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The Effects of Sitting and Standing Hygiene on Posture in Dental Hygiene Students

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THE EFFECTS OF SITTING AND STANDING HYGIENE ON POSTURE IN DENTAL HYGIENE STUDENTS

by

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ABSTRACT

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ON POSTURE IN DENTAL HYGIENE STUDENTS

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Problem: The purpose of this pilot study was to assess biomechanical and postural impacts of sitting and standing independently during dental hygiene practice. Methods: A convenience sample of thirty-four second-year dental hygiene students with no history of musculoskeletal disorders were enrolled in this study. Participants were randomly assigned to instrument one quadrant of the mouth on buccal or lingual surfaces while seated or standing during two independent research sessions. Two images per session, for a total of four images per participant, were taken to assess biomechanical demands of each posture using the Rapid Upper Limb Assessment (RULA) tool. The images were independently scored by four calibrated researchers and then a mean score was utilized for data analyses. An end-user survey was also completed by participants at both sessions to gather participant perceptions of posture and pain. Results: Thirty-four female second year dental hygiene students completed the study and had useable images for data analyses. Results revealed statistically significant differences in mean RULA scores indicating better posture while seated (M = 3.91, SD = 0.77) when compared to standing (M = 4.50, SD = 1.00) (p=0.001). No participants had acceptable postures for either sitting or standing, as indicated by scores on the RULA. Overall, 79% of participants perceived their posture to be *neutral, somewhat good,* or *very good* when seated and 71% of participants perceived their posture to be *neutral, somewhat poor*, or *very poor* when standing. Conclusion: The results support the need for additional ergonomic training and education in the dental hygiene curriculum and future research on biomechanical and postural loads of each posture. A larger, more diverse sample of clinically practicing dental hygienists could provide more insight

into the ergonomic benefits of sitting and standing postures and the associated musculoskeletal disorder (MSD) risks throughout the workday.

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CHAPTER I

INTRODUCTION

The Occupational Health and Safety Administration (OSHA) and The National Institute for Occupational Safety and Health (NIOSH) define musculoskeletal disorders (MSDs) as soft tissue injuries caused by sudden or sustained exposure to force (load), vibration, repetitive movement, and awkward or static posture; these affect the muscles, nerves, blood vessels, ligaments, and tendons.[1,2] Risk factors for MSDs include, but are not limited to, lifting heavy items, bending, reaching overhead, pushing and pulling heavy loads, working in awkward body postures or being in the same posture for long periods of time, and performing the same or similar tasks repetitively.[1-4] Additionally, occupations involving repetitive movements and prolonged, static postures such as sitting or standing are most commonly associated with work-related MSDs,[1-4] both of which are commonplace in the dental profession.[5] By nature, clinical practice involves performing intricate intraoral tasks while working in the small, dimly lit area of the oral cavity, resulting in adopting unnatural postures.[9,10] Furthermore, dentistry requires the use of the dominant and non-dominant hand simultaneously while performing tasks, which can lead to asymmetry of the body sides, placing the dental professional at a higher risk for developing MSDs.[10] The use of static working postures, precise hand movements, vibrating instruments, repetitive tasks, and high physical workloads further contribute to the development of MSDs in dental professionals.[9,10,13-16] Most musculoskeletal disorders in dental professionals occur from the accumulation of repetitive, forceful and/or awkward movements and positions utilized during lengthy procedures performed over the course of many years.[5-7,9,10,13,15,17-20] In dentistry, body regions most often affected by MSDs can include the upper and lower back, hands and wrists, neck, shoulders, and arms.[5] The pains caused by MSDs are a major contributing factor for sick leave, decreased work productivity, loss of earnings, reduction in working hours, and disability or early retirement.[5-13] The burden of clinical work in dentistry is an occupational health risk for all practitioners, but can be seen especially high prevalence rates for

dental hygienists. Even with widespread knowledge and awareness of occupational health burdens seen in dentistry, dental professionals are still affected by MSDs at alarmingly high prevalence rates above 60%.[5,7,8,10,21,22]

Dental hygienists, in comparison to dentists and dental assistants, are at an increased risk for MSDs due to the high number of clinical tasks performed each day involving precise and repetitive motions, prolonged pinch-grasping, forceful exertions, vibrations, poor ergonomics, insufficient breaks, and awkward and static postures.[21,25] Dental hygienists spend 5.25 to 7.5 hours performing scaling and root debridement procedures using these precise movements and repetitive motions each day.[25] On average, scaling requires thirty instrument strokes per minute, which can increase based on level of calculus build-up, requiring additional strength and lateral pressure further increasing the risk for repetitive muscle strain injuries.[25,26] Additionally, during a one hour appointment, 30 to 50 minutes are spent in static and awkward positions that can lead to poor circulation and increased muscular pressure further resulting in muscular pain and fatigue.[25,26] Because of the overwhelming number of MSD risk factors associated with dental hygiene practice, identifying methods to mitigate these risk factors have become increasingly important in dental hygiene research.

Research in sound ergonomic practice is critical to prevent and reduce risk factors associated with developing these disorders. Ergonomics focuses on human performance and workplace design to amplify health, comfort, and efficiency during the workday.[1,23,24] Basic ergonomic practices have been introduced in dental hygiene curriculum;[21] however, most ergonomic instruction consists of operator and patient positioning, commonly known as clock positions. These operator clock positions are determined in relation to the patient's head to increase visibility and accessibility of the oral cavity for clinical tasks, but do not typically include body posture recommendations.[16,21,23,24] Though operator and patient positioning have important components to ergonomic practices in dental hygiene, recommended guidelines are minimally developed in most dental hygiene curriculum and ergonomic education does not extend far

beyond clock positioning.[26] In fact, dental hygiene ergonomic curricula rarely includes all risk factors for MSDs, preventive ergonomic practices, and/or proper body mechanics that could impact musculoskeletal health in clinicans.[26]

A large body of research exists examining best ergonomic practices in dental hygiene. Possible ergonomic interventions for reducing MSDs identified in the literature include use of magnification loupes, instrument handle design, and ergonomic seating (e.g., saddle chairs).[8,9,17,27-29] Magnification loupes are often used in dentistry to enhance visibility and improve posture.[17,27] It is surmised, the magnified field of vision loupes provide allows the clinician to sit upright at the neck and trunk, reducing awkward, nonneutral postures.[8,17,27] In an attempt to address ergonomic concerns with pinch force and muscle fatigue or overuse, instrument handle designs may vary in diameter, shape, weight, and material.[28,29] For example, studies have found a lighter instrument with a larger diameter could result in reduced risk for MSDs in dental hygienists.[28,29] Finally, saddle chairs have been designed and studied to address ergonomic posture recommendations while sitting.[9,17] The Salli Saddle Chair® is ergonomically designed to create a neutral pelvic position and natural curvature of the spine, similar to standing, by positioning the clinician's thigh at a 45-degree angle.[17] In another design, the Bambach Saddle Seat® was designed to keep the clinician's hips at a 60-degree angle with a forward sloping seat to relieve tension in the hamstrings and pull the pelvis forward.[9] Though magnification loupes, instrument handle designs, and saddle chairs have been designed to potentially address ergonomic concerns of dental hygiene practice and reduce MSD incidence, minimal research has examined long-term impacts on MSD development and many other risk factors for MSDs are not addressed with these interventions.

One potential ergonomic intervention yet to be examined in dental hygiene is the impact of seated and standing postures during clinic care. Seated and standing postures involve the use of different muscles, each having postural advantages and disadvantages.[8] In a seated position, muscles required to maintain body posture have more force (load) exerted on them,

resulting in difficulties obtaining a balanced posture and performing precise manipulative work.[8,10] Additionally, a seated posture increases the load on back muscles and ligaments which can lead to pain.[8] Prolonged sitting may also cause the abdominal muscles to weaken and make the spine slump, straining the spine ligaments and stretching the muscles of the back.[17] While seated postures have disadvantages, there are also positive postural impacts such as reducing the load on lower joints, reducing the weight placed on lower limbs, and improving the stability required from the upper limbs when preforming fine and precise movements.[8,9] In contrast, a standing posture promotes less forward flexion of the neck and the legs are more supported; however, with standing postures the upper arm has greater flexion.[8] These findings may have important ergonomic implications for dental hygiene practice.

