The effects of static seated and standing positions on posture in dental hygiene students: a pilot study

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PRACTICAL IMPLICATIONS OF THIS RESEARCH

- Dental hygiene students tend to have suboptimal standing and seated postures when providing clinical care.
- Increased biomechanical loads resulting from poor posture put dental hygienists at risk for MSDs.
- Ergonomic training in dental hygiene programs may help to decrease postural loads of static seated and standing positions, thereby reducing MSD risk.

ABSTRACT

Background: Musculoskeletal disorders (MSDs) are highly prevalent among dental hygiene professionals. The purpose of this pilot study was to evaluate and compare seated and standing postures during simulated dental hygiene practice to determine ergonomic risks associated with each posture. **Methods:** A convenience sample of 35 female second-year dental hygiene students with no history of musculoskeletal disorders was enrolled in this IRB-approved study. In 2 separate sessions, 1 seated and 1 standing, participants instrumented 1 quadrant of the mouth in a simulated oral environment. Two images per session, per participant, were taken to evaluate biomechanical demands of each posture using the Rapid Upper Limb Assessment (RULA) tool. The same 4 calibrated researchers scored all images independently and mean scores for each posture were analysed. **Results:** Thirty-four students completed the study. Results revealed statistically significant ($p = 0.001$) differences in mean RULA scores between seated (M = 3.91, SD = 0.77) and standing (M = 4.50, SD = 1.00) postures, although these differences may not be clinically relevant. **Discussion:** When postures were independently assessed, seated postures were more acceptable on average compared to standing postures, yet both were in the unacceptable range. Lack of training in standing postures may have impacted the results. **Conclusion:** Results support the need for additional ergonomic training in dental hygiene curricula. Less than ideal posture when seated or standing could increase MSD risk. Future research should examine biomechanical loads of seated and standing postures, as well as the combination of these postures, for more insight into their ergonomic benefits and associated MSD risks.

RÉSUMÉ

Contexte : Les troubles musculosquelettiques (TMS) sont très répandus parmi les professionnels de l'hygiène dentaire. Cette étude pilote visait à évaluer et à comparer les postures assise et debout dans le cadre de simulations de la pratique de l'hygiène dentaire afin de définir les risques sur le plan de l'ergonomie liés à chacune de ces postures. **Méthodes :** Dans le cadre de cette étude approuvée par un comité d'examen institutionnel, on a examiné un échantillon de commodité réunissant 35 étudiantes en hygiène dentaire de 2e année sans antécédents de troubles musculosquelettiques. À l'occasion de 2 séances distinctes, une effectuée en position assise et une effectuée en position debout, les participantes ont travaillé sur un quadrant de la bouche dans un environnement oral simulé. On a pris 2 images par séance et par participante pour évaluer les exigences biomécaniques de chacune des postures à l'aide de l'outil d'évaluation rapide des membres supérieurs (RULA). Les 4 mêmes chercheurs calibrés ont attribué une note à toutes les images de façon indépendante. On a ensuite analysé la moyenne de ces notes pour chacune des postures. **Résultats :** Trente-quatre étudiantes ont participé à l'étude jusqu'à son terme. Les résultats ont révélé des différences statistiquement significatives ($p = 0{,}001$) dans les moyennes des notes de l'outil RULA entre les postures assise (M = 3,91, ET = 0,77) et debout (M = 4,50, ET = 1,00). Toutefois, ces différences pourraient ne pas être pertinentes sur le plan clinique. **Discussion :** Dans le cadre de l'évaluation indépendante des postures, en moyenne, la position assise était plus acceptable que la position debout. Cependant, les 2 postures se trouvaient dans la fourchette de valeurs inacceptables. Il est possible que le manque de formation en position debout ait une incidence sur les résultats. **Conclusion :** Les résultats confirment la nécessité d'une formation supplémentaire sur l'ergonomie dans les programmes d'hygiène dentaire. Une posture non idéale en position assise ou debout pourrait entraîner une hausse du risque de TMS. À l'avenir, des études devraient examiner les charges biomécaniques des postures assise et debout, ainsi que la combinaison de ces postures, afin de renforcer la compréhension de leurs avantages ergonomiques et des risques de TMS connexes.

