Tennessee Health Science Center College of Dentistry. To participate in this study, the student must have met requirements to be classified as a third- or fourth-year dental students. Data was gathered in the spring of 2021 between the dates of 01/25/21 to 02/08/21 in Tennessee. These findings cannot be generalized to the entire population. The limitations of the study were the participants were not randomly selected and only represent students at the UTHSC COD. Additionally, the results were self-reported and could include participant dishonesty.

Assumptions

It is assumed all participants will respond to the questionnaire honestly. It is also assumed that the reported MSD pain is a result of work-related musculoskeletal disorder while in dental school and not as a result of a prior injury.

Definition of Terms

1. Musculoskeletal disorder (MSD): injuries or pain in the human musculoskeletal system, including the joints, ligaments, muscles, nerves, tendons, and structures that support limbs, neck and back (“Musculoskeletal disorder”, 2019).
2. Ergonomics: an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely (Merriam-Webster, n.d.).
3. Work-related musculoskeletal disorders (WMSDs): a group of painful disorders of muscles, tendon, and nerves. Carpal tunnel syndrome, tendonitis, thoracic outlet syndrome, and tension neck syndrome are examples (“Work-related Musculoskeletal Disorders (WMSDs), 2019).
4. Sedentary: doing or requiring much sitting; characterized by lack of physical activity (Merriam-Webster, n.d.).

Chapter 2. Literature Review

Musculoskeletal Disorder

Musculoskeletal disorders (MSDs) are commonly found among dental professionals. This disorder affects the muscles, tendons, ligaments, nerves, discs, blood vessels, and joints by causing micro damage to the musculoskeletal system. Musculoskeletal disorder is also called *repetitive motion injury* (Middlesworth, 2015). Symptoms of MSDs include frequent reoccurring pain, decrease in range of motion, muscle stiffness, and feelings of warmth and cold in extremities (Kapitan et al., 2018).

Work-related Musculoskeletal Disorders

Work-related musculoskeletal disorders are pain of the muscles, nerves, tendons, joints, cartilage, and spinal disc due to the work environment or performance of work (CDC, 2020). Work-related activities leading to MSD include constantly lifting heavy objects, using vibrating machinery, chronic neck flexion working positions, or performing repetitive tasks that require force (CDC, 2020). Static positions and repetitive motions are the causes of most work-related musculoskeletal disorders (Roshene & Loganathan, 2017). Work-related musculoskeletal disorders are very common among dental professionals. It is one of the top occupational hazards that affect dental professionals (Mehta & Lodha, 2014; Pejic et al., 2017).

Musculoskeletal Disorders in Dental Professionals

Dental professionals are in a demanding profession that requires precision and focus. This puts them at risk for developing cumulative trauma disorders. Ninety-two percent of dentists were found to experience pain in two regions of the spine, neck and lower back (Kierklo et al., 2011). Working long hours in awkward static positions, using repetitive movements, with

no recovery or rest breaks has placed dental professionals at high risk for work-related musculoskeletal disorders (Stratford, 2020). Because dentists assume awkward positions for prolonged periods and maintain their neck, shoulders, and head in fixed positions for long periods, they are susceptible to developing musculoskeletal disorders, psychological stress, and fatigue (Kierklo et al., 2011). Hip, feet, shoulder and elbow pain was reported as significant for dentists who did not take rest breaks between patients (Kierklo et al., 2011). One study suggested taking rest breaks between patients, exercising, maintaining standard working positions, changing posture during dental procedures, and avoiding fixed and prolonged neck flexion (Tirgar et al., 2015).

Spine

The spine provides support for the entire body and holds the body upright (Highsmith, 2020). The natural S-shape of the spine helps to alleviate compression of the nerves within the spine. The spine depends on several supporting structures to maintain its S-shape and route the nerves to innervate the proper organs (Highsmith, 2020). These supporting structures include spinal discs, facet joints, spinal ligaments, and spinal muscles and tendons. The spinal muscles and tendons “help stabilize and strengthen the vertebral column while supporting and limiting extreme bending, flexing, and twisting movements” (Highsmith, 2020). Dental professionals use static posture for long periods throughout the day. This increases the risk of MSD because the spine is forced into an unnatural C-shaped position (Langham, 2013b). When the spine is forced into the C-shaped position due to prolonged sitting, nerves, intervertebral discs, and vessels are compressed leading to MSD (Anu et al., 2018).

Posture

Dental professionals utilize awkward working positions for extended periods of time to access the patient's oral cavity. Clinicians are forced to bend and extend their torso while working over a lying patient causing additional stress on the back and spine (Samoladas et al., 2018). Risk factors for MSD include high task repetition and repetitive or sustained awkward posture (Middlesworth, 2015). Dentistry is demanding on posture and requires precision (Alogaibi et al., 2018; Ijaz et al., 2016; Partido, 2017). Dental professionals perform procedures requiring repetitive movements and static posture leading to neck, back and shoulder pain. Improper posture while performing repetitive tasks like scaling and root planing contribute to the risk of MSD and loss of productivity (Roshene & Loganathan, 2017). Physical posture that incorporates relaxed muscles and a well-balanced, neutral position allows the dental professional to maintain control, increased visibility, and decreased pain associated with MSD (Roshene & Loganathan, 2017).

Static Posture

Dentistry carries high risks of disability and premature career loss due to the use of static postures and prolonged use of unsupported, elevated arms and extended neck positions (Cherniack et al., 2010). Dental procedures involve precision movements for instrumentation in a small operative field which require focus and static postures to perform. Prolonged static postures increase the risk of developing lower back pain. The internal spinal load is increased during static seating positioning. Maintaining poor posture for prolonged periods can result in muscular fatigue and lead to soft tissue adaptation and disability (Kierklo et al., 2011; Roshene, 2017). Regularly changing sitting positions throughout dental procedures is thought to reduce back problems (Zemp et al., 2013). Ergonomists suggest varying seat posture and moving

regularly preserves spinal health (Pope et al., 2002). A study in Poland reported 29.1% of dentists worked more than 8 hours a day. In the study, 46.3% of dentists took at least 1 break during the course of the 8-hour day (Szymanska, 2002). Similarly, a study in Northern Greece found 47.1% of participants correlated their pain with their working hours, with peak incidence 1 hour after initiation of work (Samoladas et al., 2018). Hayes et al. (2009) reported long working hours, inadequate breaks, and working in a static position for prolonged periods contributed to developing work-related musculoskeletal disorders. A study of dental hygienists showed where 53.79% worked more than 7 hours per day, 77.62% of them treated 10 to 20 patients per day and 83.45% reported that they had no recovery or comfort breaks other than lunch break (Stratford, 2020). Students who worked longer hours in the clinic were 12 times more likely to report discomfort in one or more areas of the body (Khan & Chew, 2013).

Technology

The advancement of technology including mobile phones, computers, and tablets has had an effect on posture. Gold et al. (2010) reported that high volumes of text messaging lead to MSDs. The flexed neck position and non-neutral wrist postures while holding mobile devices were shown as a common posture among college-aged students (Gold et al., 2012; Gustafsson et al., 2017). The flexed neck position over long periods causes nerve entrapment syndrome (Padua et al., 2016). This was also exhibited in the elbow due to the flexed elbow when holding a mobile phone during phone call conversations or when texting (Padua et al., 2016).

Most Common Musculoskeletal Disorders

The most common MSDs are Carpal Tunnel Syndrome, tendinitis, neck and shoulder pain, and lower back strain (Kluksdahl, 2017). These disorders prevent employees from working

and cost businesses \$15-\$18 billion yearly (Kluksdahl, 2017). Carpal Tunnel Syndrome is caused by inflammation in the hands causing pressure on the median nerve. The median nerve controls movement in the first three fingers. It is characterized by pain or numbness that increases with use or stiff fingers. Tendinitis is caused by inflammation of a tendon. Its symptoms include inflammation of the tendon that occurs suddenly or gradually, and a loss of motion in the affected area. A rotator cuff tear injury is due to overuse of the tendon. The tendon becomes severed due to a sudden action or normal wear and tear. Weakness in the arm and a dull achy pain are symptoms of a rotator cuff injury. When the muscles in the back are stretched too far, lower back strain occurs. Back stiffness, radiating leg pain, muscle aches and stabbing pains are characteristics of lower back pain (Kluksdahl, 2020).

Carpal Tunnel Syndrome

One of the most common musculoskeletal disorders affecting the hand and wrist is carpal tunnel syndrome (CTS). The wrist and palm are connected through a narrow passageway called the carpal tunnel. The carpal tunnel houses the tendons and median nerve. The tunnel is narrowed or thickened due to repetitive wrist motions and high levels of pinch force. Carpal tunnel syndrome (CTS) is characterized by numbness, weakness, pain in the hand and wrist. These symptoms can be found to be worse at night and with repetitive motions (Hamann et al., 2001). Researchers found a correlation between the longer numbers of hours a dentist worked using repetitive motions with the wrist and a higher prevalence of CTS (Hamann et al., 2001). CTS tends to be more prevalent in the dominant hand than in the general population (Hamann et al., 2001).

Neck and Lower Back Pain

Dental professionals are susceptible to lower back and neck pain due to many predisposing work-related factors. Dental professionals are required to lean over their patients during procedures while extending their neck and torsos to access the oral cavity. The extension of the neck and torso for long periods burdens the lumbar and cervical spine (Samoladas et al., 2018). During dental procedures, dental professionals tend to raise their arms unsupported while performing delicate maneuvers using small instruments. The forces produced from awkward postures and the extension of the neck and torso for prolonged time exhaust the musculature and lead to work-related cervical and lumbar pain (Samoladas et al., 2018). Dentists who have been practicing longer have higher prevalence of lower back and neck pain than dentists working fewer years (Hayes et al., 2009). Women also reported having a greater prevalence of cervical pain than men (Hayes et al., 2009). Lower back pain is the most prevalent musculoskeletal disorder found in male dentists (Grado et al., 2019; Hayes et al., 2009). In dental students, researchers found pain in the neck/shoulder and lower back regions were the most symptomatic and frequently reported (Rising et al., 2005).