Alternating seated and standing postures has also been researched in other settings and professions as a potential ergonomic consideration.[6,8,10,17,19,20,30-36] Several studies in differing professions have suggested the importance of varying posture throughout the day because the muscular load shifts to different body regions for each posture, thus decreasing the duration of postural impacts seen with sitting and standing independently.[7,8,10,20,30] For example, when sit-stand workstations were an available option to workers in different professions, a significant decrease in discomfort and occurrence of injury were seen among participants.[30-36] Ognibene et al. determined sit-stand work stations for office employees resulted in statistically significant reductions in lower back pain after a 12-week study.[33] Similarly, Husemann et al. found that sit-stand workstations for data entry personnel resulted in a reduction of musculoskeletal complaints.[34] One research study also found standing for at least one hour in an eight-hour workday or implementing standing intervals, had beneficial reductions on MSD discomforts.[30] While studies in other disciplines have found positive impacts related to MSD risk and pain when alternating seated and standing postures, there is a gap in the literature related to dental hygiene practice. It is possible dental hygiene clinicians may benefit from similar sitting and standing protocols used in other disciplines. Research in clinical dental hygiene settings is

necessary to determine if these ergonomic impacts expand to patient care settings and reduce the risk for MSD development in dental hygienists.

Problem Statement

Poor posture and ergonomics, common in dental hygiene practice, increase MSD risk and pain.[5,7,8,10,21,22] While previous studies have examined magnification loupes, instrument handle designs, and saddle chairs, minimal research has explored the impacts postural variation may have on improving ergonomics and reducing MSD risk and pain in dentistry.[8,9,17,27-29] To the researcher's knowledge, there are no studies examining sitting and standing postures in dental hygiene settings. Therefore, the purpose of this pilot study was to determine impacts of sitting and standing independently on posture during the delivery of dental hygiene care services. This preliminary study would assist in gathering information on postural impacts and potential MSD risk for dental hygienists. This research most appropriately supported the ADHA National Dental Hygiene Research Agenda in the research priority area: *Occupational Health and Safety: Determination and assessment of risks for occupational injury by investigating the impact of ergonomics and exposure to environmental stressors on the health of the dental hygienist (aerosols, chemicals, latex, nitrous oxide, handpiece/instrument noise, and infectious disease).*[37]

Definition of Terms

For the purpose of this study, the following terms were defined:

1. Posture: the position in which the body is held while standing, sitting, or lying down.[38] Good posture is the correct alignment of body parts supported by the right amount of muscle tension against gravity.[38] Posture will be measured with the RULA.[39,40]
2. Standing Posture: a person's weight is primarily on the balls of the feet, knees are slightly bent, feet are shoulder-width apart, shoulders are pulled back, stomach is

tucked in, and head is leveled with the ear lobes in line with the shoulders.[38] Weight is switched from toes to heels if standing for a long period of time.[38] Standing posture will be measured with the RULA.[39,40]

3. Sitting Posture: a person's feet are flat on the floor, ankles are in front of the knees, a small gap is present between the back of the knees and the seat, knees are at or below hip level, shoulders are relaxed, and forearms are parallel to the ground.[38] Sitting posture will be measured with the RULA.[39,40]
4. Dental Hygiene Care Services: services including, but not limited to, patient screening procedures, taking dental radiographs, periodontal health assessments, scaling and root debridement, providing oral hygiene care instructions, applying fluoride or sealants, polishing teeth, and/or giving local anesthesia.[41]
5. Rapid Upper Limb Assessment (RULA): a valid and reliable instrument for assessing biomechanical and postural load requirements of job tasks/demands on the neck, trunk, and upper extremities.[39,40] A single page form is used to evaluate required body posture, force, and repetition.[39]

Research Questions and Hypotheses

This study intended to address the following research questions:

1. What impact does a sitting posture have on biomechanical and postural load requirements during instrumentation as measured by the RULA?
2. What impact does a standing posture have on biomechanical and postural load requirements during instrumentation as measured by the RULA?
3. What are the comparative effects of sitting and standing posture on biomechanical and postural load requirements during instrumentation as measured by the RULA?

This study tested the following null hypotheses at the 0.05 level:

1. There will be no statistically significant impact on biomechanical and postural load requirements during instrumentation as measured by the RULA when a sitting posture is used.
2. There will be no statistically significant impact on biomechanical and postural load requirements during instrumentation as measured by the RULA when a standing posture is used.
3. There will be no statistically significant differences in the effects on biomechanical and postural load requirements during instrumentation as measured by the RULA when sitting and standing postures are compared.

CHAPTER II

REVIEW OF LITERATURE

Dental hygiene practice requires precise hand movements, the use of vibrating instruments, static postures, and repetitive tasks performed over long periods of time; contributing to MSD risk and prevalence.[5,8,13,15,17] Musculoskeletal disorders occur at alarming rates in dental professionals with prevalence rates ranging from 60-93%.[5,7,8,10,12,14,16,18] One recent literature review revealed a pooled MSD prevalence rate of 78% and high rates of related pain among dental professionals.[13] This review also placed dental hygienists at the highest risk for developing MSDs and related pains when compared to other dental professionals.[13] In 2015, Humann et al. conducted a survey to determine MSD pain and patterns among dental hygienists.[6] Results revealed 96% of respondents had some level of MSD pain and this pain caused one quarter of the participants to miss work.[6] Several studies identify the lower back (39-56%), neck (39-84%), and shoulders (39-76%) as the most at risk areas for MSD pain and occurrence due to biomechanical demands of the dental hygiene scope of practice.[16,21] With high MSD prevalence rates among dental hygienists, identifying risk factors and interventions for addressing MSDs is critical in dental hygiene research.

Research has also identified multifactorial causes of MSDs in dental hygiene such as repetitive motions, static and awkward postures, and minimal rest periods.[5,8,13,15,17,20] Repetitive tasks involve the same movement for greater than 50% of the work cycle;[43] this is common for many clinical task hygienists perform including scaling, probing, and polishing. Furthermore, completing these highly repetitive tasks in the oral cavity, a small and poorly lit environment for work tasks, contributes to poor postures associated with MSD pain in the upper limbs, neck, and back.[16,21] Additionally, patient care is delivered with the dental hygienist sitting on one side of the patient, the resulting posture is often awkward, inflexible, and static further increasing the risk for MSDs.[9-11,17,18,21] To compensate for awkward postures, muscles generate higher loads to

accomplish tasks versus if a neutral position was adopted.[43] Physical demands associated with dental hygiene work are linked to high prevalence rates of MSDs.

Specific body regions have also been identified to be at an increased risk for MSDs due to the biomechanical demands of dental hygiene work. These include the trunk, lower back, upper body, and limbs. Physical demands specifically in the trunk and lower back region for dental hygienists depends greatly on their chosen working position and includes seat-pressure distribution, spinal posture, and muscular loading.[21] Sixty-six percent of a dental hygienist's time is spent seated with 40% of that time in a forward-flexed trunk posture of at least 30 degrees.[16] This is vastly different than the ideal trunk posture of zero degrees identified in the literature and increases the risk for trunk and lower back MSDs.[39,40] Furthermore, static postures with lumbar spine twisting during patient treatment also contributes to MSD pain in the trunk and lower back.[13,20] Musculoskeletal disorder-related pain associated with the upper body and limbs experienced by dental hygienists is linked to muscle fatigue caused by awkward static postures adopted during patient care.[15] These fixed working postures cause blood vessel compression resulting in decreased oxygen supply to the muscles, thus reducing muscle recovery.[15,20,43] Various interventions have been identified to minimize the risks for MSDs in these body regions for dental hygienists.