Keywords: dental auxiliaries; dental hygiene; ergonomics; musculoskeletal disorders; posture; risk assessment
CDHA Research Agenda category: capacity building of the profession

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INTRODUCTION

Occupation-related musculoskeletal disorders (MSDs) are highly prevalent in the dental hygiene profession.[1-8] Well-known biomechanical risk factors include use of vibrating tools, repetitive motions and tasks, static and non-neutral postures, and awkward positioning for extended periods of time.[1-8] Furthermore, most MSDs among dental hygienists occur from cumulative effects of repetitive, forceful and/or awkward movements and positions during patient care.[5-7,9-21] As a result, MSDs of the upper and lower back, hands and wrists, neck, shoulders, and arms commonly affect dental hygienists.[6] In 2020, researchers in Canada conducted a survey which revealed that 28% of dental hygienist participants had a medical diagnosis of an MSD.[22] Of those with a medical diagnosis, the most prevalent conditions were carpal tunnel syndrome (18%) and tendonitis (17%). Results also revealed diagnoses of arthritis, pinched nerves, repetitive strain injuries, shoulder injuries, and tennis elbow at a prevalence rate of 5% or greater among participants.[22] A literature review conducted by Hayes et al.[23] in 2010 identified many common MSDs affecting dental hygienists including, but not limited to, De Quervain's tenosynovitis, tension neck syndrome, thoracic outlet compression syndrome, lateral epicondylitis, trigger thumb, and pronator syndrome. Pain caused by occupation-related MSDs is a major contributing factor for sick leave, decreased work productivity, loss of earnings, reduction in working hours, and disability or early retirement.[5-13]

Ergonomic interventions to reduce the incidence of upper and lower body MSDs in oral health professionals identified in the literature include magnification loupes, lighter and round instrument handles, and ergonomic seating (e.g., saddle chairs).[8,17,24-31] However, early education on positioning is crucial, as MSDs may occur among dental hygiene students as a result of poor ergonomics while performing pre-clinical and clinical skills to successfully complete dental hygiene competencies required for graduation.[39] To minimize the risk of MSDs, emphasis must be placed on proper ergonomics as part of the dental hygiene curriculum and early in the career trajectory of dental hygienists.[5,8,9,12,13] Though equipment and technological interventions may benefit overall musculoskeletal health of dental hygienists, postural loads of static and awkward positions during dental hygiene care and variation of these postures may also contribute to increased MSD risk and discomfort and need to be addressed.[8-10,39]

Despite there being extensive research in other occupational settings of the ergonomic considerations of seated and standing postures,[32-38] there is limited research examining postural loads experienced by dental hygienists, including the impact of seated and standing postures during clinical care.[8-10,39] Studies of other professions have suggested the importance of varying posture throughout the workday to decrease muscular load which may contribute to MSDs.[32-38] Varying posture can be beneficial as assuming a static posture may increase MSD risk, although a specific length of time for risk increase has not been identified.[9-10,20,32] For example, in one study, sit–stand workstations available to office workers resulted in a significant decrease in MSD discomfort and injury among participants. Though these participants were not working in a clinical oral health care setting, the findings can be applicable to many professions, including dental hygiene, where a seated working posture is the norm.[34] Findings from studies of other professions may reveal important insights into postural impacts for dental hygienists. One study examining postural differences of dentists when delivering clinical care from either a static seated or static standing position found that participants' neck, shoulder, and back muscles held higher muscular loads in a seated posture compared to a standing posture.[10] Therefore, varying posture while working may reduce MSD risks due to different physical workload distribution in the body, especially among the upper extremities.[8,10,33-39]