Musculoskeletal Disorders in Dental Students

Dental professionals can begin to experience MSD pain as early as dental school. Third year dental students reported having the most pain as compared to first year dental students (Rising et al., 2005). Many dental students begin treating actual patients, instead of manikins, clinically during their third year of dental school allowing for exposure to awkward positioning and prolonged static postures. Some studies have found that third-year dental students begin to complain of back pain (Alogaibi et al., 2018; Kapitan et al., 2019). Dental students at UTHSC COD begin their clinical experience of scaling, restorations, and extractions during their third

year of dental school. During these clinical experiences, dental students work alone without the use of dental auxiliary therefore requiring greater movement (Anu et al., 2018). Repetitive movements and constant twisting of the trunk of the body lead to symptoms of MSDs. Possible causes of the increased prevalence of MSD during the third year of dental school include: as students progress to the clinic, they experience longer working hours, nature of work, work environment, and working load in the pre-clinical and clinical practice (Rayyan et al., 2015). Researchers found dental professionals begin to experience MSD pain within the first five years of practicing but experience elevated pain after the initial five years (Alhusain et al., 2019; Grado et al., 2019; Kierklo et al., 2011; Szymanska, 2002). Tigrar et al. (2015) reported dentists experience the most pain in the first half of all their years of practice. Musculoskeletal disorders lead to a loss of productivity and decrease in quality of work due to fatigue. During the first years of practice after dental school, young dentists tend to work intensively for long hours which lead to MSDs. The body begins to adapt to the abnormal postures that develop as a result of muscle imbalances and the unbalanced postures are then carried over into leisure activities as well (Valachi & Valachi, 2003). . Experienced dentists adjust their posture to avoid pain or leave the profession due to severe WMSD (Leggat, 2007).

Prevention of Musculoskeletal Disorders in Dental Professionals

Pain associated with the development of musculoskeletal disorders is common for dental professionals. This pain is often ignored as it persists and eventually can result in a change of career, reduced work hours, loss of productivity and life altering pain. Researchers have offered suggestions of how dental professionals can prevent or alleviate pain associated with musculoskeletal disorders (Chismark & Hung, 2015; Sharma et al., 2016; Zemp et al., 2013).

The prevalence of developing MSDs can be reduced by correcting posture, instrument design and grip, magnification, choosing the proper chair, exercise and lighting.

Using the correct working posture while performing dental procedures allows the muscles of the lower back to relax. When dental professionals use a neutral working posture, the risk of developing MSDs is reduced. During awkward posture, muscles in the lower back have to contract in order to support the trunk of the body. A neutral position allows the joints to exert a full range of motion (Sharma et al., 2016). As the trunk of the body moves out of the neutral position, it decreases its range of motion and exerts strain on the muscles of the lower back around the joints. The more awkward and repetitive the position, the more likely musculoskeletal disorders are to develop. Dental professionals tend to adopt awkward posture because of improper seating of the operator and/or the patient (Sharma et al., 2016). Patients are suggested to be positioned in a supine position with the feet slightly elevated above the head. This positioning allows the operator to work effectively in a neutral position encouraging the patient to tilt the head upward when working on the maxillary arch and downward when working on the mandibular arch. Poor patient positioning often leads to the operator using an awkward posture to access the patient's oral cavity. By adjusting the patient chair and patient, a neutral position can be obtained and sustained to maintain musculoskeletal health (Rempel et al., 2015).

Pinch Force

Repetitive use of high levels of pinch force applied to instruments when performing dental procedures such as scaling and root planing can lead to musculoskeletal disorders (Rempel et al., 2015). Using a proper grasp while using the instrument allows the operator to use less pinch force and have better control of the instrument. In addition, using an ultrasonic scaler to perform gross debridement prior to hand scaling, allows the operator to use less pinch force to

remove remaining debris. A higher level of grip force is needed when using a smaller diameter instrument over long periods. Lightweight, larger diameter instruments and instruments with a good grip surface help to reduce high levels of pinch force. Lightweight, larger diameter instruments have been shown to reduce to prevalence of pain in the upper extremities (Rempel et al., 2012). Operators reported experiencing less hand pain during sleeping hours and taking less pain medications after using lightweight, larger diameter instruments (Rempel et al., 2012). The grip surface of an instrument is designed to increase the friction between the gloved finger and the instrument (Rempel et al., 2015). The increased friction prevents the instrument from slipping during instrumentation and allowing the operator to use a more relaxed grip and less pinch force. Sharp instruments also help to decrease high levels of pinch force. Scaling and root planing require high levels of pinch force which increases risks of developing musculoskeletal disorders, such as carpal tunnel syndrome.

Loupes

Loupes are glasses with magnifying lenses attached to increase visibility in the oral cavity (Rempel et al., 2015). Loupes help the operator maintain a neutral working posture therefore helping to prevent pain associated with musculoskeletal disorders. Loupes help to prevent the operator from assuming a forward position which increases the risk of neck flexion. The magnification is typically between 2x to 3x. Oftentimes, a light is attached to the loupes to provide better illumination of the oral cavity.

Chairs

The type of chair used during dental procedures plays an important role on the development of musculoskeletal disorders (Langham, 2013a). Early humans were constantly on

the move scavenging and hunting for food. As humans evolved, the chair became more popular to symbolize authority. Kings, emperors and people of high authority sat upon chairs to distinguish themselves (Langham, 2013a). Many dental procedures like scaling and root planing, restorations, and routine care are lengthy procedures and require dental professionals to sit on a stool with or without a backrest. The use of a backrest was found to not have a significant effect on improving posture (Dable et al., 2014). The upper body tends to slump when sitting in a conventional chair or stool over long periods of time. This slumping causes the spine to lose its natural “S” shape where muscles are supported to form a more “C” shape which increases intradiscal pressure, ligament tension, and disc degeneration (Westley, 2013; Pynt et al., 2001).

The proper chair used during dental procedures can directly affect the prevalence of musculoskeletal disorders in dental professionals. Chairs provide support to the body to allow muscles to relax while working and support the natural S-shape of the spine. The design of the chair and seat affects how the spine will be supported when sitting (Rempel et al., 2015). Most dental office chairs have flat seats. The flat seat does not support the natural S-shape of the spine and causes the spine to flatten in the lower back (Rempel et al., 2015). When the lower spine is flattened, the spine curves forward increasing the risk of pain associated with MSDs. Studies support the use of a saddle chair which tilts anteriorly to encourage the pelvis to maintain a more neutral position thereby supporting the natural S-shape curve of the spine (Gandavadi et al., 2005; Rempel et al., 2015; Sharma et al., 2016). The tilt of the saddle chair also allows full range of motion of the spine, which supports upper limb stability to help dental professionals experience less pain (Gandavadi et al., 2005). When a saddle seat is unavailable, a wedge-shaped cushion can be placed on the flat dental chair. The wedge will help to decrease lower back pain by tilting the pelvis anteriorly and maintain a neutral position (Rempel et al., 2015).

Exercise

Exercises like Yoga, stretching and relaxation help to prevent pain associated with musculoskeletal disorders. These activities help to relieve muscle tension in the lower back, neck and shoulders. Yoga helps to make the neck and back less prone to injury by toning the muscles. Yoga as a means of relaxation, in conjunction with proper nutrition and exercise, helps to combat stress (Sharma et al., 2016). Stretch breaks during lengthy procedures allows the body an opportunity to relax muscles and discontinue the use of static postures. The body is able to replenish blood flow to stressed muscles during stretching. Stretching has several benefits on the body. Stretching can serve to:

- Increase blood flow to muscles
- Increase the production of joint synovial fluid
- Reduce the formation of trigger points
- Maintain normal joint range of motion
- Increase nutrient supply to vertebral disks
- Create a relaxation response in the central nervous system
- Warm up the muscle before beginning to work
- Identify tight structures that may be predisposed to injury. (Occupational Health Clinics for Ontario Workers Inc. [OHCOW], 2012, p. 23)

Frequent stretch breaks are essential to replenishing and repairing the muscles, however, having long periods in between stretch breaks can lead to the breakdown of tissue (OHCOW,

2012). Baheti and Toshniwal (2014) suggest exercises for body strengthening, hand, neck, back, and shoulder to prevent work-related musculoskeletal disorders among dental professionals. The researchers suggested the health and integrity of the spinal column would be enhanced by performing these exercises. One study found nearly 68% of dentists exercise only occasionally or when the MSDs appear (Kierklo et al., 2011). Another study found 66% of dentists reported they perceived regular physical activity prevented or decreased the prevalence of musculoskeletal disorders (Symanska, 2002).

Dental Light

The dental light positioning is critical to maintain a neutral position when performing dental procedures. The dental light is designed to help provide a shadow-free, color-correcting illumination on concentrated areas in the oral cavity (OHCOW, 2012). The effect of producing a shadow on the oral cavity during dental procedures increases the risk of the operator sitting in an awkward position to obtain a better view. The dental light should be positioned close to the line of sight to provide optimal illumination. The operator should position the light above and slightly behind the patient's oral cavity. The light should also be positioned where the operator can adjust as needed (OHCOW, 2012).

Ergonomics

Ergonomics is defined as “an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely” (Merriam-Webster, Definition of ergonomics section). Proper ergonomics includes designing equipment that is correct for the job (Roshene & Loganathan, 2017). Ergonomics is effective in reducing the prevalence of MSDs. Educating professionals about ergonomics can help prevent

musculoskeletal disorders. Utilizing magnification devices during dental procedures and using correct posture can help alleviate lower back and neck pain (Amin et al., 2019).

Chapter 3. Methods

Overview

The purpose of this study was to identify the prevalence of musculoskeletal disorders (MSD) among third- and fourth-year dental students at the University of Tennessee Health Science Center, College of Dentistry. This study also determined the differences between the prevalence of MSDs in third- and fourth-year dental students at the University of Tennessee Health Science Center, College of Dentistry.

Research Design

A non-experimental research design will be used in this proposed study. Cottrell and McKenzie (2011) stated that non-experimental research designs “are typically utilized when it is not practical, possible, feasible, or desirable to manipulate an independent variable as would be necessary in experimental research” (p. 194). Non-experimental research design is important to health education profession because it often answers important questions about the profession.

A modified, validated online questionnaire will be used to determine the prevalence of musculoskeletal disorders of third-and fourth-year dental students. The questionnaire will also help determine if third-year dental students experience more or less pain associated with musculoskeletal disorders than fourth-year dental students. “Survey research is an excellent way to gain information about a particular group of people” (Cottrell & McKenzie, 2011, p. 195). A cross-sectional survey design was used because it allowed collection of data at a specific point in time (Cottrell & McKenzie, 2011). Dental students at UTHSC follow an academic schedule which includes promotion to the next level and graduation. In order to survey third-year dental students who have worked with patients in the clinic, the cross-sectional survey design was used.