Proper ergonomics is frequently cited as a mitigating factor for MSD development in dental professionals.[6,11,16,19,23,24] Ergonomics include implementing equipment and practices that reduce work-related risk and associated pain caused by MSDs.[1,4] Previous research in the dental profession indicates use of certain equipment such as magnification loupes, saddle chairs, and differing instrument handle designs, may improve ergonomics, thereby reducing the incidence of MSDs.[7,8,16,28,42] Additionally, proper ergonomic practices such as limiting repetitive movements, maintaining neutral postures, and allowing for sufficient muscle recovery time can help reduce the risk of developing an MSD.[24] Adopting equipment and sound ergonomic

practices is critical for dental hygienists to reduce clinical burdens that lead to MSD development.

One ergonomic practice with limited research in dentistry that may reduce MSD incidence is postural variation. Multiple studies in various workplace settings have examined the ergonomic impacts of seated and standing postures;[30-36] results reveal alternating between the two postures has ergonomic benefits.[30-36] In 2015, Karol and Robertson conducted a review of the literature on ergonomic benefits of sit-stand workstation use in various settings.[30] In one study, the introduction of sit-stand workstations resulted in 23% of participants choosing to stand while working and alternating their posture between seated and standing on average 3.6 times per day.[30,31] As a result, the researchers found a reduction in use of static postures and MSD pain among the workers.[30,31] Similarly, researchers of another study examined the benefits of introducing a sit-stand desk in call centers, where employees spend up to 90% of their work day sitting.[30,35] Results revealed sit-stand desks were associated with variations in posture throughout the day and positive benefits for musculoskeletal health such as decreased musculoskeletal pain and overall reduced fatigue.[30,35] Overall, the literature review revealed postural variation, such as standing for at least one hour during an eight-hour workday or implementing standing intervals, has beneficial reductions on MSD risk and discomfort.[30,35] However, the researchers determined that with the available literature, there is not enough evidence to make concrete suggestions for postural variation and further research is needed.[30]

In a systematic review, Karakolis and Callaghan examined the impact of postural variation on worker discomfort in office settings with long term use of sit-stand workstations.[36] For the purpose of the review, discomfort was defined as an unpleasant state of the human body in reaction to its physical environment.[36] One study found when a sit-stand workstation was made available to employees, there was a 12.9% increase of self-reported standing throughout the workday, resulting in an average of 27.5% decrease in musculoskeletal related discomfort.[32,36] Similarly, another study reported, after a sit-stand workstation was introduced

there was a significant reduction in self-reported musculoskeletal complaints from workers in the intervention group.[34,36] There was no significant change in self-reported musculoskeletal complaints from the control group, suggesting use of a sit-stand desk could be ergonomically benefical.[34,36] Overall, the systematic review revealed a reduction of reported discomfort in workers who used sit-stand workstations compared to sit only work.[36] Interestingly, the systematic review also found trends in increased worker productivity.[36] The systematic review indicated several positive benefits to postural variaition;[36] however, more research is needed to identify possible negative outcomes of sit-stand workstations due to reported cases of increased upper body discomfort in some of the studies and the shorter duration of most studies included in the systematic review.[36]

Despite positive findings from both the literature and systematic reviews, these studies also had limitations.[30,36] More research is needed before recommending postural variations related to sitting and standing throughout the work day.[30,34,36] One study from the systematic review reported a limitation of only a one week use of the sit-stand work station, which cannot be used to recommend any sit-stand ratios that may have positive ergonomic benefits over long term periods.[34,36] Research has yet to determine an optimal ratio for time spent sitting versus standing.[30,36] Additionally, workers who previously experienced pain were twice as likely to use the sit-stand workstations rather than workers using them to prevent pain.[34] Ultimately, there is a lack of longitudinal studies, overall knowledge on impact, and concrete recommendations to fully support the use of varying posture between sitting and standing.[30,34,35] Despite the lack of generalized recommendations, research indicates several ergonomic benefits from varied postures in the workplace,[36] something that has not been thoroughly examined in dentistry.

Since seated and standing postures use different muscles, each position has different postural advantages and disadvantages that could potentially impact MSD development in dental hygienists.[10,43] Because dental hygienists are at a high risk for developing MSDs, it is critical to explore the impacts of sitting and standing on postural loads during dental hygiene

tasks. Previous research indicates muscular loads are heavier in various areas of the body depending on which posture is being used.[8,10,17] A seated posture may increase the muscular load on the back, a common area for MSD pain in dental hygienists.[17] In contrast, standing posture may cause increased muscular load leading to fatigue in the lower extremities; however, in the dental field the back, shoulders and neck muscles are typically affected by pain more commonly than lower extremities.[10] To the researchers' knowledge, no research has been conducted to explore alternating between these postures throughout the day or during a single appointment in dentistry or dental hygiene; however, one study in dentistry looked at postural differences in a static seated posture and in a static standing posture when delivering clinical care.[10] That study examined postural differences among dentists in static postures and found that neck, shoulder and back muscles held higher muscular loads for participants when in a seated posture compared to a standing posture, as well as in the muscles used to maintain body posture during dental procedures.[10] These findings suggests that it may be more difficult to find an adequate posture during fine, precise manipulative procedures such as those used in dentistry while seated.[10] Postural variations may have impacts on reducing the risk for MSDs; this reduction in risk is attributed to variation in movements that can achieve different physical workloads in the body, especially the upper extremities.[8,10,43] By alternating between sitting and standing postures, a dynamic working posture can be adapted which may be less tiring and more efficient than fixed, static working postures.[10] Though research has examined static sitting and standing postures in dentistry, there are currently no studies exploring the impact of static sitting or standing postures, or alternating between the two, in dental hygiene. With dental hygienists being the most affected dental professional for MSDs, research in this area is of utmost importance to ergonomic instruction and career satisfaction. Therefore, the purpose of this pilot study was to gather baseline information on postural impacts and potential MSD risk for dental hygienists. This was accomplished by examining and analyzing the impacts of

standing and sitting postures independently on biomechanical and postural loads during instrumentation.

CHAPTER III

METHODS

Sample Description

A convenience sample of 35 second-year dental hygiene students from an entry-level dental hygiene program were recruited for this IRB-approved study (Appendix A). To determine whether participants met inclusion criteria, a preliminary screening questionnaire was completed at the time of recruitment. Included participants were generally healthy, 18 years or older, and enrolled in his or her second year of dental hygiene school. Any past or present injury, or disability of the working hand, wrist, forearm, shoulder, neck, and/or trunk excluded participants from this study. Participants were recruited via email (Appendix B) and offered dental hygiene products as incentives for participation. At the time of recruitment, participants were informed that data collection would occur during two thirty minute, on-campus sessions.

Research Design

The university's Institutional Review Board approved this study. After informed consent was obtained, participants completed dental hygiene care services in a simulated oral environment using a dental chair-mounted typodont with an artificial face. Participants completed hand instrumentation services typically provided during a patient care appointment in a simulated oral environment in one of two postures: seated or standing. This study utilized a counterbalanced design with participants completing instrumentation in both postures. Participants used the ODU 11/12 Explorer instrument, and a variety of scaling instruments typically taught in entry-level, dental hygiene curriculum during two separate, thirty-minute simulated sessions on different days to eliminate muscle fatigue and other postural load impacts.