Studies involving dental and dental hygiene student populations are rare; only 1 study was identified that examined the impact of posture during clinical care of clients on the risk of MSDs in dental hygiene students.[39] In that study, participants were randomly assigned to either a control group (seated posture) or treatment group (alternating seated and standing postures) and were scored with the Modified Dental Operator Posture Assessment Instrument (M-DOPAI) and Rapid Upper Limb Assessment (RULA). Participants also completed a questionnaire for self-reported pain levels assessed at baseline, week 4, and study conclusion (week 8). Results revealed no significant differences in posture scores, injury risks or pain scores at the 3 timepoints for the treatment group, and participants reported less pain over time in both groups via qualitative feedback. Therefore, researchers concluded that alternating postures resulted in minimal effects during dental hygiene care.[39] Although the participants in that study were instructed on alternating postures for delivering care,[39] most entry-level dental hygiene curricula include seated posture principles only, which continues into patient care after graduation. Some limitations to the study were lack of adherence to seated–standing protocols, lack of faculty training prior to incorporation in clinical courses, and physical limitations of the operatory.[39] More research is needed to assess MSD risk associated with postures among dental hygiene student populations. The purpose of this study was to determine and compare MSD risk during delivery of dental hygiene care from seated and standing positions by dental hygiene students who received seated posture training only in their school curriculum. This study gathered information on baseline postural loads and potential MSD risk associated with each posture for dental hygiene students to inform potential changes to dental hygiene curriculum.

METHODS

This study was approved by Old Dominion University's Institutional Review Board (#20-028) and informed consent was obtained from each participant. A convenience sample of 35 second-year dental hygiene students from an entry-level dental hygiene program was recruited via posted advertisements and a recruitment email for this study. The sample size was based on a power calculation (Effect size [Hedge's G] = 0.52, $\alpha = 0.05$, $1\text{-}\beta = 0.95$) from a similar study that assessed posture in dental hygiene students. A minimum of 15 participants per group was needed to achieve a 95% confidence interval and 94% power.[39]

This study sought to gather baseline information as a foundation for further investigations. To determine whether participants met inclusion criteria, a preliminary screening questionnaire was completed at the time of recruitment. Included participants were second-year dental hygiene students, generally healthy, and 18 years of age or older. 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 offered dental hygiene products as incentives for participation. At the time of recruitment, participants were informed data collection would occur during two 30-minute, on-campus sessions where they would instrument on a dental simulator (Kilgore International, Inc., Coldwater, MI). Two separate sessions were conducted 1 week apart to reduce the impact of fatigue on posture. Prior to data collection, participants did not receive ergonomic training beyond what was included in the entry-level dental hygiene curriculum (e.g., seated clock positions, ideal neutral postures, and neutral hand and wrist positioning) over 3 semesters in didactic, laboratory, and clinical settings for an average of 9 to 12 hours per week. Though these hours were not strictly centred around ergonomics, ergonomics were evaluated, and feedback provided as needed. At the time of the study, no instruction on standing postures was included in the curriculum at the institution and no training on standing postures was provided to students prior to data collection.

Instrument

The Rapid Upper Limb Assessment (RULA)[40] was used to evaluate the seated and standing postures of participants. The RULA is a valid and reliable research instrument for assessing individuals for upper extremity MSD risks and has been used in multiple oral health professional clinician studies.[8,9,17,39-41] The same 4 calibrated researchers used a RULA worksheet to score biomechanical and postural load on the neck, trunk, and upper extremities for each participant using images taken during the instrumentation sessions.[40] The worksheet consists of a 2-part scoring system: part A includes an arm and wrist analysis; part B includes a neck, trunk, and leg analysis. Scores from parts A and B are used to calculate a final RULA score ranging from 1 to 7. This score is used to determine the level of MSD risk and whether or not corrective action should be taken. Scores of 1 to 2 indicate "negligible risk and no action required", 3 to 4 indicate "low risk and change may be needed", 5 to 6 indicate "moderate risk and further investigation and change is needed soon", and a score higher than 6 indicates "very high risk and change is needed now".[40] Images taken of each participant were scored independently by 4 researchers and averaged to obtain an overall RULA posture score for each session (seated and standing). The average seated and standing posture scores for each participant were used for further data analyses.

Procedure

After giving informed consent, each participant was assigned a unique identifier to link data between sessions and was randomly assigned to start the testing procedure either standing or seated using a random assignment generator (www.random.org). Participants performed instrumentation in a simulated oral environment during 2 separate sessions (1 seated and 1 standing). Data were collected on different days to eliminate sequence bias and postural load impacts due to potential fatigue. Participants were permitted to use any instrument in the dental hygiene cassette, which included an ODU 11/12 explorer, anterior and posterior scalers, Gracey curettes, and universal curettes. This approach simulated a normal dental hygiene scaling appointment during which clinicians use a variety of instruments. Research has not indicated differences in posture based on instrument type at this time. Participants were instructed to use their preferred instrument(s) for the duration of each session, in any sequence, based on personal comfort. Participants had demonstrated competence in using the instruments in the previous academic year.