Study Sample

The convenience sample for this study will consist of third- and fourth-year dental students who are over the age of 18 and enrolled at the University of Tennessee Health Science Center, College of Dentistry.

Informed Consent Consideration

Consent will be obtained from all participants in the study. An invitation to participate will be emailed to the students. The invitation will be sent to third- and fourth- year dental students at UTHSC, COD and will explain the study. All participants will be informed that they have the right to accept or refuse to participate in the study. When the participant accesses the questionnaire provided by the link in the email, the participant is directed to the RedCap survey which provides an informed consent document. They must choose whether or not to agree to participate in the survey. If they agree, the willingness to complete the survey will serve as consent to participate in the study. They then will be directed to the survey. If they do not agree, the survey will end. “That is, if after being informed about the study, the participants complete the research instrument, it is assumed that they consent” (Cottrell & McKenzie, 2011, p. 109). Students are also assured that their anonymity will not be compromised.

Data Collection Procedures

Data will be collected using the web-based survey software, REDcap. An invitation with the link to participate in the online survey will be sent out on 01/25/21 to the third- and fourth year dental students' UTHSC email accounts. The questionnaire will address the student's knowledge of MSD, demographical information, and presence or absence of musculoskeletal pain. Reminder communications will be sent out three times within the following two weeks to increase response rate. Data collection will conclude on 02/08/21.

Instrument

A modified Standardized Nordic Questionnaire survey instrument will be used (Appendix B). Permission to use the questionnaire was obtained through the Copyright Clearance Center (Appendix C). All participants will provide demographic information from questions asked in the questionnaire. This survey will illustrate the back of the body and common areas where musculoskeletal symptoms are experienced. The survey will aid in identifying these areas for study participants.

Research Questions

The following questions guide this project:

Do third- and fourth-year dental students experience pain associated with musculoskeletal disorders?

Do third-year dental students experience more pain associated with musculoskeletal disorders than fourth-year dental students at the University of Tennessee Health Science Center, College of Dentistry?

Data Analysis Procedures

The collected data will be analyzed using IBM-SPSS version 26. The objective of this study was to assess musculoskeletal pain using the Value scale. Pain was self-reported and noted by Yes and No responses. This analysis will be performed using the Mann-Whitney U test for differences.

Chapter 4. Results: Presentation and Analysis of the Data

Introduction

Because little research exists about the significance of the effects of musculoskeletal disorders in dental students, this study was conducted to determine the prevalence of musculoskeletal disorders in third- and fourth-year dental students at the University of Tennessee Health Science Center. This study also aimed to determine whether a difference existed in the prevalence of musculoskeletal disorders between these third- and fourth-year dental students. The following questions guided this study:

1. Do third- and fourth-year dental students experience pain associated with musculoskeletal disorders?
2. Do third-year dental students experience more pain associated with musculoskeletal disorders than fourth-year dental students at the University of Tennessee Health Science Center College of Dentistry?

Response Rate

A total of 190 students were emailed a 22-item online questionnaire. Fifty-one responded after one email reminder over a two-week data collection period. One response was identified as incomplete. The incomplete response was not included in the data analysis. Participants were required to answer every question yielding a response rate of 26%.

Respondents

Participants of this study were third- and fourth-year dental students at the University of Tennessee Health Science Center, College of Dentistry and were over the age of 18. Of the 50 participants in the study, 21 participants were third-year dental students and 29 participants were

fourth-year dental students (Figure 1). Over half of the respondents were fourth-year dental students (58%; Figure 1).

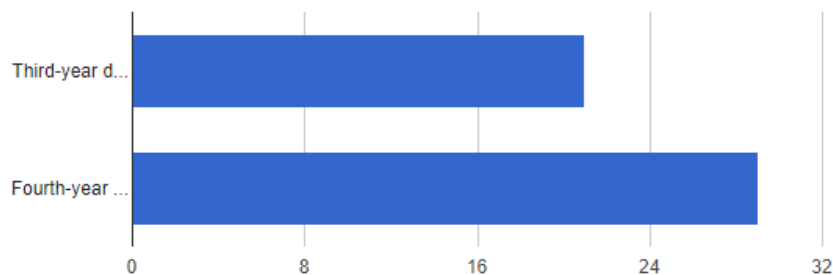
Figure 1

Year in Dental School

I am a: *(year)*

Total Count (N)	Missing*	Unique
50	1 (2.0%)	2

Counts/frequency: Third-year dental student (21, 42.0%), Fourth-year dental student (29, 58.0%)



Descriptive Results

A majority (98%) of the respondents use magnifying loupes during dental procedures (Figure 2). While sixty percent of respondents reported performing dental procedures from a standing position, one hundred percent of the respondents reported performing dental procedures from a sitting position (Table 1). The data shows there is an overlap of students who stand and/or sit while performing dental procedures.

Figure 2

Number of Dental Students Using Magnifying Loupes During Patient Care

Do you use magnifying loupes during dental procedures?

Total Count (N)	Missing*	Unique
50	1 (2.0%)	2

Counts/frequency: Yes (49, 98.0%), No (1, 2.0%)

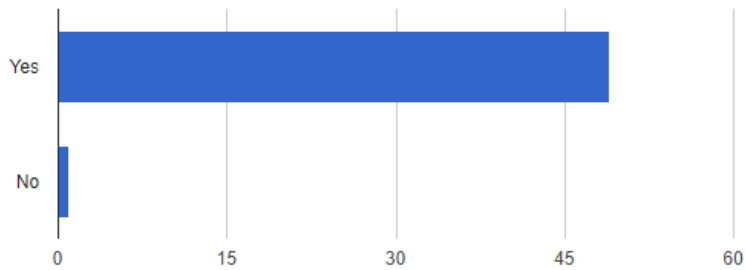


Table 1

Sitting vs. Standing Dental Procedures

Position	Counts of students	Percentage
Standing	30	60%
Sitting	50	100%

Both third- and fourth-year dental students reported being provided lectures on ergonomics or proper positioning (100.0%; Table 1). Ninety-two percent of respondents reported being provided lectures on musculoskeletal disorders (Table 2).

Table 2*Educational History of Third- and Fourth-Year Dental Students*

Response	Ergonomics/ Proper Positioning Lectures(n=50)	Musculoskeletal Disorders Lectures (n=50)
Yes	50(100.0%)	46 (92.0%)
No	0(0.00%)	4(8.0%)

Participants reported having experienced MSD pain within the past 12 months primarily in the neck (80.0%), lower back (68.0%), shoulders (66.0%), and upper back (62.0%)(Table 3). Within the last seven days, participants reported MSD pain primarily in the neck (50.0%) and shoulders (48.0%) (Table 4). Table 5 reflects MSD pain participants were experiencing during the time of the questionnaire.

Table 3*MSD Pain Responses by Site During the Last 12 months*

MSD Pain Site	YES n(%)	NO n(%)
Neck	40(80%)	10(20%)
Shoulders	33(66%)	17(34%)

Upper back	31(62%)	19(38%)
Elbows	2(4%)	48(96%)
Wrists/Hands	16(32%)	34(68%)
Lower back	34(68%)	16(32%)
Hip/Thighs	10(20%)	40(80%)
Knees	8(16%)	42(84%)
Ankles/Feet	5(10%)	45(90%)

Table 4

MSD Pain responses by Site During the Last 7 days

MSD Pain Site	YES n(%)	NO n(%)
Neck	25(50%)	25(50%)
Shoulders	24(48%)	26(52%)
Upper back	24(48%)	26(52%)
Elbows	1(2%)	49(98%)
Wrists/Hands	5(10%)	45(90%)
Lower back	21(42%)	29(58%)
Hip/Thighs	7(14%)	43(86%)
Knees	5(10%)	45(90%)
Ankles/Feet	2(4%)	48(96%)

Table 5*MSD Pain responses by Site Currently Experiencing*

MSD Pain Site	YES <i>n</i> (%)	NO <i>n</i> (%)
Neck	20(40%)	30(60%)
Shoulders	15(30%)	35(70%)
Upper back	15(30%)	35(70%)
Elbows	1(2%)	49(98%)
Wrists/Hands	2(4%)	48(96%)
Lower back	9(18%)	41(82%)
Hip/Thighs	3(6%)	47(94%)
Knees	2(4%)	48(96%)
Ankles/Feet	2(4%)	48(96%)

Participants who reported experiencing MSD pain before entering dental school is reflected in Table 6. Lower back (34%), shoulders (24%), and upper back (24%) were the primary sites of MSD pain before entering dental school. Participants reported an increase in MSD symptoms while in dental school as seen in Table 7.

Table 6*MSD Pain Responses by Site Before Entering Dental School*

MSD Pain Site	YES <i>n</i> (%)	NO <i>n</i> (%)
Neck	10(20%)	40(80%)
Shoulders	12(24%)	38(76%)
Upper back	12(24%)	38(76%)

Elbows	1(2%)	49(98%)
Wrists/Hands	3(6%)	47(94%)
Lower back	17(33%)	33(66%)
Hip/Thighs	3(6%)	47(94%)
Knees	7(14%)	43(86%)
Ankles/Feet	4(8%)	46(92%)

Table 7

MSD Pain Responses by Site While in Dental School

MSD Pain Site	YES <i>n</i> (%)	NO <i>n</i> (%)
Neck	33(66%)	17(34%)
Shoulders	27(54%)	23(46%)
Upper back	29(58%)	21(42%)
Elbows	1(2%)	49(98%)
Wrists/Hands	12(24%)	38(76%)
Lower back	20(40%)	30(60%)
Hip/Thighs	3(6%)	44(88%)
Knees	7(14%)	47(94%)
Ankles/Feet	2(4%)	48(96%)

Participants began to experience MSD pain primarily in the neck (40%), shoulders (34%), and upper back (36%) during their third year of dental school (Table 8; Figure 3).

Participants who were in their fourth year of dental school reported beginning to experience

MSD pain during their fourth year of dental school as opposed to their third year of dental school. The neck (39.3%) and shoulders (28.6%) were the most affected areas of MSD pain development during their fourth year of dental school (Table 9; Figure 3).