Prior to the start of the first session, participants were randomly assigned to one quadrant of the mouth and the buccal or lingual surfaces of the teeth to be utilized during both

instrumentation sessions; therefore, there were eight possible combinations of quadrants and surfaces assigned to participants: upper right quadrant (UR) buccal surfaces, UR lingual surfaces, lower right quadrant (LR) buccal surfaces, LR lingual surfaces, upper left quadrant (UL) buccal surfaces, UL lingual surfaces, lower left quadrant (LL) buccal surfaces, and LL lingual surfaces. A unique participant identifier was utilized to link data between sessions. Participants were also randomized for postures utilized during the simulated instrumentation, with one session of seated hygiene and one session of standing hygiene. For this study, participants were instructed not to use magnification loupes. Participants explored and scaled their assigned quadrant and surface for both sessions; however, they changed postures between the first and second session. For example, if a participant started their first session instrumenting in a seated position, when they returned for their second session, they completed instrumentation in a standing position on the same assigned quadrant and surfaces. The use of the same quadrant and surface for participants was critical for using the RULA tool to compare postural loads between sitting and standing postures during instrumentation.

Standardized instructions (Appendix C) were provided to each participant during both sessions. Additionally, during the second session, participants were reminded of the quadrant and surfaces they were assigned and given the posture they would be using for the current session. For both sessions, the participant started with a five-minute practice session to adjust the simulator, chair, and bracket table for the assigned quadrant and surface. Participants were also allowed to practice scaling or exploring in the assigned area during this warm-up period. This was followed by twenty-five minutes of scaling or exploring to remove artificial calculus deposits for the assigned quadrant and surface. Participants were instructed to utilize the sequence and instruments they would typically use for calculus removal in that quadrant and on those surfaces. Scaling was limited to supragingival surfaces to eliminate differences in technique associated with subgingival scaling. Photographic images were captured of the participants at two different times per session, for a total of four images per participant; Figure 1

is an example of a seated posture and Figure 2 is an example of a standing posture image utilized for this study. In each session, the first image was taken after the participant had been working for at least ten minutes after they had moved on from the warm-up period. This gave the participant time to find a working position they were comfortable with for the assigned quadrant and surface. The second image was taken twenty minutes into the working time. The images were rated by the researchers to ensure clear views of postural body positions for scoring with the RULA tool and the best seated and standing image were used for RULA scoring. Therefore, only two images were used for postural assessment using the RULA.

Data Collection Instrument

The RULA[40] is a valid and reliable tool that has been used to measure posture during dental hygiene tasks in multiple studies.[8,9,17] The single-page RULA form was used among four calibrated researchers to score biomechanical and postural load on the neck, trunk, and upper extremities utilizing the images taken during instrumentation sessions to evaluate body posture, force, and repetition for each posture: sitting and standing (Appendix D). Using images allowed the researchers to score and assess participants the same way each time and is standard practice for this assessment of posture using the RULA.[8,9,17] The RULA scores are entered for each body region in section A for the arm and wrist and section B for the neck and trunk. A score between one and seven is given to determine the level of MSD risk: scores of one to two indicate “negligible risk and no action required,” three to four is “low risk and change may be needed,” five to six is “medium risk and further investigation and change is needed soon,” and a score of six or higher is considered “very high risk and change is needed now.”[40] The two images were then scored independently by the researchers and averaged to quantify an overall RULA posture score for each session. Therefore, each participant had an average score for the seated posture session and an average score for the standing posture session that were utilized for data analysis.

After completion of each session, an end-user survey was completed by participants to gauge his or her perceptions of discomfort and pain for each posture (Appendix E). The end-user survey consisted of thirteen questions asking participants to rate any pain/discomfort from that simulated session. Additionally, demographic information was collected including age, ethnicity, and gender identity. The two end-user surveys were linked to the data collection through the unique patient identifiers created at the first research session. Perceptions of posture from the end-user survey were compared to RULA scores.

Prior to data collection, a pilot study was conducted to ensure appropriate camera use, photographic angulation for diagnostic imaging, and scoring using the RULA tool. This calibrated the researchers to help eliminate bias and possible threats to validity. To calibrate on scoring using the RULA tool, the four researchers met to review the RULA worksheet together and conducted individual practice of scoring images not utilized in the study for data analysis. The independent scores were reviewed to ensure each researcher was calibrated on scoring with the RULA. After this calibration, researchers were able to independently score images of seated and standing postures and combined mean score were used for data analysis.

Data Analysis

Descriptive statistics such as mean scores and frequencies were utilized for individual scores on the RULA. Additionally, paired sample t-tests were used to compare each individual student's sitting posture RULA score to their standing posture RULA score. Descriptive statistics were utilized to summarize survey results and compare participant perceptions to RULA scores. All data were analyzed using SPSS 24, significance was set to $p = 0.05$ level.

CHAPTER IV

RESULTS

Thirty-five dental hygiene students completed both sessions of data collection (n=35, 100%); however, only 97% (n=34) of participant data were used in data analysis. One participant's images were eliminated because body regions were obscured and could not be scored accurately with the RULA assessment tool. All participants were female (n=34, 100%) and second-year dental hygiene students (n=34, 100%). A majority of participants were between 18-24 years old (n=29, 85%) and reported always wearing dental magnification loupes while delivering hygiene care in the clinic setting (n=30, 88%). All demographic data can be seen in Table I.

All sitting and standing image sets were independently scored using the RULA tool by the four researchers and the averages for each participant's sitting and standing RULA scores can be seen in Table II. Overall, none of the participant scores for sitting or standing postures were in the acceptable RULA range of 1-2. In fact, the minimum RULA score for seated postures among all participants was 3.00 and the maximum score was 6.33, indicating "a needed change" since postures are outside of the acceptable range. The minimum RULA score for standing postures among all participants was slightly higher than sitting at 3.33 and the maximum was slightly higher at 6.75, also indicating "a needed change" since postures outside of an acceptable range. Side by side comparisons of sitting and standing scores (Table II) indicate most participants (n=23, 68%) had worse postures while standing to deliver hygiene services. This is also evident when the average is compared for all participants; the mean seated RULA score for all participants was 3.91 ± 0.77. This score on the RULA assessment indicates a "low risk and change may be needed". The mean standing RULA score for all participants was 4.50 ± 1.00 (Table II), indicating a "moderate risk and change is needed soon". Results of paired sample t-tests revealed a statistically significant difference in average RULA scores for standing and sitting postures, $t(33) = -3.467$, $p = 0.001$. The mean RULA score was

higher when participants used a standing posture (x= 4.50) to deliver dental hygiene care services when compared to seated postures (x= 3.91), thus indicating standing postures were significantly worse.

An end user survey asked participants to rate their discomfort on a Likert scale for the feet, legs, hips, lower trunk (abdomen and back), upper trunk (chest and back), arms, wrist, and neck. The data was compiled and separated based on whether the seated posture was used, or the standing posture was used.

End-User Survey Results: Seated Posture

A Likert scale was used to gauge participants' perceptions of pain for various body regions for both postures; see all results for seated postures in Table III. Most participants reported *no pain* or *neutral* for the feet, legs, and hips regions. For the lower trunk (abdomen and back), upper trunk (chest and back), arms, and wrist regions, very few participants reported *slight* or *very strong pain.* After performing simulated instrumentation in a seated posture, slightly more than half the participants (n= 18, 53%) reported *slight* or *very strong pain* in the neck region. Overall, the results from this survey indicate that participants were mostly comfortable delivering patient care while in the seated position. Furthermore, participants were asked to rate their overall perception of the seated posture used during dental hygiene care in this study (Table V). When asked to rate their overall posture after sitting to deliver dental hygiene services, the majority of participants (n=24, 70.6%) reported having *somewhat good* or *neutral postures*, with some reporting *very good posture* (n= 3, 8.8%) and no participants reporting *very poor posture* (n=0, 0%).