Participants were provided standardized instructions and began in the position that had been randomly assigned to them. Participants were allotted 5 minutes of instrumentation practice at the beginning of each session and were allowed to adjust the simulator, chair, and bracket table for instrumentation. Participants explored and scaled a simulated quadrant for 25 minutes after the practice time in each of the separate sessions (seated and standing). 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. This was critical for using the RULA tool to compare postural loads between seated and standing postures of each participant. Furthermore, it was critical for participants to act as their own controls because the RULA instrument is not designed to compare postures between people as individual differences may vary greatly and quadrants varied among participants.[40]

Participants were photographed twice during each session. These images allowed the researchers to score and assess participants the same way each time as is standard practice for assessment of posture using the RULA.[8,9,18]

Two images of the front and profile view were used in a previous study examining seated and standing postures in dental hygiene students, and this method was replicated in the current study.[39] Sample images are found in Figure 1. In each session, the first images were taken after the participant instrumented their assigned simulated quadrant and surface for 10 minutes, which allowed time to establish a comfortable working position. The second images were taken at the 20-minute mark. All images were assessed by the 4 researchers independently to ensure the images with the clearest views of seated and standing postural body positions were used for RULA scoring.

Prior to data collection, a calibration session was conducted to ensure appropriate camera use, proper location for producing clear images of the participants' postures, and to standardize researchers on RULA scoring. The same researcher took all images during each session from a predetermined location identified during pilot testing of the methods with 4 student participants. A training session on scoring seated and standing images using the RULA was conducted to calibrate the 4 researchers. Following standardization, researchers independently scored images of seated and standing postures and mean scores were used for data analyses.

Descriptive statistics (mean scores and frequencies) were used to analyze individual scores on the RULA. Additionally, paired sample t-tests were used to compare seated posture RULA scores to standing posture RULA scores in dental hygiene students trained in seated postures only. All data were analyzed using SPSS Version 24 (IBM; Armonk, NY, USA).

RESULTS

Thirty-five dental hygiene students completed both sessions of data collection, but only 97% (n = 34) of participant data was used in data analyses. One participant's images were excluded because body postures were obscured and could not be scored accurately with the RULA. All participants were second-year female dental hygiene students. Most participants were between 18 and 24 years old (n = 29, 85%) and reported always wearing dental magnification loupes while delivering hygiene care in clinical settings (n = 30, 88%). Demographic data are presented in Table 1.

Average scores for seated and standing postures for individual students are shown in Table 2. These scores were calculated from independent researcher scores (N = 4) that were then averaged to produce a final RULA score. Overall, no participant scores for seated or standing postures were in the acceptable/negligible risk RULA range of 1 to 2. In seated postures, scores ranged from 3.00 to 6.33. For standing postures the minimum score was 3.33 and the maximum was 6.75, also indicating that all participants' standing postures presented an increased risk for MSDs. Side-by-side comparisons of seated and standing RULA scores (Table 2) indicate more participants (n = 23, 68%) had worse postures while standing when compared to sitting during instrumentation. This finding is also evident when the average is compared for all participants; the mean seated RULA score for all participants was 3.91 ± 0.77 indicating "low risk and change may be needed". The mean standing RULA score for all participants was 4.50 ± 1.00 indicating a "moderate risk and change is needed soon". Results of paired sample t-tests revealed a

Figure 1. A) example of seated posture; B) example of standing posture

Table 1. Demographic data by number and percentage of participants (n = 34)

	Number	Percentage
Sex		
Male	0	0
Female	34	100
Prefer not to answer	0	0
Age (years)		
18 to 29	29	85.3
30 to 44	3	8.8
45 to 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 (during clinic)		
Yes, always	30	88
Yes, but only sometimes	0	0
No	4	12

statistically significant difference in average RULA scores for standing and seated postures, $t(33) = -3.467$, $p = 0.001$, 95% CI [−0.93, −0.24], with standing postures (4.50 ± 1.00) being significantly worse than seated postures (3.91 ± 0.77). However, the mean scores between postures differed by 0.59, which may have negligible clinical significance for dental hygienists.