Table 8

MSD Pain responses by Site Development of Symptoms during Third Year of Dental School

MSD Pain Site	YES <i>n</i> (%)	NO <i>n</i> (%)
Neck	20(40%)	30(60%)
Shoulders	17(34%)	33(66%)
Upper back	18(36%)	32(64%)
Elbows	1(2%)	49(98%)
Wrists/Hands	7(14%)	43(86%)
Lower back	12(24%)	38(76%)
Hip/Thighs	5(10%)	45(90%)
Knees	3(6%)	47(94%)
Ankles/Feet	2(4%)	48(96%)

Table 9

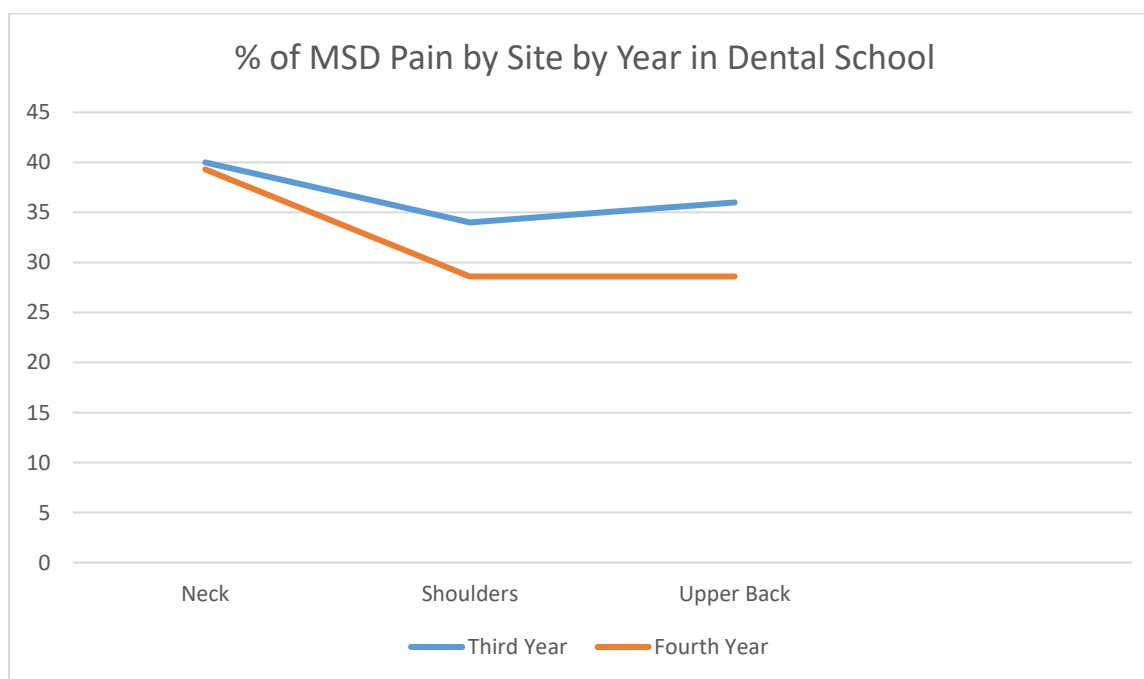
MSD Pain responses by Site Development of Symptoms during Fourth Year of Dental School

MSD Pain Site	YES <i>n</i> (%)	NO <i>n</i> (%)
Neck	11(39.3%)	17(60.7%)
Shoulders	8(28.6%)	20(71.4%)
Upper back	8(28.6%)	20(71.4%)
Elbows	1(3.6%)	27(96.4%)

Wrists/Hands	1(3.4%)	28(96.6%)
Lower back	5(17.9%)	23(82.1%)
Hip/Thighs	0(0.0%)	28(100.0%)
Knees	0(0.0%)	28(100.0%)
Ankles/Feet	0(0.0%)	28(100.0%)

Figure 3

Percentage of MSD Pain by Site by Year in Dental School



Only ten participants (20.0%) reported having to modify treatment on a patient because of musculoskeletal symptoms (Figure 4). Fourteen (28.0%) of participants reported seeking treatment for musculoskeletal symptoms (Figure 5).

Figure 4

Treatment Modification due to MSD Symptoms

Have you had to modify treatment on a patient because of musculoskeletal symptoms?

Total Count (N)	Missing*	Unique
50	1 (2.0%)	2

Counts/frequency: Yes (10, 20.0%), No (40, 80.0%)

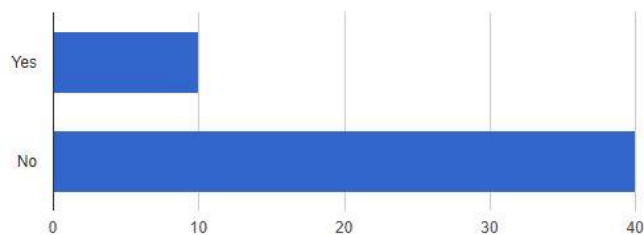


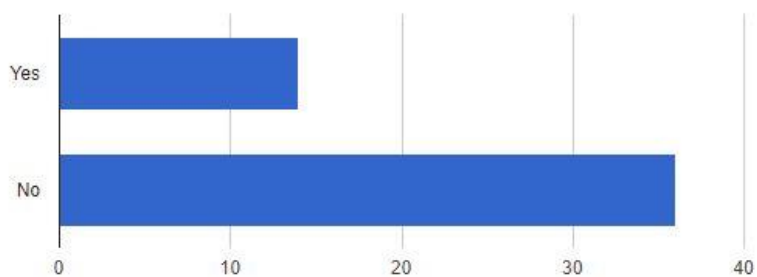
Figure 5

Respondents Who Sought Treatment for MSD pain

Have you had to seek treatment for musculoskeletal symptoms?

Total Count (N)	Missing*	Unique
50	1 (2.0%)	2

Counts/frequency: Yes (14, 28.0%), No (36, 72.0%)



A majority of the participants reported symptoms of MSD occurring after the patient appointment (71.4%). Other symptom occurrences were reported in the evening (40.8%), and during the patient appointment (38.8%; Figure 6). Most participants (86.0%) were more likely to adjust their positioning when having difficulty seeing an area of the mouth (Figure 7).

Figure 6

Respondents' Occurrence of MSD pain

If you answered yes to any of the above questions, when do your symptoms occur?

Total Count (N)	Missing*	Unique
49	2 (3.9%)	6

Counts/frequency: Early morning (2, 4.1%), Evening (20, 40.8%), During Sleep (6, 12.2%), All the time (8, 16.3%), After patient appointment (35, 71.4%), During patient appointment (19, 38.8%)

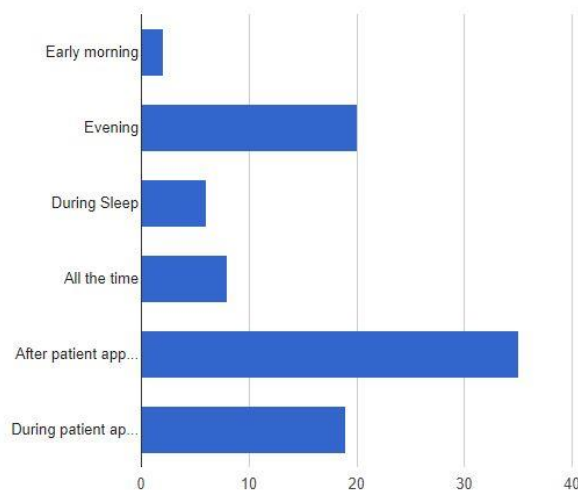


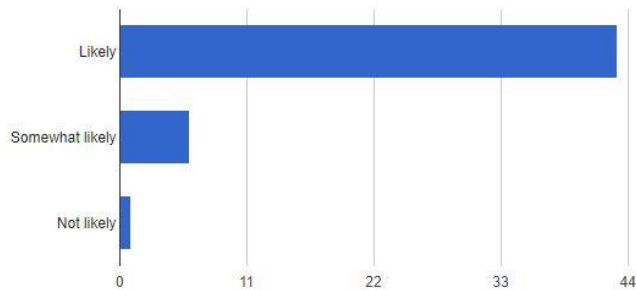
Figure 7

Likelihood of Respondents to Adjust Posture

How likely are you to adjust your positioning when having difficulty seeing an area of the mouth?

Total Count (N)	Missing*	Unique
50	1 (2.0%)	3

Counts/frequency: Likely (43, 86.0%), Somewhat likely (6, 12.0%), Not likely (1, 2.0%)



Thirty-eight participants (76%) reported currently exercising (Figure 8). Most participants (55.3%) reported exercising one to three times weekly. Other participants (36.8%) reported exercising four to six times weekly. Three participants (7.9%) reported exercising every day. Figure 9 illustrates the frequency of exercise of the participants.

Figure 8

Number of Respondents Who Exercise

Are you currently exercising?

Total Count (N)	Missing*	Unique
50	1 (2.0%)	2

Counts/frequency: Yes (38, 76.0%), No (12, 24.0%)

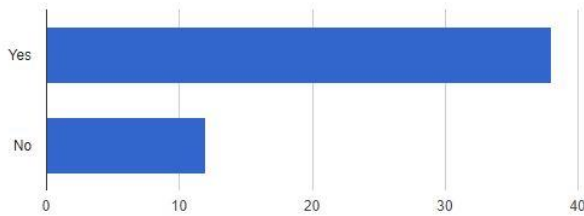


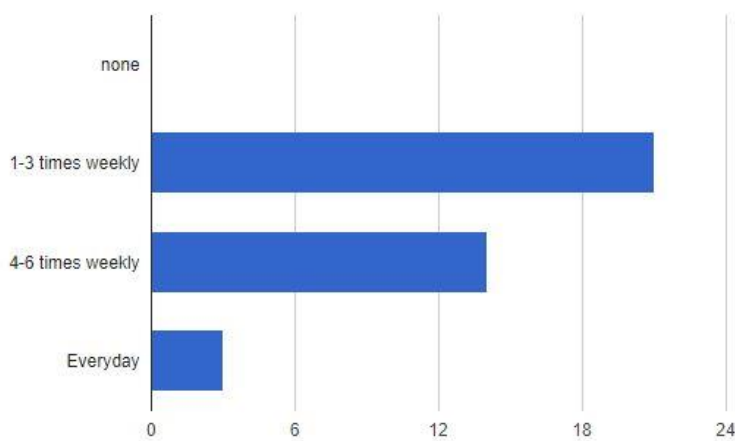
Figure 9

Frequency of Exercise of Respondents

How often do you exercise?