End-User Survey Results: Standing Posture

In comparison, results from this survey indicated participants were not as comfortable delivering patient care while in a standing posture when compared to a seated posture; see all

results in Table IV. Unlike seated postures, participants indicated *slight* or *very strong pain* in all body regions after utilizing a standing posture during instrumentation. For the feet, lower trunk, upper trunk, and neck, more than one third of participants reported *slight* or *very strong pain*. The neck had the highest number of reported pains with 17 participants (50%) reporting *slight* or *very strong pain*. Participants were also asked to rate their overall perception of the standing posture used during dental hygiene care in this study (Table V). When asked to rate their overall posture after standing to deliver dental hygiene services, most participants reported having *somewhat poor* or *neutral postures* (n= 20, 58.9%), with some reporting *very poor posture* (n= 4, 11.7%). However, eight participants reported somewhat good posture (23.5%) and two participants indicated *very good posture* (5.9%) after standing to deliver dental hygiene services.

CHAPTER V

DISCUSSION

Musculoskeletal disorders continue to be highly prevalent among dental hygienists with many body regions being negatively affected.[5,7,8,10,21,22] Research has identified several interventions to improve ergonomics including magnification loupes, instrument handle designs, and saddle chairs.[8,9,17,27-29]In other disciplines, alternating seated and standing postures found an overall decrease in the use of static posture that resulted in a decrease of reported MSD pain or discomfort.[30-36] In dentistry, research in static postures found that different muscles held higher muscular loads dependent on which posture was being adopted.[10] Identifying postural variation impacts in dental hygiene may have a positive effect on reducing the prevalence of MSDs and MSD-related pain. This study gathered baseline information on how the biomechanical and postural loads were affected by standing and sitting postures independently during the delivery of simulated instrumentation. All thirty-four (100%) participants had postures that were unacceptable and required further investigation as found by the RULA tool for both sitting and standing postures.[40] When postures were looked at independently, seated postures were slightly better on average when compared to standing postures. Participants' perceptions were similar to these findings as end-user survey results determined participants felt less pain overall and in less body regions when using sitting postures to deliver dental hygiene services.

The RULA scores for the sitting postures ranged from 3.00 to 6.33 indicating the postures should be further investigated; twenty-eight participants (82.4%) fell within the range of 3-4 on the RULA for sitting postures indicating "low risk and that a change may be needed soon", whereas six participants (17.6%) scored within the range of 5-6 indicating "moderate risk and a change is definitely needed soon" (Table II).[40] The overall mean RULA score for sitting postures for all participants was 3.91 ± 0.77 suggesting postural "changes may be needed"[40] because biomechanical demands and postural loads were outside of the acceptable range. Since the participants currently perform dental hygiene services on patients while sitting the

majority of the time, this suggests their postures may have already been unacceptable or adopted early in student clinical practice. Despite seated postures outside of the acceptable range, the majority of participants (n=27, 79.4%) rated their seated posture as *neutral*, *somewhat good*, or *very good,* indicating they were unaware of the unacceptable posture being utilized during instrumentation in this study (Table V). Interestingly, participants reported minimal pain in various body regions on the end-user survey even with postures outside of the acceptable range (Table III). It is likely they have not utilized these poor postures long enough to develop MSD-related pains in these body regions. Research indicates that MSDs in dental hygienists occur from cumulative exposure to occupational risks and it is possible that the short duration of clinical practice these student participants had before the study did not accurately represent the impacts poor postures can have on MSD risk and pain. Additionally, in the present study, participants did not utilize magnification loupes in order to eliminate any confounding variables, but this may have impacted findings for sitting postures. Research indicates personalized magnification loupes may diminish the need to use excessive neck flexion, twist the torso or slouch, thus aiding in maintaining an acceptable working posture.[8,17,27] Eighty-eight percent of the participants (n=30) reported always wearing loupes during dental hygiene care and may have better seated postures when utilizing loupes. Ergonomic training beyond magnification loupes may be indicated for dental hygiene students to identify poor sitting postures early in their career to adopt better postural habits that may prevent MSDs. Results from another study revealed that training with faculty evaluations of posture and self-assessments of posture could also impact seated postures in student dental hygienists.[19] When faculty members were able to give feedback to students and the students were able to self-assess their seated postures with photographs during dental hygiene services, their ergonomic scores on the modified dental operator posture assessment instrument (M-DOPAI) improved. This suggests education and/or training could impact postural behaviors while sitting.[19] Similar self-assessments of posture should be incorporated in dental hygiene curriculum to encourage

accurate self-perception among students for acceptable seated postures while delivering patient care to prevent MSD development.

Similar to the results for seated postures, results revealed standing postures also had significant impacts on biomechanical and postural loads as determined by the RULA assessment. The RULA scores for standing posture ranged from 3.33 to 6.75 suggesting the standing posture "need to be further investigated;" nineteen participants (55.8%) fell within the range of 3-4 on the RULA for standing postures indicating "low risk and that a change may be needed soon," thirteen participants (38.2%) fell within the range of 5-6 on the RULA meaning "moderate risk and a change is definitely needed soon," and two participants (5.8%) scored in the 7-8 range on the RULA indicating "high risk and a change should be implemented immediately" (Table II).[40] The overall mean RULA score for standing postures for all participants was 4.50 $\pm$ 1.00 suggesting that postural change is needed soon;[40] therefore, the participants had biomechanical and postural loads outside the range deemed acceptable for standing postures as well. In contrast to the self-perceptions for sitting postures, the majority of participants (n= 24, 70.6%) rated their standing posture as *very poor, somewhat poor,* or *neutral* indicating they were aware of the unacceptable posture adopted during simulated dental hygiene care for this study. Additionally, participants reported pain in more body regions for standing when compared to sitting, including the feet, legs, hips, lower trunk (abdomen and back), upper trunk (chest and back), and neck (Table IV). Participants of this study had no prior training on proper standing postures for delivery of patient care and likely lacked self-awareness of what would be acceptable or not. Additionally, without training, participants likely were not familiar with ergonomic adjustments that may be needed to achieve acceptable postures while standing during instrumentation. One research study on ergonomic faculty instruction and self-assessments found positive results for improving postural scores for dental hygiene students while seated and it is possible that this could be extended to standing postures as well.[19] However, acceptable standing postures are not commonly explored in dental hygiene

curriculum and training. It is possible that education and training in standing postures would result in different scores on the RULA assessment and potentially positive postural impacts.

When comparing the two postures with the RULA tool, results revealed statistically significant differences in biomechanical and postural load scores between sitting and standing postures. Results from paired sample t-tests indicated mean standing RULA scores (x= 4.50) were significantly higher than mean sitting RULA scores (x= 3.91). The results from this study indicated that participants had better overall posture when using a seated posture to deliver patient care. The end-user survey results supported these RULA findings as the participants also perceived better postures during instrumentation while seated. Participants also indicated less pain in various body regions on the end-user survey for sitting postures. While these end-survey results support the better RULA scores for seated postures, participants did not have acceptable postures regardless of which posture was adopted. The end-user survey results reflect that participants were not aware of their unacceptable posture while sitting, due to an overall report of *neutral, somewhat good,* or *very good* posture by participants. Participants likely scored better on the RULA assessment when a seated posture was adopted because of the ergonomic principles included in entry-level dental hygiene curriculum and because they currently practice in a seated position; this likely resulted in the participants being more aware of ergonomic principles while seated. The participants' perceptions could also be explained by the ergonomic education currently in dental hygiene curriculum that does not train students for proper postures or positioning while standing, rather it is focused on seated postures for patient care.[11,16,21] Regardless, both postures were unacceptable for all participants according to the RULA and ergonomic training or interventions should be explored to decrease postural loads during dental hygiene services to reduce the risk of MSDs.