DISCUSSION

Musculoskeletal disorders continue to be highly prevalent among dental hygienists, with several body regions being negatively affected.[5,7,8,10,24] Research involving other professionals, such as dentists, office workers, and postal workers, reveals that alternating seated and standing positions decreases overall static posture resulting in a decrease in reported pain or discomfort.[32-38] Research on alternating work positions in dental hygiene is limited. This study was, therefore, designed to gather pilot data on how seated or standing postures on their own may impact MSD risk as determined by the RULA in dental hygiene students who were trained in seated postures only.[25,26] All 34 (100%) participants had seated and standing postures that may benefit from ergonomic correction as indicated by the RULA.[40,41] While both postures were in the increased risk range, when postures were independently assessed, seated postures were more acceptable on average compared to standing postures, though the clinical significance of this may be minimal as neither posture was ideal.

Table 2. Mean values of seated and standing RULA scores by participant

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

Table 2 Key

3–4	Low risk: further investigation, change may be needed soon
5–6	Moderate risk: further investigation, change soon
7	High risk: investigate and implement change

Note: Because mean scores were determined by averaging the independent scoring of 4 researchers, scores were rounded up or down, as appropriate (e.g., a score of 4.2 would be included in the 3–4 range whereas a score of 4.7 would be included in the 5–6 range).

The RULA scores for seated postures ranged from 3.00 to 6.33, indicating the postures should be further investigated. The majority of participants (82.4%) fell within the RULA range indicating "low risk and a change may be needed soon"; fewer than one-quarter of the participants (17.6%) scored within the range of "moderate risk and a change is definitely needed soon" (Table 2).[40,41] The overall mean RULA score for seated postures for all participants suggested postural "changes may be needed"[41] because biomechanical demands and postural loads were outside the acceptable range. In other words, dental hygiene students' seated postures may put them at risk for the development of MSDs despite specific ergonomic instruction within their curriculum on the seated posture. It is possible that this risk could be mitigated by interventions and feedback.

Results from another study that collected photos over time in student clinician groups revealed that both faculty evaluations and students' self-assessments of posture during dental hygiene care could positively impact seated postures in student dental hygienists.[19] A previous study found that when faculty were able to give feedback and students were able to self-assess their seated postures repeatedly over time based on photographs, the students' ergonomic scores on the Modified Dental Operator Posture Assessment Instrument (M-DOPAI) improved. This finding suggests that education and/or training can improve postural behaviours while seated.[19]

Self-assessments of posture should be considered as additions to dental hygiene curriculum to encourage accurate self-perception of acceptable seated postures while delivering patient care to decrease the risk of MSDs. In the study participants' current program, faculty feedback on ergonomics and seated posture is commonly given in laboratory and clinical settings, but self-assessment has not yet been incorporated. It is possible that repeated self-assessments in addition to faculty feedback could improve ergonomic scores and reduce MSD risk.

Similar to the results for seated postures, standing posture results also suggested a significant MSD risk as determined by the RULA. As seen in Table 2, RULA scores indicated that standing posture "needs to be further investigated" and "postural change may be needed soon".[40,41] Therefore, participants had biomechanical and postural loads outside the range deemed acceptable for standing postures. Participants in 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. Without training, participants may not have been familiar with ergonomic adjustments to achieve acceptable postures while standing during simulated instrumentation. This finding indicates a need for possible ergonomic education in a standing position. It is possible faculty feedback and self-assessments identified in previous studies of dental hygiene students could be extended to standing postures as well.[19] However, acceptable standing postures are not commonly explored in dental hygiene curriculum and training. Although education and training in standing postures might result in different scores on the RULA and potential postural improvements in this position, seated postures, for which participants had been trained, had similarly concerning scores. Future studies should explore ergonomic instruction in standing positions and the effects on posture to quantify MSD risks of standing postures after training is provided.