Total Count (N)	Missing*	Unique
38	13 (25.5%)	3

Counts/frequency: none (0, 0.0%), 1-3 times weekly (21, 55.3%), 4-6 times weekly (14, 36.8%), Everyday (3, 7.9%)



Most participants (52.0%) reported spending one to four hours per day using a phone, tablet, computer or some other type of electronic device. The flexed neck position while holding electronic devices were common among college-aged students (Gold et al., 2012; Gustafsson et al., 2017). Padua et al. (2017) discussed how nerve entrapment syndrome can develop when the neck is in a flexed position over long periods of time. Some participants (44.0%) used technology devices five to eight hours daily, while a small number of participants (4.0%) spent more than eight hours daily using technology devices (Figure 10).

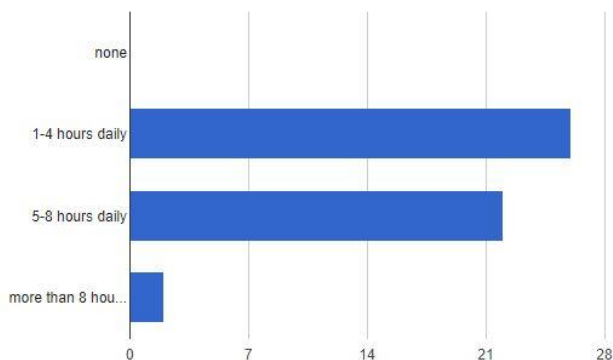
Figure 10

Frequency of Technology Devices

How many hours per day do you spend using your phone, tablet, computer or some other type of electronic device?

Total Count (N)	Missing*	Unique
50	1 (2.0%)	3

Counts/frequency: none (0, 0.0%), 1-4 hours daily (26, 52.0%), 5-8 hours daily (22, 44.0%), more than 8 hours daily (2, 4.0%)



Results from the Whitney Mann U test indicated there was no statistically significant difference between third- and fourth-year dental students reported musculoskeletal pain (alpha=0.05). Both groups experienced some pain distribution at all musculoskeletal sites during

the last twelve months (Table 3). The mean for neck pain within the last twelve months for third-year dental students was 25.6 as compared to fourth-year dental students 25.67. The p (sig) values from all MSD pain sites ranged from 0.093 to 0.887 and all exceeded the study's significance level ($\alpha=0.05$) (Figure 11). No statistically significant difference was seen between the third- and fourth-year dental students' MSD pain symptoms within the last seven days (Figure 12). Additionally, there was no statistically significant difference seen between third- and fourth-year dental students currently experiencing MSD pain (Figure 13). A statistically significant difference ($p=0.049$) was found in the lower back pain developed during third year of dental school (Figure 14).

Figure 11

Hypothesis Test Summary for MSD pain site for Third- and Fourth-Year Dental Students During Last Twelve Months

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of neck pain during last 12 months is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.887	Retain the null hypothesis.
2	The distribution of shoulder pain during last 12 months is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.200	Retain the null hypothesis.
3	The distribution of upper back pain during last 12 months is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.567	Retain the null hypothesis.
4	The distribution of elbow pain during last 12 months is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.093	Retain the null hypothesis.
5	The distribution of wrist/hand pain during last 12 months is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.166	Retain the null hypothesis.
6	The distribution of lower back pain during last 12 months is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.296	Retain the null hypothesis.
7	The distribution of hip/thigh pain during last 12 months is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.571	Retain the null hypothesis.
8	The distribution of knee pain during last 12 months is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.620	Retain the null hypothesis.
9	The distribution of ankles/feet pain during last 12 months is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.395	Retain the null hypothesis.

Figure 12

Hypothesis Test Summary for MSD pain site for Third- and Fourth-Year Dental Students During Last Seven Days

Hypothesis Test Summary				
Null Hypothesis		Test	Sig.	Decision
1	The distribution of neck pain during last 7 days is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.395	Retain the null hypothesis.
2	The distribution of shoulders pain during last 7 days is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.097	Retain the null hypothesis.
3	The distribution of upper back pain during last 7 days is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.276	Retain the null hypothesis.
4	The distribution of elbow pain during last 7 days is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.240	Retain the null hypothesis.
5	The distribution of wrist/hand pain during last 7 days is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.395	Retain the null hypothesis.
6	The distribution of lower back pain during last 7 days is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.918	Retain the null hypothesis.
7	The distribution of hip/thigh pain during last 7 days is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.961	Retain the null hypothesis.
8	The distribution of knee pain during last 7 days is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.925	Retain the null hypothesis.
9	The distribution of ankles/feet pain during last 7 days is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.925	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .050.

Figure 13

Hypothesis Test Summary for MSD pain site for Third- and Fourth-Year Dental Students Currently Experiencing

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Current pain in neck is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.354	Retain the null hypothesis.
2	The distribution of Current pain in shoulders is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.293	Retain the null hypothesis.
3	The distribution of Current pain in upper back is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.095	Retain the null hypothesis.
4	The distribution of Current pain in elbows is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.240	Retain the null hypothesis.
5	The distribution of Current pain in wrist/ hands is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.817	Retain the null hypothesis.
6	The distribution of Current pain in lower back is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.565	Retain the null hypothesis.
7	The distribution of Current pain in hip/thigh is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.756	Retain the null hypothesis.
8	The distribution of Current pain in knees is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.817	Retain the null hypothesis.
9	The distribution of Current pain in ankles/feet is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.093	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .050.

Figure 14

Hypothesis Test Summary for MSD pain site Development during Third year of Dental School

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Neck pain development during third year of dental school is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.728	Retain the null hypothesis.
2	The distribution of Shoulder pain development during third year of dental school is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.087	Retain the null hypothesis.
3	The distribution of Upper back pain development during third year of dental school is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.395	Retain the null hypothesis.
4	The distribution of Elbow pain development during third year of dental school is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.240	Retain the null hypothesis.
5	The distribution of Wrist/hand pain development during third year of dental school is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.961	Retain the null hypothesis.
6	The distribution of Lower back pain development during third year of dental school is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.049	Reject the null hypothesis.
7	The distribution of Hip/thigh pain development during third year of dental school is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.925	Retain the null hypothesis.
8	The distribution of Knee pain development during third year of dental school is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.377	Retain the null hypothesis.
9	The distribution of Ankles/feet pain development during third year of dental school is the same across categories of year in dental school.	Independent-Samples Mann-Whitney U Test	.093	Retain the null hypothesis.

Chapter 5. Summary, Discussion, Conclusion and Recommendations

Summary

The effects of musculoskeletal disorders on dental professionals can be career altering and life threatening. Little is known about the prevalence of musculoskeletal disorders in third- and fourth-year dental students at the University of Tennessee Health Science Center, College of Dentistry. This study sought to determine the prevalence of musculoskeletal disorders in third- and fourth-year dental students. Additionally, the focus of this study was to determine if a difference existed in the prevalence of musculoskeletal disorders between third- and fourth-year dental students. Insight to the questions guiding this project was provided through the results.

Do third- and fourth-year dental students experience pain associated with musculoskeletal disorders?

A majority of participants reported experiencing MSD pain (Table 2) in the neck (40), shoulders (33), upper back (31), and lower back (34) within the last twelve months. Additionally, about half of the participants (Table 3) reported experiencing MSD pain in the neck (25), shoulders (24), and upper back (24) during the last seven days. Interestingly, only 20 third- and fourth-year dental students (Table 4) reported currently experiencing MSD pain in the neck (20), shoulders (15), and upper back (15). This finding may be due to the third- and fourth-year dental students being on spring break during the time of the questionnaire and not treating patients in the clinic.

A lower number of participants (Table 5) reported experiencing MSD pain in the neck (10), shoulders (12), upper back (12), and lower back (17) before entering dental school. Alternatively, over half of third- and fourth-year dental students (Table 6) reported beginning to experience MSD pain while in dental school in the neck (33), shoulders (27), and upper back

(29). Less than half of the participants reported MSD pain developing (Table 7) in their third year of dental school in the neck (20), shoulders (17), and upper back (18). Similarly, less half of fourth-year dental students reported developing MSD pain symptoms (Table 8) in the neck (11), shoulders (8), and upper back (8) during their fourth year of dental school.

Do third-year dental students experience more pain associated with musculoskeletal disorders than fourth-year dental students at the University of Tennessee Health Science Center, College of Dentistry?

All statistical results failed to reject the null hypothesis showing there is no significant difference between the amount of MSD pain experienced between third- and fourth-year dental students. The only exception was results shown for lower back pain development in the third year of dental school. The *p-value* (0.049) showed a statistical significance, therefore rejecting the null hypothesis.

Conclusions

Limiting this study to dental students at the University of Tennessee Health Science Center College of Dentistry was considered when developing the study. However, the participation in this study was much lower than anticipated.

Although a majority of participants reported receiving lectures about ergonomics and proper positioning (50) and musculoskeletal disorders (46), they still experienced pain as a result of MSD symptoms. This study demonstrated the prevalence of MSD pain among third- and fourth-year dental students and the need for continued awareness of the prevention of MSD. This study also showed how although students were experiencing MSD pain, they were less likely to modify treatment and continue with scheduled procedures. Alogaibi et al. (2008) and Kapitan et al. (2019) reported that dental students begin to complain about back pain during their

third year of dental school. The results from this study were inconsistent with the findings from the afore mentioned study. Less than half of the participants in this study (Table 8) reported developing MSD pain during their third year of dental school in the neck (20), shoulders (17), lower back (12).

Based on the findings of this study, I concluded more lectures or a dedicated course is needed to reinforce the importance of ergonomics and proper positioning to decrease the prevalence of MSD pain in third- and fourth-year dental students at UTHSC College of Dentistry.

Recommendations

Kluksdahl (2017) stated MSDs cost businesses \$15-\$18 billion yearly due to the inability to work. This study demonstrated the prevalence of MSD pain in third- and fourth-year dental students at UTHSC College of Dentistry. Participants reported MSD pain in the most common reported areas of the neck, shoulders, and lower back. Recommendations for future research include surveying first- and second-year dental students at UTHSC College of Dentistry to determine the prevalence of MSD pain. Also, I suggest research to determine if there is an increase of MSD pain as students transition from didactic training to clinical training where actual patients are being treated. The results from these studies could result in implementation of more in-depth course on ergonomics, positioning, and MSD. Additionally, results from this study could lead to the implementation of restructuring the grading forms to include positioning and posture as a graded item. A follow-up questionnaire could also be utilized to determine if the type of student exercise decreased or increased the prevalence of MSD pain. Body strengthening exercises for the hand, neck, back, and shoulder have been shown to prevent work-related musculoskeletal disorders (Baheti & Toshniwal, 2014).