Some research indicates advantages in alternating postures, however this study examined sitting and standing postures independently.[10] It is possible that varying these postures throughout a clinical workday could have more ergonomic benefits that reduce MSD

risk and pain. Varying postures throughout the workday could vary the biomechanical demands on the body; each posture has advantages and disadvantages that can be exacerbated if just one is adopted for a full workday. Seated postures result in more loading of muscles and greater neck flexion to maintain an acceptable posture that result in difficulty using precise movements associated with hygiene practice.[8,10] However, standing postures can also lead to negative ergonomic impacts including greater flexion of the upper arm and more force on the lower joints.[8] To limit the individual negative impacts, it is surmised that postural variation throughout the workday may reduce the risks of each individual posture. Postural variation would reduce the load on specific joints and muscles impacted by the postures individually. This is supported by research in other workplace settings that utilize sit-stand workstations for postural variation.[30-36] Additionally, individual posture effects have been explored in dentistry during restorative work and researchers identified postural variation as a possible ergonomic benefit that should be further explored.[10] Alternating postures throughout the workday should be examined among dental hygiene professionals to determine the impact on MSD risk.

Limitations

Several limitations may have influenced the findings in this pilot study. This pilot study only had student dental hygienists as participants and did not analyze the sitting and standing postures of registered dental hygienists. Future studies should examine a larger, more diverse sample size of clinically practicing dental hygienists. Furthermore, this study used a simulated dental hygiene environment for a shorter duration than typical patient care appointments. Therefore, this duration may not have been long enough for postural impacts to be revealed or for participants' true postural preferences to be assessed. Photographic images were taken twice during each session at 10 and 20 minutes in an effort to assess normal postures of the participants; however, with a simulated environment this may not have been possible. Furthermore, postures may get worse over a longer period such as a full eight-hour workday.

Future research should examine these postures during patient care for an entire eight-hour workday to determine the impact during a full workday during clinical care. Hawthorne effect was another limitation present in this study. Participants knew they were being observed and photographed for the study which may have led to postural changes. Participants were unaware of when images would be taken to reduce these impacts. Additionally, many of the participants reported the use of loupes when providing dental hygiene care services, but they were not used for the purpose of this study and that could have affected the participants' postures as well. Future studies may want to allow participants to utilize loupes if this is common practice for them during patient care and could impact postural scores on the RULA assessment.

CHAPTER VI

CONCLUSION

Findings suggest that both sitting and standing postures are unacceptable in the student dental hygiene participants. Most participants perceived their posture as acceptable when sitting; however, the RULA scores revealed postures for both sitting and standing were unacceptable. The perceptions and RULA scores for participants support the need for additional ergonomic training and education in dental hygiene curriculum and further research on the impacts of each posture. The purpose of this pilot study was to provide baseline information on postural loads for individual sitting and standing postures. This baseline information may help future studies evaluate the impact of using a combination of sitting and standing postures when delivering dental hygiene care services, which may provide greater ergonomic benefit. A larger sample size of clinically practicing dental hygienists during a full eight-hour workday may provide more information into the ergonomic benefits of sitting and standing postures and MSD risks.

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Table 1. Demographic Data by Number and Percentage of Total Participants (n=34)

	Number	Percentage
Gender		
Male	0	0%
Female	34	100%
Prefer not to answer	0	0%
Age (years)		
18-29	29	85.3%
30-44	3	8.8%
45-59	2	5.9%
60+	0	0%
Ethnicity		
White	16	47.1%
Black or African American	8	23.5%
American Indian or Alaska Native	0	0%
Hispanic	1	2.9%
Native Hawaiian and other Pacific Islander	1	2.9%
Asian	6	17.6%
Other	2	6.0%
Wearing Magnification Loupes		
Yes, always	30	88%
Yes, but only sometimes	0	0%
No	4	12%

Table 2. Mean Values of Seated and Standing RULA Scores by Participant

Participant	Sitting RULA Score	Standing RULA Score
1	3.33	3.50
2	4.50	4.00
3	3.00	4.00
4	3.67	6.00
5	4.00	3.75
6	5.00	4.50
7	3.50	4.50
8	4.00	3.33
9	3.75	3.33
10	4.00	6.75
11	4.00	6.00
12	4.00	4.50
13	3.00	4.00
14	3.33	4.00
15	5.75	6.75
16	4.00	3.50
17	3.25	3.75
18	6.33	6.00
19	4.00	4.25
20	3.33	6.00
21	3.33	4.25
22	3.25	4.00
23	3.67	4.25
24	4.67	4.50
25	4.00	3.67
26	4.00	3.33
27	3.00	5.00
28	4.00	4.00
29	3.00	3.75
30	3.67	4.75
31	3.33	3.75
32	4.25	6.25
33	5.25	4.50
34	3.75	4.50
Mean and Standard Deviation	3.91 ± 0.77	4.50 ± 1.00

Table II Key[1]	
3-4	Low risk-further investigation, change may be needed soon
4-6	Moderate risk-further investigation, change soon
7-8	High risk-investigate and implement change

[1] *Participant scores were mean scores determined by the independent scoring of four researchers, scores were included with the nearest range for interpretation, e.g., scores of 4.2 were included in the 3-4 range whereas scores of 4.7 were included in the 5-6 range.*

Table 3. Perception of Pain and Discomfort: Seated Posture by Number and Percentage (n= 34)

	Number	Percentage
Feet		
Very strong discomfort or pain	0	0%
Slight discomfort or pain	0	0%
Neutral, I felt no pain or discomfort in this area	6	17.6%
There was no discomfort or pain	28	82.4%
Legs		
Very strong discomfort or pain	0	0%
Slight discomfort or pain	0	0%
Neutral, I felt no pain or discomfort in this area	5	14.7%
There was no discomfort or pain	29	85.3%
Hips		
Very strong discomfort or pain	0	0%
Slight discomfort or pain	0	0%
Neutral, I felt no pain or discomfort in this area	6	17.6%
There was no discomfort or pain	28	82.4%
Lower trunk (abdomen and back)		
Very strong discomfort or pain	1	3.0%
Slight discomfort or pain	8	23.5%
Neutral, I felt no pain or discomfort in this area	8	23.5%
There was no discomfort or pain	17	50%
Upper trunk (chest and back)		
Very strong discomfort or pain	0	0%
Slight discomfort or pain	12	35.3%
Neutral, I felt no pain or discomfort in this area	6	17.6%
There was no discomfort or pain	16	47.1%
Arms		
Very strong discomfort or pain	0	0%
Slight discomfort or pain	5	14.7%
Neutral, I felt no pain or discomfort in this area	8	23.5%
There was no discomfort or pain	21	61.8%
Wrist		
Very strong discomfort or pain	0	0%
Slight discomfort or pain	8	23.5%
Neutral, I felt no pain or discomfort in this area	7	20.6%
There was no discomfort or pain	19	55.9%
Neck		
Very strong discomfort or pain	2	5.9%
Slight discomfort or pain	16	47.1%
Neutral, I felt no pain or discomfort in this area	3	8.8%
There was no discomfort or pain	13	38.2%

Table 4. Perception of Pain and Discomfort: Standing Posture by Number and Percentage (n= 34)