When comparing the 2 postures, the mean seated RULA scores were significantly different from the mean standing RULA scores. Participants may have scored better on the RULA when a seated posture was adopted because ergonomic principles included in entry-level dental hygiene curriculum may have improved their understanding of neutral positions while seated. At the time of this study, participants practised exclusively in a seated position while supervised by faculty who offered feedback on ergonomics which could have raised the participants' awareness of seated ergonomic principles. Students may have been unable to apply the skills to standing postures while delivering patient care. Nevertheless, the differences between mean seated and standing scores may not be significant clinically. These results are similar to other studies on the posture of dental hygiene students, which found poor posture regardless of seated or standing position.[19,39] Though the RULA was not used in those studies, the assessments utilized, such as M-DOPAI and qualitative means, still identified poor postures in need of ergonomic improvement.[19,39] Because both postures in the current study put all participants at an increased risk for MSDs according to the RULA, ergonomic training or interventions should be explored to decrease postural loads during dental hygiene services to reduce MSD risks.

While research indicates advantages to alternating postures,[8,10,33-39] this pilot study examined seated and standing postures independently to assess postural impacts of each individually as well as compared to each other. It is possible that varying these postures throughout a clinical workday may have more ergonomic benefits that reduce MSD risk and pain. Varying postures throughout the workday could reduce biomechanical demands as each posture (seated and standing) has advantages and disadvantages. Future studies are required to test this hypothesis.

If just one posture is adopted for a full workday, the disadvantages associated with that posture may be exacerbated and result in negative impacts. Seated postures result in more loading of muscles and greater neck flexion to maintain an acceptable posture, making it difficult to use precise movements associated with dental hygiene practice.[11-13,19-21,30] However, standing postures can also lead to negative ergonomic impacts including greater upper arm flexion and more force on lower joints, which may have contributed to RULA scores in the current study's participants.[19] It is surmised that postural variation

throughout the workday may reduce risks associated with each posture by reducing the load on specific joints and muscles impacted by the postures individually. This assumption is supported by research in other workplace settings that utilize sit–stand workstations for postural variation.[32-38] Additionally, individual posture effects have been explored in dentistry during restorative work, and researchers have identified postural variation as a possible ergonomic benefit that should be further studied.[10]

Limitations

Several limitations may have influenced the findings in this study. This study used a simulated dental hygiene environment for a shorter duration than a typical patient care appointment. This duration may not have been long enough for postural impacts to be revealed or for participants' true postural preferences to be assessed. Another limitation was that participants were not provided with instruction on standing postures. Additionally, though participants did not know the exact type of assessment, they were aware that posture was being assessed and this knowledge could have impacted findings.

Future research

Future research should examine seated and standing postures during patient care for an entire workday to determine clinical implications. Future research should also explore the impacts of alternating positions and posture considerations for various regions of the mouth (i.e., seated or standing positions may be indicated for specific quadrants of the mouth). A randomized controlled trial should be conducted to examine the effects of ergonomic instruction in proper standing posture; lack of training most likely influenced standing posture results. Finally, future research should consider incorporating videorecordings of postures for further data analyses as indicated in previous literature as this may allow for multiple views for scoring with the RULA.[19,39]

CONCLUSION

Results of this study show that these dental hygiene students tended to have suboptimal standing and seated postures as indicated by RULA scores, which could potentially put them at risk for MSDs. However, seated postures resulted in lower risk scores when compared to standing postures. Additionally, the statistically significant differences between postures may have little clinical relevance as both postures were considered outside of the acceptable range according to the RULA tool. This pilot study provides baseline information on postural loads for static seated and standing postures in dental hygiene students. Future studies may evaluate the impact of using a combination of seated and standing postures when delivering dental hygiene care, or the benefits of different ergonomic interventions. A larger sample size of dental hygiene students could provide more information and insight into the ergonomic benefits of seated and standing postures and MSD risks over a full workday and under normal working conditions.

CONFLICTS OF INTEREST

The authors have declared no conflicts of interest.