References

- Algaibi, Y.A., Alhowaish, M.A., Baokbah, R.A., Alharthy, H., Hatrom, A., & Hassan, A.A. (2018). Prevalence of musculoskeletal disorders (back, neck, shoulders' pain) among dental personnel in Jeddah-Saudi Arabia. *Dental Health Oral Disorders & Therapy*, 9(5), 399-405.
- Alhusain, F., Almohrij, M., Althykeir, F., Alshater, A., Alghamdi, B., Masuadi, E., & Basudan, A. (2019). Prevalence of carpal tunnel syndrome symptoms among dentists working in Riyadh. *Annals of Saudi Medicine*, 39(2), 104-111.
- Amin, J., Siddiqui, A.A., & Amin, S. (2019). Ergonomics, exercises and education to prevent neck and back pain among dentists. *Journal of Dentistry and Oral Sciences*, 1(1-3).
- Anu, V., Babu, A.M., & Kumar, P.D. (2018). Insights about dental ergonomics among dental students: The need of the hour to recommend dental ergonomics in academic curriculum. *Journal of Advanced Oral Research*, 9(1/2), 49-54.
- Ayatollahi, J., Ayatollahi, F., Ardekani, A.M., Bahrololoomi, R., Ayatollahi, J., Ayatollahi, A. & Owlia, M.B. (2012). Occupational hazards to dental staff. *Dental Research Journal*, 9(1), 2-7. <https://doi.org/10.4103/1735-3327.92919>
- Ayers, K.M., Thomson, W.M., Newton, J.T., Morgaine, K.C., & Rich, A.M. (2009). Self-reported occupational health of general dental practitioners. *Occupational Medicine*, 59(3), 142–148. <https://doi.org/10.1093/occmed/kqp004>
- Babaji, P., Samadi, F., Jaiswal, J.N., & Bansal, A. (2011). Occupational hazards among dentists: A review of literature. *Journal of International Dental and Medical Research*, 4(2) 87-93.

- Barry, R.M., Spolarich, A.E., Weber, M., Krause, D., Woodall, W.D., & Bailey, J.H. (2017). Impact of operator positioning on musculoskeletal disorders and work habits among Mississippi dental hygienists. *Journal of Dental Hygiene*, 91(6), 6-14.
- Beach, T.A., Parkinson, R.J., Stothart, J.P., & Callaghan, J.P. (2005). Effects of prolonged sitting on the passive flexion stiffness of the in vivo lumbar spine. *The Spine Journal*, 5(2), 145-154.
- Centers for Disease Control and Prevention (CDC). (2020, February 12). *Work-related musculoskeletal disorders & ergonomics. Workplace health strategies by condition. Workplace health promotion.* <https://www.cdc.gov/workplacehealthpromotion/health-strategies/musculoskeletal-disorders/index.html>
- Chikilieng, S., & Suggaravetsiri, P. (2015). Ergonomics risk and neck shoulder back pain among dental professionals. *Procedia Manufacturing*, 3, 4900-4905.
- Cottrell, R.R. & McKenzie, J.F. (2011). *Health promotion & education research methods: Using the five-chapter thesis/dissertation model*. (2nd edition). Jones and Bartlett Publishers.
- Dable, R., Wasnik, P., Yeshwante, B., Musani, S., Patil, A., & Nagmode, S. (2014). Postural assessment of students evaluating the need of ergonomic seat and magnification in dentistry. *Journal of Indian Prosthodont Society*, 14, 51-58.
- Occupational Health Clinics for Ontario Workers Inc. (2012). *Ergonomics and dental work*. Retrieved on October 17, 2020 from <https://www.ohcow.on.ca/edit/files/workbooks/ERGONOMICS%20AND%20DENTAL%20WORK.pdf>

- Gandavadi, A., Ramsay, J., James, G. (2005). Effect of two seating positions on upper limb function in normal subjects. *International Journal of Therapy and Rehabilitation*, 12(11).
- Gold, J.E., Driban, J.B., Thomas, N., Chakravarty, T., Channell, V., & Komaroff, E. (2012). Postures, typing strategies, and gender differences in mobile device usage: An observational study. *Applied Ergonomics*, 43(2), 408-412.
- Grado, G., Denni, J., Musset, A., & Offner, D. (2019). Back pain prevalence, intensity and associated factors in French dentists: A national study among 1004 professionals. *European Spine Journal*, 28(11), 2510-2516.
- Gustafson, E., Thomee, S., Grimby-Ekman, A., & Hagberg, M. (2017). Texting on mobile phones and musculoskeletal disorders in young adults: A five-year cohort study. *Applied Ergonomics*, 58, 208-214.
- Hamann, C., Werner, R., Franzblau, A., Rodgers, P., Siew, C., & Gruninger, S. (2001). Prevalence of carpal tunnel syndrome and median mononeuropathy among dentists. *Journal of American Dental Association*, 132(2), 163-170.
- Hayes, M., Cockrell, D., & Smith, D. (2009). A systematic review of musculoskeletal disorders among dental professionals. *International Journal of Dental Hygiene*, 7(3), 159-165.
- Heneghan, N.R., Baker, G., Thomas, K., Falla, D., & Rushton, A. (2018). What is the effect of prolonged sitting and physical activity on thoracic spine mobility? An observational study of young adults in a UK university setting. *British Medical Journal Open*, 8(5), 1-6.
<https://doi.org/10.1136/bmjopen-2017-019371>

Highsmith, J.M. (2020, March 3). Spinal anatomy center.

<https://www.spineuniverse.com/anatomy>

Ijaz, A., Khan, I., Ahmed, A., & Sadiq, S. (2016). Frequency of neck pain among dentists.

Pakistan Orthodontic Journal, 8(2), 89-93.

Kapitan, M., Pibauerova, N., Vavrickova, L., Sustova, Z., & Machac, S. (2018). Prevalence of musculoskeletal disorder symptoms among Czech dental students. Part 1: A questionnaire survey. *Acta Medica*, 61(4), 131-136.

Khan, S. & Chew, K. (2013). Effect of working characteristics and taught ergonomics on the prevalence of musculoskeletal disorders amongst dental students. *BioMed Central Musculoskeletal Disorders*, 12(1), 118-118.

Kierklo, A., Kobus, A., Jaworska, M., & Botulinski, B. (2011). Work-related musculoskeletal disorders among dentists-A questionnaire survey. *Annals of Agricultural and Environmental Medicine*, 18(1), 79-84.

Kluksdahl, A. (2017, October 3). Understanding the 4 most common musculoskeletal disorders. *Nova Medical Centers*. <https://n-o-v-a.com/blog/understanding-4-commonmusculoskeletal-disorders/>

Kuorinka, I., Jonsson, B., Kilborn, A., Vinterburg, H., Biering-Sorensen, F., Andersson, G., & Jorgensen, K. (1987). Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics*, 18(3), 233-237

Langham, C. (2013a, March). *Dying for a seat-part 1*. Retrieved from The Bambach Saddle Seat: <https://www.bambach.co.uk/brochures/4-Dying-for-a-seat.pdf>

Langham, C. (2013b, May). *Dying for a seat-part 3*. Retrieved from The Bambach Saddle Seat:

<https://www.bambach.co.uk/brochures/7-Dying-for-a-seat-3.pdf>

Leggat, P., Kedjarune, U., & Smith, D. (2007). Occupational health problems in dentistry: A review. *Industrial Health*, 45(5), 611-621.

Merriam-Webster (n.d.). Ergonomics. In *Merriam-Webster.com dictionary*. Retrieved February 20, 2020, from <https://merriam-webster.com/dictionary/ergonomics>

Merriam-Webster (n.d.). Sedentary. In *Merriam-Webster.com dictionary*. Retrieved February 20, 2020, from <https://www.merriam-webster.com/dictionary/sedentary>

Middlesworth, M. (2015). The definition and causes of musculoskeletal disorders. Retrieved from ErgoPlus: <https://ergo-plus.com/musculoskeletal-disorders-msd/>

Padua, L., Coraci, D., Erra, C., Doneddu, P.E., Granata, G., & Rossini, P.M. (2016). Prolonged phone-call posture causes changes of ulnar motor nerve conduction across elbow. *Clinical Neurophysiology*, 127(8), 2728-2732.

Partido, B.B. (2017). Dental hygiene students' self-assessment of ergonomics utilizing photography. *Journal of Dental Education*, 81(10), 1194-1202.

Pejcic, N., Petrovic, V., Markovic, D., Milicic, B., Dimitrijevic, I., Perunovic, N., & Cakic, S. (2017). Assessment of risk factors and preventive measures and their relations to work-related musculoskeletal pain among dentists. *Work*, 57(4), 573-593.
<https://doi.org/10.3233/WOR-172588>

Pope, M., Goh, K., & Magnusson, M. (2002). *Spine ergonomics. Annual Review of Biomedical Engineering*, 4(3), 769-781.

- Pynt, J., Higgs, J., & Mackey, M. (2001). Seeking the optimal posture of the seated lumbar spine. *Physiotherapy Theory and Practice*, 17(1), 5-21.
- Rampel, D., Azevedo, S., Raider, F. (2015). Dental hygiene work: Pain is not in the job description. *Journal of the California Dental Hygienists' Association*, 33(1), 12-39.
- Rayyan, M., Hetou, S., Salem, R., Tokhtah, H., Alrajhi, A., Mohamed, L., Alkhoulja, K., Zaben, R., & Shahri, A. (2015). Work-related musculoskeletal disorders among dental students of different academic levels. *Journal of International Oral Health*, 8(4), 471-475.
- Rempel, D., Lee, D., Dawson, K., & Loomer, P. (2012). Effect of periodontal curette handle weight and diameter on dental practitioner arm pain: A 4-month randomized controlled trial. *Journal of American Dental Association* 143(10), 1105-1113.
- Rising, D., Bennett, B., Hursh, K., & Plesh, M. (2005). Reports of body pain in a dental student population. *Journal of American Dental Association*, 136(1), 81-86.
- Roshene, R. & Longanathan, S. (2017). Ergonomic and musculoskeletal disorder as an occupational hazard in dentistry-A pilot study. *Journal of Pharmaceutical Sciences and Research*, 9(5), 712-715.
- Samoladas, E., Barmpagianni, C., Papadopoulos, D., & Gelalis, I. (2018). Lower back and neck pain among dentistry students: Across-sectional study in dentistry students in northern Greece. *European Journal of Orthopaedic Surgery & Traumatology*, 28, 1261-1267.