	Number	Percentage
Feet		
Very strong discomfort or pain	1	2.9%
Slight discomfort or pain	10	29.4%
Neutral, I felt no pain or discomfort in this area	7	20.6%
There was no discomfort or pain	16	47.1%
Legs		
Very strong discomfort or pain	0	0%
Slight discomfort or pain	6	17.7%
Neutral, I felt no pain or discomfort in this area	10	29.4%
There was no discomfort or pain	18	52.9%
Hips		
Very strong discomfort or pain	0	0%
Slight discomfort or pain	6	17.7%
Neutral, I felt no pain or discomfort in this area	10	29.4%
There was no discomfort or pain	18	52.9%
Lower trunk (abdomen and back)		
Very strong discomfort or pain	5	14.7%
Slight discomfort or pain	7	20.6%
Neutral, I felt no pain or discomfort in this area	7	20.6%
There was no discomfort or pain	15	44.1%
Upper trunk (chest and back)		
Very strong discomfort or pain	3	8.8%
Slight discomfort or pain	9	26.5%
Neutral, I felt no pain or discomfort in this area	8	23.5%
There was no discomfort or pain	14	41.2%
Arms		
Very strong discomfort or pain	0	0%
Slight discomfort or pain	5	14.7%
Neutral, I felt no pain or discomfort in this area	13	38.2%
There was no discomfort or pain	16	47.1%
Wrist		
Very strong discomfort or pain	0	0%
Slight discomfort or pain	2	5.9%
Neutral, I felt no pain or discomfort in this area	13	38.2%
There was no discomfort or pain	19	55.9%
Neck		
Very strong discomfort or pain	5	14.7%
Slight discomfort or pain	12	35.3%
Neutral, I felt no pain or discomfort in this area	5	14.7%
There was no discomfort or pain	12	35.3%

Table 5. Overall Perception of Posture for Sitting and Standing by Number and Percentage (n= 34)

	Number	Percentage
Sitting: Overall Posture Rating		
Very poor	0	0%
Somewhat poor	7	20.6%
Neutral	11	32.4%
Somewhat good	13	38.2%
Very good	3	8.8%
Standing: Overall Posture Rating		
Very poor	4	11.7%
Somewhat poor	11	32.4%
Neutral	9	26.5%
Somewhat good	8	23.5%
Very good	2	5.9%

Figure 1. Sitting Posture

Figure 2. Standing Posture

APPENDIX A

IRB APPROVAL

OFFICE OF THE VICE PRESIDENT FOR RESEARCH

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DATE: March 11, 2020

TO: Jessica Suedbeck
FROM: Old Dominion University Institutional Review Board

PROJECT TITLE: [1563204-2] The Effects of Standing and Sitting Hygiene on Ergonomics REFERENCE #: 20-028
SUBMISSION TYPE: New Project

ACTION:
APPROVED
APPROVAL DATE: March 11, 2020
EXPIRATION DATE: February 19, 2021
REVIEW TYPE: Full Committee Review

Thank you for your submission of New Project materials for this project. The Old Dominion University Institutional Review Board has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Full Committee Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

Please note that any revision to previously approved materials must be approved by this office prior to initiation. Please use the appropriate revision forms for this procedure.

All UNANTICIPATED PROBLEMS involving risks to subjects or others (UPIRSOs) and SERIOUS and UNEXPECTED adverse events must be reported promptly to this committee. Please use the appropriate reporting forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to this committee.

This project has been determined to be a MINIMAL RISK project. Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of February 19, 2021.

Please note that all research records must be retained for a minimum of three years after the completion of the project.

If you have any questions, please contact Danielle Faulkner at (757) 683-4636 or dcfaulkn@odu.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Old Dominion University Institutional Review Board's records.

APPENDIX B

INVITATION LETTER TO STUDENT DENTAL HYGIENISTS

IRB APPROVED
PROJECT NUMBER: 1563204-2

Dear Dental Hygiene Student,

My name is Taylor Kace, and I am a graduate student in the School of Dental Hygiene at Old Dominion University. I'm currently working on my thesis project with other faculty members in the school titled "The Effects of Standing and Sitting Hygiene on Ergonomics". The purpose of this study is to provide more information on the ergonomic benefits associated with standing and sitting postures while delivering dental hygiene are services.

This study consists of two separate thirty-minute simulated sessions at least one week apart; one session the participant will be using a sitting posture while delivering regular dental hygiene care services such as exploring and scaling, and the second session the participant will be using a standing posture. During both sessions', images will be captured of the participant so that the researchers can accurately score the participant using the ergonomics tool, "Rapid Upper Limb Assessment", at a later time. At the end of both sessions the participant will answer a web-based end-user survey asking them to rate their pain/discomfort for that session.

If you choose to participate, the information will be kept confidential. None of the information in the survey, the four photographs, or data collection will be linked back to any personally identifiable information. Data will be reported in group form only. Participation is voluntary and you may stop participating in the research study at any time. Results of this study will be available to you by request to the Responsible Principal Investigator (RPI), Jessica Suedbeck, once the data is analyzed.

A goodie bag filled with dental hygiene care samples and donations from Crest Oral-B, Listerine, and Young will be given to each participant after completing the second session. Crest Oral-B donated two manual pro-health toothbrushes: one is soft bristles, and one is extrasoft bristles, two replacement toothbrush heads for the Oral-B Genius electric toothbrush: one pro Gumcare replacement head and one crossaction replacement head, a tube of Crest Deep Clean Gum Detoxify toothpaste, and a tube of the new Crest Gum and Sensitivity toothpaste. Listerine donated samples of their Reach UltraClean floss and Total Care Zero Alcohol mouthwash. Young donated two prophy angles and two of their D-Lish course grit prophy paste per participant.

To participate in this study, please schedule a time by emailing me with the dates and times that work best for you – availability can be seen via the link provided below. Your first session and second session must be one week apart – please pick dates accordingly. Once there are 5 slots filled by students, the remaining spots will be removed, as we will only be doing five data collection times a day. You can reach me at tkace001@odu.edu if you have any questions. Thank you in advance for your time and participation.

Schedule link:
https://docs.google.com/spreadsheets/d/1yzOFrrhN_8u3LSbR2bEqdrzDZ8yNkEktxtcaRqb7Xwl/edit?usp=sharing

Sincerely,

Taylor Shay Kace, BSDH, RDH

APPENDIX C

STANDARDIZED INSTRUCTIONS GIVEN TO PARTICIPANTS

Read this explanation to every participant (word for word):

- A dental hygiene cassette with a variety of instruments that are typically used to provide care to patients will be provided for you. You will be scaling and exploring in Quadrant _____ on the _____ surfaces, you will be scaling for a maximum of 25 minutes. You will use the same Quad and surfaces at both of your sessions.
- Prior to starting the 25 minutes, you will have a five-minute warm-up period – during this time you can adjust the stimulator, adjust your chair/stance, and get comfortable. Once you feel you are ready to begin let me know and we can get started.
- Utilize whatever sequence you feel comfortable with and whichever instruments you would typically utilize for calculus removal, exploring or a combination of the two in that quadrant and on those surfaces. You do not need to remove any calculus; you can explore the whole time if you'd like.
- You will not be assessed on your calculus removal or correct instrumentation.
- Scaling is limited to supragingival surfaces only.
- Two images per session, for a total of four images, will be captured and scored with the Rapid Upper Limb Assessment tool by the investigators at a later date; this tool uses a systematic process to evaluate required body posture, force, and repetition for the job task in relation to exposure of individual workers to ergonomic risk factors associated with upper extremity MSD. A single page worksheet is used to evaluate required or selected body posture, muscle use frequency, and forceful exertions
- At the completion of the stimulated hygiene care you will be asked to complete an end-user survey.