REFERENCES

1. United States Department of Labor, Occupational Safety and Health Administration (OSHA). Ergonomics [Internet]. 2019 [cited 2019 Nov 15]. Available from: www.osha.gov/SLTC/ergonomics/index.html
2. Centers for Disease Control and Prevention, The National Institute for Occupational Safety and Health (NIOSH). Ergonomics and Musculoskeletal Disorders [Internet]. 2019 [cited 2019 Nov 15]. Available from: www.cdc.gov/niosh/topics/ergonomics/
3. ErgoPlus. The Definition and Causes of Musculoskeletal Disorders [Internet]. 2019 [cited 2020 Nov 15]. Available from: https://ergo-plus.com/musculoskeletal-disorders-msd/
4. Centers for Disease Control and Prevention. Musculoskeletal Health Program [Internet]. 2019 [cited 2020 Nov 15]. Available from: www.cdc.gov/niosh/programs/msd/description.html
5. Ng A, Hayes MJ, Polster A. Musculoskeletal disorders and working posture amount dental and oral health students. *Healthcare (Basel).* 2016;4(13):5–15.
6. Humann P, Rowe DJ. Relationship of musculoskeletal disorder pain to patterns of clinical care in California dental hygienists. *J Dent Hyg.* 2015;89(5):305–312.
7. Di Sio S, Traversini V, Rinaldo F, Colasanti V, Buomprisco B, Perri R, et al. Ergonomic risk and preventive measures of musculoskeletal disorders in the dentistry environment: an umbrella review. *PeerJ.* 2018;6(1):1–16.
8. McLaren W, Parrott L. Do dental students have acceptable working posture? *Br Dent J.* 2018;225(1):59–67.
9. Gandavadi A, Ramsay JRE, Burke FJT. Assessment of dental student posture in two seating conditions using RULA methodology—a pilot study. *Br Dent J.* 2007;203(7):601–605.
10. Pejcic N, Duric-Jovicic M, Milijkovic N, Popovi, DB, Petrovic V. Posture in dentists: Sitting vs. standing positions during dentistry work—an EMG study. *Srpski Arhiv Za Celokupno Lekarstvo.* 2016;144(3–4):181–87.
11. Lietz J, Kozak A, Nienhaus A. Prevalence and occupational risk factors of musculoskeletal diseases and pain among dental professionals in western countries: a systematic literature review and meta-analysis. *PLoS One.* 2018;13(12):1–26.
12. Warren N. Causes of musculoskeletal disorders in dental hygienists and dental hygiene students: a study of combined biomechanical and psychosocial risk factors. *Work.* 2010;35:441–54.
13. Botta AC, Presoto CD, Wajngarten D, Campos JA, Garcia PP. Perception of dental students on risk factors of musculoskeletal disorders. *Eur J Dent Educ.* 2018;22(4):209–214.
14. Howarth SJ, Grondin DE, La Delfa NJ, Cox J, Potvin JR. Working position influences the biomechanical demands on the lower back during dental hygiene. *Ergonomics.* 2016;59(4):545–55.