- Sharma, A., Bansal, P., Shabnam, Kaur, Manpreet (2016). Ergonomics in dental practice: Musculoskeletal disorders, approaches and interventions. *Pakistan Oral & Dental Journal*, 36(2), 349-355.
- Singh, S., Chandra, R., Misra, A., Arya, A., Samant, P., Uttam, P., Mehrotra, H., & Chaudhary, A.A. (2012). Etiology of occupational hazards in dentistry: A review. *Journal of Ecophysiology Occupational Health*, 12(3/4), 43-49.
- Stratford, D. (2020). A survey of the prevalence and type of work-related musculoskeletal disorders affecting dental hygienists and therapists and their related workplace environment. *Dental Health*, 59(2), 29-33.
- Szymanska, J. (2002) Disorders of the musculoskeletal system among dentists from the aspect of ergonomics and prophylaxis. *Annals of Agricultural and Environmental Medicine*, 9(2), 169-173.
- Tirgrar, A., Khodabakhsh, J., Talebian, A., Amini, F., & Alireza, P. (2015). Musculoskeletal disorders among a group of Iranian general dental practitioners. *Journal of Back and Musculoskeletal Rehabilitation* 28(4), 755-759.
- Valachi, B. & Valachi, K. (2003). Mechanisms leading to musculoskeletal disorders in dentistry. *Journal of the American Dental Association*, 132(10), 1344-1350
<https://doi.org/10.14219/jada.archive.2003.0048>
- Westley, H. (2013). An overview of saddle seats and their benefits in dentistry. *Dental Nursing*, 9(10), 584-587.

APPENDICES

Appendix A: Questionnaire

DEMOGRAPHICS

1. Year in dental school: ☐ Third-year dental student ☐ Fourth-year dental student

PRACTICE HISTORY

2. Do you use magnifying loupes during dental procedures? ☐ Yes ☐ No
3. Do you perform dental procedures from a standing position? ☐ Yes ☐ No
4. Do you perform dental procedures from a sitting position? ☐ Yes ☐ No

EDUCATIONAL EXPERIENCE

5. Have you been provided any lectures on ergonomics or proper positioning?

☐ Yes ☐ No

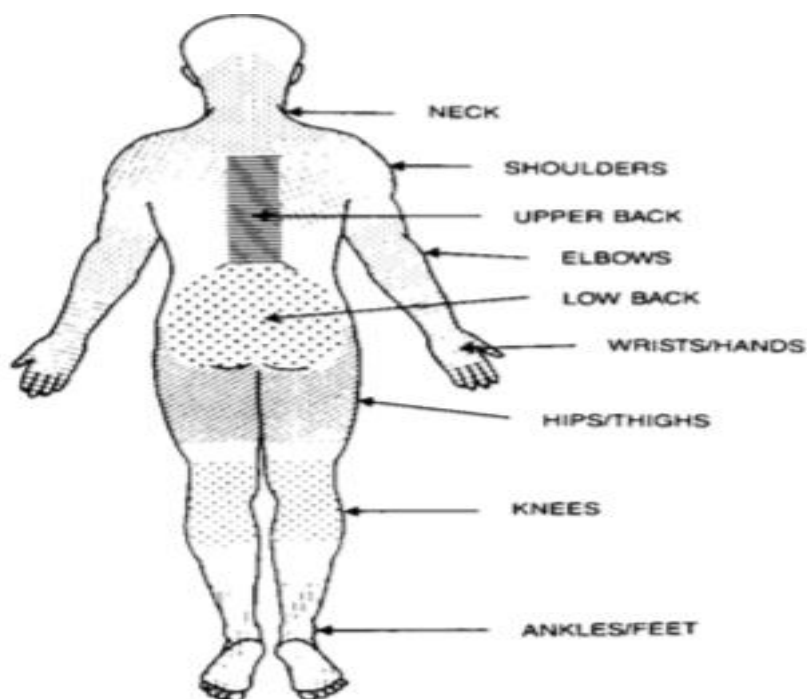
6. Have you been provided any lectures on musculoskeletal disorders?

☐ Yes ☐ No

MUSCULOSKELETAL DISORDERS

Using a modified Nordic questionnaire, you will be asked to identify any musculoskeletal symptoms in nine different regions of the body as illustrated on the diagram.

Please ONLY mark answers that have been affected as a result of being a dental student.



(Kuorinka et al., 1987)

Regions are shown above. Please mark Yes or No.	During the last 12 months, have you had pain or discomfort in:		During the last 7 days, have you had pain or discomfort in:		Are you currently experiencing any pain or discomfort in:		Did you experience pain or discomfort in these areas before entering dental school?		Did you develop these symptoms while in dental school?		Did you develop these symptoms in your third year of dental school?		Did you develop these symptoms in your fourth year of dental school?	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Neck														
Shoulders														
Upper Back														
Elbows														
Wrist/hands														
Lower back														
Hips/thighs														
Knees														
Ankles/feet														

16. If you answered yes to any of the above questions, when do your symptoms occur?

- ☐ Early morning ☐ Evening ☐ During Sleep ☐ All the time
- ☐ After patient appointment ☐ During patient appointment

17. Have you had to modify treatment on a patient because of musculoskeletal symptoms?

- ☐ No ☐ Yes

18. Have you had to seek treatment for musculoskeletal symptoms?

- ☐ No ☐ Yes

OTHER ACTIVITIES

19. Are you currently exercising?

- ☐ No ☐ Yes

20. If so, how many times a week? _____ (# of days weekly)

21. How many hours per day do you spend using your phone, tablet, computer or some other type of electronic device? _____ (# of hours per day)

22. How likely are you to adjust your positioning when having difficulty seeing an area of the mouth?

- ☐ Likely ☐ Somewhat likely ☐ Not likely

Appendix B: Copyright Permission

ELSEVIER LICENSE TERMS AND CONDITIONS Apr 25, 2020

This Agreement between Felisa Jackson ("You") and Elsevier ("Elsevier") consists of your license details and the terms and conditions provided by Elsevier and Copyright Clearance Center.

License Number	4815970222832
License date	Apr 25, 2020
Licensed Content Publisher	Elsevier
Licensed Content Publication	Applied Ergonomics
Licensed Content Title	Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms
Licensed Content Author	I. Kuorinka,B. Jonsson,A. Kilbom,H. Vinterberg,F. Biering-Sørensen,G. Andersson,K. Jørgensen
Licensed Content Date	Sep 1, 1987
Licensed Content Volume	18
Licensed Content Issue	3
Licensed Content Pages	5
Start Page	233
End Page	237
Type of Use	reuse in a thesis/dissertation
Portion	figures/tables/illustrations
Number of figures/tables/illustrations	1
Format	both print and electronic
Are you the author of this Elsevier article?	No
Will you be translating?	No
Title	Prevalence of Musculoskeletal Disorders Among Third- and Fourth-Year Dental Students
Institution name	East Tennessee State University

Expected presentation date	May 2021
Portions	Figure 1 Anatomical areas Felisa Jackson 5031 Royston Ln
Requestor Location	MEMPHIS, TN 38125 United States Attn: Felisa Jackson
Publisher Tax ID	98-0397604
Billing Type	Invoice Felisa Jackson 5031 Royston Ln
Billing Address	MEMPHIS, TN 38125 United States Attn: Felisa Jackson
Total	0.00 USD
Terms and Conditions	

INTRODUCTION

1. The publisher for this copyrighted material is Elsevier. By clicking "accept" in connection with completing this licensing transaction, you agree that the following terms and conditions apply to this transaction (along with the Billing and Payment terms and conditions established by Copyright Clearance Center, Inc. ("CCC"), at the time that you opened your Rightslink account and that are available at any time at <http://myaccount.copyright.com>).

GENERAL TERMS

2. Elsevier hereby grants you permission to reproduce the aforementioned material subject to the terms and conditions indicated.

3. Acknowledgement: If any part of the material to be used (for example, figures) has appeared in our publication with credit or acknowledgement to another source, permission must also be sought from that source. If such permission is not obtained then that material may not be included in your publication/copies. Suitable acknowledgement to the source must be made, either as a footnote or in a reference list at the end of your publication, as follows:

"Reprinted from Publication title, Vol /edition number, Author(s), Title of article / title of chapter, Pages No., Copyright (Year), with permission from Elsevier [OR

APPLICABLE SOCIETY COPYRIGHT OWNER]." Also Lancet special credit - "Reprinted from The Lancet, Vol. number, Author(s), Title of article, Pages No., Copyright (Year), with permission from Elsevier."

4. Reproduction of this material is confined to the purpose and/or media for which permission is hereby given.

5. Altering/Modifying Material: Not Permitted. However figures and illustrations may be altered/adapted minimally to serve your work. Any other abbreviations, additions, deletions and/or any other alterations shall be made only with prior written authorization of Elsevier Ltd. (Please contact Elsevier at permissions@elsevier.com). No modifications can be made to any Lancet figures/tables and they must be reproduced in full.

6. If the permission fee for the requested use of our material is waived in this instance, please be advised that your future requests for Elsevier materials may attract a fee.

7. Reservation of Rights: Publisher reserves all rights not specifically granted in the combination of (i) the license details provided by you and accepted in the course of this licensing transaction, (ii) these terms and conditions and (iii) CCC's Billing and Payment terms and conditions.

8. License Contingent Upon Payment: While you may exercise the rights licensed immediately upon issuance of the license at the end of the licensing process for the transaction, provided that you have disclosed complete and accurate details of your proposed use, no license is finally effective unless and until full payment is received from you (either by publisher or by CCC) as provided in CCC's Billing and Payment terms and conditions. If full payment is not received on a timely basis, then any license preliminarily granted shall be deemed automatically revoked and shall be void as if never granted. Further, in the event that you breach any of these terms and conditions or any of CCC's Billing and Payment terms and conditions, the license is automatically revoked and shall be void as if never granted. Use of materials as described in a revoked license, as well as any use of the materials beyond the scope of an unrevoked license, may constitute copyright infringement and publisher reserves the right to take any and all action to protect its copyright in the materials.