APPENDIX D

RAPID UPPER LIMB ASSESSMENT WORKSHEET

ERGONOMICS PLUS

RULA Employee Assessment Worksheet

Task Name: Date:

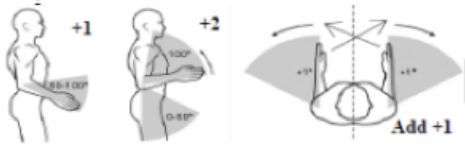
A. Arm and Wrist Analysis

Step 1: Locate Upper Arm Position:

Step 1a: Adjust...
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Upper Arm Score

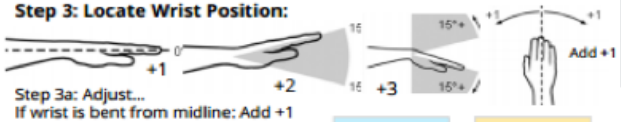
Step 2: Locate Lower Arm Position:



Lower Arm Score

Step 2a: Adjust...
If either arm is working across midline or out to side of body: Add +1

Step 3: Locate Wrist Position:



Step 3a: Adjust...
If wrist is bent from midline: Add +1

Wrist Twist Score

Wrist Score

Step 4: Wrist Twist:
If wrist is twisted in mid-range: +1
If wrist is at or near end of range: +2

Step 5: Look-up Posture Score in Table A:
Using values from steps 1-4 above, locate score in Table A

Posture Score A

Step 6: Add Muscle Use Score
If posture mainly static (i.e. held>10 minutes),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score

Step 7: Add Force/Load Score
If load < .4.4 lbs. (intermittent): +0
If load 4.4 to 22 lbs. (intermittent): +1
If load 4.4 to 22 lbs. (static or repeated): +2
If more than 22 lbs. or repeated or shocks: +3

Force / Load Score

Step 8: Find Row in Table C
Add values from steps 5-7 to obtain Wrist and Arm Score. Find row in **Table C**.

Wrist & Arm Score

Scores

Table A		Wrist Score							
		1		2		3		4	
Upper Arm	Lower Arm	Wrist Twist		Wrist Twist		Wrist Twist		Wrist Twist	
		1	2	1	2	1	2	1	2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

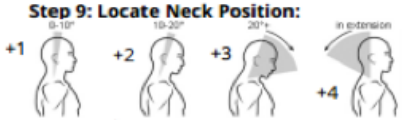
Table C		Neck, Trunk, Leg Score						
		1	2	3	4	5	6	7+
Wrist / Arm Score	1	1	2	3	3	4	5	5
	2	2	2	3	4	4	5	5
	3	3	3	3	4	4	5	6
	4	3	3	3	4	5	6	6
	5	4	4	4	5	6	7	7
	6	4	4	5	6	6	7	7
	7	5	5	6	6	7	7	7
	8+	5	5	6	7	7	7	7

Scoring: (final score from Table C)
1-2 = acceptable posture
3-4 = further investigation, change may be needed
5-6 = further investigation, change soon
7 = investigate and implement change

RULA Score

B. Neck, Trunk and Leg Analysis

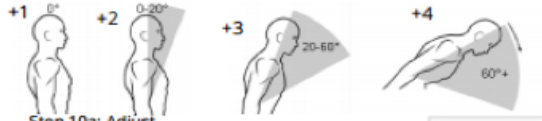
Step 9: Locate Neck Position:



Neck Score

Step 9a: Adjust...
If neck is twisted: +1
If neck is side bending: +1

Step 10: Locate Trunk Position:



Step 10a: Adjust...
If trunk is twisted: +1
If trunk is side bending: +1

Trunk Score

Step 11: Legs:
If legs and feet are supported: +1
If not: +2

Leg Score

Neck Posture Score	Table B: Trunk Posture Score											
	1		2		3		4		5		6	
	Legs		Legs		Legs		Legs		Legs		Legs	
	1	2	1	2	1	2	1	2	1	2	1	2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

Step 12: Look-up Posture Score in Table B:
Using values from steps 9-11 above, locate score in Table B

Posture B Score

Step 13: Add Muscle Use Score
If posture mainly static (i.e. held>10 minutes),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score

Step 14: Add Force/Load Score
If load < .4.4 lbs. (intermittent): +0
If load 4.4 to 22 lbs. (intermittent): +1
If load 4.4 to 22 lbs. (static or repeated): +2
If more than 22 lbs. or repeated or shocks: +3

Force / Load Score

Step 15: Find Column in Table C
Add values from steps 12-14 to obtain Neck, Trunk and Leg Score. Find Column in **Table C**.

Neck, Trunk, Leg Score

www.ergo-plus.com | 765.384.4499

based on RULA: a survey method for the investigation of work-related upper limb disorders, McAtamney & Corlett, Applied Ergonomics 1993, 24(2), 91-99

APPENDIX E

END USER SURVEY

Start of Block: Default Question Block

Q1 Please follow these directions to enter a unique four digit identifier in the space provided:
What is the last digit of your address? For example, if your address is 2811 Emerson Drive, it would be 1.
What is the last digit of your birth year? For example, 1996 would be a 6.
What is the last digit of your UIN? For example, 00452357 would be a 7.
What is the last digit of your phone number? For example, 7572629789 would be a 9.
So you would enter: 1679:

_____

Q2 Dear Dental Hygiene Student,

Thank you for participating in this research study. You will now complete a short post-opinion survey about your experience during today's session.

This survey should take approximately 2 minutes to complete. This study has been approved by the Old Dominion University Institutional Review Board.

Participation in this survey is voluntary. Results will be reported in the aggregate at the completion of the study.

Q3 Based on **today's** simulated care session, how would you rate your pain or discomfort in the following areas:

	Very strong discomfort or pain (1)	Slight discomfort or pain (2)	Neutral, I felt no pain or discomfort in this area (3)	There was no discomfort or pain (4)	I am unsure for this area (5)
Feet (1)	○	○	○	○	○
Legs (2)	○	○	○	○	○
Hips (3)	○	○	○	○	○
Lower trunk (abdomen and back) (4)	○	○	○	○	○
Upper trunk (chest and back) (5)	○	○	○	○	○
Arms (6)	○	○	○	○	○
Wrist (7)	○	○	○	○	○
Neck (8)	○	○	○	○	○

Q4 Based on **today's** simulated care session, which of the following best describes how you feel your posture was while providing care?

- ○ Very poor posture (1)
- ○ Somewhat poor posture (2)
- ○ I feel neutral about my posture today (3)
- ○ Somewhat good posture (4)
- ○ Very good posture (5)

Q5 What is your age range?

- Under 18 (1)
- 18 - 29 (2)
- 30 - 44 (3)
- 45 - 59 (4)
- 60+ (5)

Q6 Select your ethnicity.

- White (1)
- Black or African American (2)
- American Indian or Alaska Native (3)
- Hispanic (4)
- Native Hawaiian and other Pacific Islander (5)
- Asian (6)
- Other (7) _____

Q7 Which gender do you identify with the most?

- Male (1)
- Female (2)
- Prefer not to answer (3)

Q8 What is your current position in the School of Dental Hygiene?

- Junior Student (1)
- Senior Student (2)

Q9 Do you normally wear magnification loupes when performing dental hygiene tasks?

- Yes, always (1)
- Yes, but only sometimes (2)
- No (3)

Q10 Was this your first or second session?

- First (1)
- Second (2)

Q11 Which quadrant and surfaces were you assigned to?

- UR buccal (1)
- UR lingual (2)
- LR buccal (3)
- LR lingual (4)
- UL buccal (5)
- UL lingual (6)
- LL buccal (7)
- LL lingual (8)

End of Block: Default Question Block

VITA

NAME: Taylor Shay Kace, RDH
ADDRESS: 4608 Hampton Boulevard
Norfolk, VA 23509

EDUCATION:

In progress	Old Dominion University Norfolk, VA Master of Science, Dental Hygiene
2018	Northern Arizona University Flagstaff, AZ Bachelor of Science, Dental Hygiene

PROFESSIONAL EXPERIENCE:

2020-Present	Adjunct Clinical Instructor, Department of Dental Hygiene, Old Dominion University, Norfolk, VA
2019-Present	Dental Hygienist, LWSS Family Dentistry, Chesapeake, VA
2018-2020	Graduate Teaching Assistant, Department of Dental Hygiene, Old Dominion University, Norfolk, VA

MEMBERSHIPS IN PROFESSIONAL SOCIETIES:

2021	American Dental Education Association
2016-Present	American Dental Hygienists' Association

SCHOLARSHIPS:

2019	Gene W. Hirschfield Scholarship, Old Dominion University
2020	Friends of Dental Hygiene, Old Dominion University