15. Barry RM, Spolarich AE, Weber M, Krause D, Woodall WD, Bailey JH. Impact of operator positioning on musculoskeletal disorders and work habits among Mississippi dental hygienists. *J Dent Hyg.* 2017;91(6):6–14.
16. Rafeemanesh E, Jafari Z, Kashani FO, Rahimpour F. A study on job postures and musculoskeletal illnesses in dentists. *Int J Occup Environ Med.* 2013;26(4):615–20.
17. Dable RA, Wasnik PB, Yeshwante BJ, Musani SI, Patil AK, Nagmode SN. Postural assessment of students evaluating the need of ergonomic seat and magnification in dentistry. *J Indian Prosthodont Soc.* 2014;14(1):51–58.
18. Kumar DK, Rathan N, Mohan S, Begum M, Prasad B, Prasad ERV. Exercise prescriptions to prevent musculoskeletal disorders in dentists. *J Clin Diagn Res.* 2014;8(7):13–16.
19. Partido B. Dental hygiene students' self-assessment of ergonomics utilizing photography. *J Dent Educ.* 2017;81(10):1194–1202.
20. Ohlendorf D, Erbe C, Nowak J, Hauck I, Hermanns I, Ditchen D, et al. Constrained posture in dentistry—a kinematic analysis of dentists. *BMC Musculoskelet Disord.* 2017;8(1):291–306.
21. La Delfa NJ, Grondin DE, Cox J, Potvin JR, Howarth SJ. The biomechanical demands of manual scaling on the shoulders & neck of dental hygienists. *Ergonomics.* 2016;60(1):127–37.
22. Harris ML, Sentner SM, Doucette HJ, Brillant MGS. Musculoskeletal disorders among dental hygienists in Canada. *Can J Dent Hyg.* 2020;54(2):61–67. PMID: 33240365; PMCID: PMC7668274.
23. Hayes MJ, Smith DR, Cockrell D. An international review of musculoskeletal disorders in the dental hygiene profession. *Int Dent J.* 2010;60(5):343–52.
24. Gaowgzeh RA, Chevidikunnan MF, Saif AA, El-Gendy S, Karrouf G, Senany SA. Prevalence of and risk factors for low back pain among dentists. *J Phys Ther Sci.* 2015;27(9):2803–2806.
25. Bowen DM, Pieren JA. *Darby and Walsh Dental hygiene: theory and practice*, 5th ed. Maryland Heights (MO): Elsevier; 2020. pp. 143–53.
26. Boyd LD, Mallonee LF, Wyche CJ. *Wilkins' Clinical practice of the dental hygienist,* 13th ed. Burlington (MA): Jones and Bartlett Learning; 2021. pp. 115–25.
27. Johnson CR, Kanji Z. The impact of occupation-related musculoskeletal disorders on dental hygienists. *Can J Dent Hyg.* 2016;50(2):72–79.
28. Sanders MA, Turcotte CM. Strategies to reduce work-related musculoskeletal disorders in dental hygienists: two case studies. *J Hand Ther.* 2002;15(4):363–74.
29. Ludwig EA, McCombs GB, Tolle SL, Russell DM. The effects of magnification loupes on dental hygienists' posture while exploring. *J Dent Hyg.* 2017;91(4):46–52.
30. Suedbeck JR, Tolle SL, McCombs G, Walker ML, Russell DM. Effects of instrument handle design on dental hygienists' forearm muscle activity during scaling. *J Dent Hyg.* 2017;91(3):47–54.
31. Dong H, Loomer P, Barr A, LaRoche C, Young E, Rempel D. The effect of tool handle shape on hand muscle load and pinch force in a simulated dental scaling task. *Appl Ergon.* 2006;38(5):525–31.
32. Karol S, Robertson MM. Implications of sit–stand workstations to counteract the adverse effects of sedentary work: a comprehensive review. *Work.* 2015;52(2):255–67.
33. Nerhood HL, Thompson SW. Adjustable sit–stand workstations in the office. *Proc Hum Factors Ergon Soc Annu Meet.* 1994;38(10):668–72.
34. Hedge A, Ray EJ. Effects of an electronic height-adjustable worksurface on computer worker musculoskeletal discomfort and productivity. *Proc Hum Factors Ergon Soc Annu Meet.* 2004;48(8):1091–1095.
35. Ognibene GT, Torres W, Eyben RV, Horst KC. Impact of a sit–stand workstation on chronic low back pain. *J Occup Med Environ Health.* 2016;58(3):287–93.
36. Husemann B, Von Mach CY, Borsotto D, Zepf KI, Scharnbacher J. Comparisons of musculoskeletal complaints and data entry between sitting and a sit–stand workstation paradigm. *Hum Factors.* 2009;51(3):310–20.
37. Straker L, Abbott RA, Heiden M, Mathiassen SE, Toomingas A. Sit–stand desks in call centres: associations of use and ergonomics awareness with sedentary behavior. *Appl Ergon.* 2013;44:517–22.
38. Karakolis T, Callaghan JP. The impact of sit–stand office workstations on worker discomfort and productivity: a review. *Appl Ergon.* 2014;45:799–806.
39. Partido B, Henderson R, Lally M. Impact of a seated–standing protocol on postures and pain among undergraduate dental hygiene students: a pilot study. *J Dent Hyg.* 2021;95(4):70–78.
40. ErgoPlus. Recommended Ergonomic Assessment Tools [Internet]. 2016 [cited 2020 Apr 30]. Available from: https://ergo-plus.com/ergonomic-assessment-tools/
41. McAtamney L, Corlett EN. RULA: a survey method for the investigation of work-related upper limb disorders. *J Applied Ergonomics.* 1993;24(2):91–99.