9. Warranties: Publisher makes no representations or warranties with respect to the licensed material.

10. Indemnity: You hereby indemnify and agree to hold harmless publisher and CCC, and their respective officers, directors, employees and agents, from and against any and all claims arising out of your use of the licensed material other than as specifically authorized pursuant to this license.

11. No Transfer of License: This license is personal to you and may not be sublicensed, assigned, or transferred by you to any other person without publisher's written permission.

12. No Amendment Except in Writing: This license may not be amended except in a writing signed by both parties (or, in the case of publisher, by CCC on publisher's behalf).

13. Objection to Contrary Terms: Publisher hereby objects to any terms contained in any purchase order, acknowledgment, check endorsement or other writing prepared by you, which terms are inconsistent with these terms and conditions or CCC's Billing and Payment terms and conditions. These terms and conditions, together with CCC's Billing and Payment terms and conditions (which are incorporated herein), comprise the entire agreement between you and publisher (and CCC) concerning this licensing transaction. In the event of any conflict between your obligations established by these terms and conditions and those established by CCC's Billing and Payment terms and conditions, these terms and conditions shall control.

14. Revocation: Elsevier or Copyright Clearance Center may deny the permissions described in this License at their sole discretion, for any reason or no reason, with a full refund payable to you. Notice of such denial will be made using the contact information provided by you. Failure to receive such notice will not alter or invalidate the denial. In no event will Elsevier or Copyright Clearance Center be responsible or liable for any costs, expenses or damage incurred by you as a result of a denial of your permission request, other than a refund of the amount(s) paid by you to Elsevier and/or Copyright Clearance Center for denied permissions.

LIMITED LICENSE

The following terms and conditions apply only to specific license types:

15. **Translation:** This permission is granted for non-exclusive world **English** rights only unless your license was granted for translation rights. If you licensed translation rights you may only translate this content into the languages you requested. A professional translator must perform all translations and reproduce the content word for word preserving the integrity of the article.

16. **Posting licensed content on any Website:** The following terms and conditions apply as follows: Licensing material from an Elsevier journal: All content posted to the web site must maintain the copyright information line on the bottom of each image; A hyper-text must be included to the Homepage of the journal from which you are licensing at <http://www.sciencedirect.com/science/journal/xxxxx> or the Elsevier homepage for books at <http://www.elsevier.com>; Central Storage: This license does

not include permission for a scanned version of the material to be stored in a central repository such as that provided by Heron/XanEdu.

Licensing material from an Elsevier book: A hyper-text link must be included to the Elsevier homepage at <http://www.elsevier.com> . All content posted to the web site must maintain the copyright information line on the bottom of each image.

Posting licensed content on Electronic reserve: In addition to the above the following clauses are applicable: The web site must be password-protected and made available only to bona fide students registered on a relevant course. This permission is granted for 1 year only. You may obtain a new license for future website posting.

17. For journal authors: the following clauses are applicable in addition to the above:

Preprints:

A preprint is an author's own write-up of research results and analysis, it has not been peer-reviewed, nor has it had any other value added to it by a publisher (such as formatting, copyright, technical enhancement etc.).

Authors can share their preprints anywhere at any time. Preprints should not be added to or enhanced in any way in order to appear more like, or to substitute for, the final versions of articles however authors can update their preprints on arXiv or RePEc with their Accepted Author Manuscript (see below).

If accepted for publication, we encourage authors to link from the preprint to their formal publication via its DOI. Millions of researchers have access to the formal publications on ScienceDirect, and so links will help users to find, access, cite and use the best available version. Please note that Cell Press, The Lancet and some society-owned have different preprint policies. Information on these policies is available on the journal homepage.

Accepted Author Manuscripts: An accepted author manuscript is the manuscript of an article that has been accepted for publication and which typically includes author-incorporated changes suggested during submission, peer review and editor-author communications.

Authors can share their accepted author manuscript:

- immediately
 - via their non-commercial person homepage or blog
 - by updating a preprint in arXiv or RePEc with the accepted manuscript

- via their research institute or institutional repository for internal institutional uses or as part of an invitation-only research collaboration work-group
- directly by providing copies to their students or to research collaborators for their personal use
- for private scholarly sharing as part of an invitation-only work group on commercial sites with which Elsevier has an agreement
- After the embargo period
 - via non-commercial hosting platforms such as their institutional repository
 - via commercial sites with which Elsevier has an agreement

In all cases accepted manuscripts should:

- link to the formal publication via its DOI
- bear a CC-BY-NC-ND license - this is easy to do
- if aggregated with other manuscripts, for example in a repository or other site, be shared in alignment with our hosting policy not be added to or enhanced in any way to appear more like, or to substitute for, the published journal article.

Published journal article (JPA): A published journal article (PJA) is the definitive final record of published research that appears or will appear in the journal and embodies all value-adding publishing activities including peer review co-ordination, copy-editing, formatting, (if relevant) pagination and online enrichment.

Policies for sharing publishing journal articles differ for subscription and gold open access articles:

Subscription Articles: If you are an author, please share a link to your article rather than the full-text. Millions of researchers have access to the formal publications on ScienceDirect, and so links will help your users to find, access, cite, and use the best available version.

Theses and dissertations which contain embedded PJAs as part of the formal submission can be posted publicly by the awarding institution with DOI links back to the formal publications on ScienceDirect.

If you are affiliated with a library that subscribes to ScienceDirect you have additional private sharing rights for others' research accessed under that agreement. This includes use for classroom teaching and internal training at the institution (including use in course packs and courseware programs), and inclusion of the article for grant funding purposes.

Gold Open Access Articles: May be shared according to the author-selected end-user license and should contain a [CrossMark logo](#), the end user license, and a DOI link to the formal publication on ScienceDirect.

Please refer to Elsevier's [posting policy](#) for further information.

18. For book authors the following clauses are applicable in addition to the above: Authors are permitted to place a brief summary of their work online only. You are not allowed to download and post the published electronic version of your chapter, nor may you scan the printed edition to create an electronic version. **Posting to a repository:** Authors are permitted to post a summary of their chapter only in their institution's repository.

19. Thesis/Dissertation: If your license is for use in a thesis/dissertation your thesis may be submitted to your institution in either print or electronic form. Should your thesis be published commercially, please reapply for permission. These requirements include permission for the Library and Archives of Canada to supply single copies, on demand, of the complete thesis and include permission for Proquest/UMI to supply single copies, on demand, of the complete thesis. Should your thesis be published commercially, please reapply for permission. Theses and dissertations which contain embedded PJAs as part of the formal submission can be posted publicly by the awarding institution with DOI links back to the formal publications on ScienceDirect.

Elsevier Open Access Terms and Conditions

You can publish open access with Elsevier in hundreds of open access journals or in nearly 2000 established subscription journals that support open access publishing. Permitted third party re-use of these open access articles is defined by the author's choice of Creative Commons user license. See our [open access license policy](#) for more information.

Terms & Conditions applicable to all Open Access articles published with Elsevier:

Any reuse of the article must not represent the author as endorsing the adaptation of the article nor should the article be modified in such a way as to damage the author's honour or reputation. If any changes have been made, such changes must be clearly indicated.

The author(s) must be appropriately credited and we ask that you include the end user license and a DOI link to the formal publication on ScienceDirect.

If any part of the material to be used (for example, figures) has appeared in our publication with credit or acknowledgement to another source it is the responsibility of the user to ensure their reuse complies with the terms and conditions determined by the rights holder.

Additional Terms & Conditions applicable to each Creative Commons user license:

CC BY: The CC-BY license allows users to copy, to create extracts, abstracts and new works from the Article, to alter and revise the Article and to make commercial use of the Article (including reuse and/or resale of the Article by commercial entities), provided the user gives appropriate credit (with a link to the formal publication through the relevant DOI), provides a link to the license, indicates if changes were made and the licensor is not represented as endorsing the use made of the work. The full details of the license are available at <http://creativecommons.org/licenses/by/4.0>.

CC BY NC SA: The CC BY-NC-SA license allows users to copy, to create extracts, abstracts and new works from the Article, to alter and revise the Article, provided this is not done for commercial purposes, and that the user gives appropriate credit (with a link to the formal publication through the relevant DOI), provides a link to the license, indicates if changes were made and the licensor is not represented as endorsing the use made of the work. Further, any new works must be made available on the same conditions. The full details of the license are available at <http://creativecommons.org/licenses/by-nc-sa/4.0>.

CC BY NC ND: The CC BY-NC-ND license allows users to copy and distribute the Article, provided this is not done for commercial purposes and further does not permit distribution of the Article if it is changed or edited in any way, and provided the user gives appropriate credit (with a link to the formal publication through the relevant DOI), provides a link to the license, and that the licensor is not represented as endorsing the use made of the work. The full details of the license are available at <http://creativecommons.org/licenses/by-nc-nd/4.0>. Any commercial reuse of Open Access articles published with a CC BY NC SA or CC BY NC ND license requires permission from Elsevier and will be subject to a fee.

Commercial reuse includes:

- Associating advertising with the full text of the Article
- Charging fees for document delivery or access
- Article aggregation
- Systematic distribution via e-mail lists or share buttons

Posting or linking by commercial companies for use by customers of those companies.

20. Other Conditions:

v1.9

Questions? customercare@copyright.com or +1-855-239-3415 (toll free in the US) or +1-978-646-2777.

VITA

FELISA JACKSON

Education: B.S. Biology (April 1997), Lane College,
Jackson, Tennessee
B.S. Dental Hygiene (June 1999), University of Tennessee
Health Science Center, Memphis, Tennessee
M.S. Allied Health (August 2021), East Tennessee State
University, Johnson City, Tennessee

Professional Experience: Clinical Dental Hygienist; Memphis, Tennessee, 1999-2017
Clinical Instructor; Department of Periodontology, University
of Tennessee Health Science Center, College of Dentistry,
Memphis, Tennessee, 2017-Present

Publications: Braxton, A., Rhoads, B., Wasson, W., Jackson, F., Hamilton, R.
(2020). *“Fostering a Healthier Teaching and Learning
Environment: A Unique Approach in the Management of Anxiety
and Stress of Dental Students at The University of Tennessee
Health Science Center School of Dentistry”*. *Journal of the
Arkansas State Dental Association* Volume 92, No. 3.